Proceedings of IAC in Budapest 2024

Budapest, Hungary

December 1 - 2, 2024

Global Education, Teaching and Learning (IAC-GETL)
Management, Economics, Business and Marketing (IAC-MEBM)
Engineering, Transport, IT and Artificial Intelligence (IAC-ETITAI)

ISBN 978-80-88203-40-7

Impressum

Title:

"Proceedings of IAC in Budapest 2024", ISBN 978-80-88203-40-7

December 2024 in Prague, *1st edition*

Publisher / Creator of publication / Copyright holder:

Czech Institute of Academic Education z.s.

Address of Publisher:

Vodnicka 309/20, 149 00 - Prague 4, Czech Republic

Email: info@conferences-scientific.cz

Web: www.conferences-scientific.cz

Technical editorial staff:

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Název:

"Proceedings of IAC in Budapest 2024", ISBN 978-80-88203-40-7

Prosinec 2024 v Praze, *První vydání*

Vydavatel / Tvůrce publikace / Nositel autorských práv:

Czech Institute of Academic Education z.s.

Adresa vydavatele:

Vodnická 309/20, 149 00 - Praha 4, Česká Republika

Email: info@conferences-scientific.cz

Web: www.conferences-scientific.cz

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ENGINEERING, TRANSPORT, IT AND AI

**Global Education, Teaching and Learning
(IAC-GETL)**

Combination of Soft Skills and Digital Technologies in Enhancing of Professional Competencies Among Teachers

Ainagul TAUTENBAYEVA[a*], Zhazira ZHAUYNSHIYEVA [b], Azhar ABDIMURAT [c]

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Abstract

The presented article describes the significance of integrating soft skills with digital technologies in the process of enhancing the professional skills of teachers. The purpose of the article is to identify the difficulties faced by teachers during the mixed use of information technologies and skills in the course of education. In the process of determining the possibilities of soft skills and information technologies in education process and in differentiating the difficulties faced by teachers, the tabular analysis method and methods of analysis and synthesis were used. Based on the review of researchers' works, issues that have a negative impact on quality of education such as inability of using active learning methods, conservatism, lack of the teacher's flexibility and rejection of new pedagogical technologies and absence of confidence were identified. In addition, the article suggested ways of effective usage of information technologies and soft skills in education.

Keywords: soft skills1, digital technologies2, teacher training3, teaching methods4

1. INTRODUCTION

The globalization of science and education, technological, economic, cultural changes taking place in the world were widely recognized in the education system of Kazakhstan. This means that the kind of education which was good for some years ago is not necessarily good enough for today and styles of teaching, quality of learning materials and organization of the universities and schools themselves have to be continuously brought up to date and improved. Since 2010, when Kazakhstan signed the Bologna declaration as a member of its process, a number of steps were taken to bring the national system of higher education of the Republic closer to the educational systems of the countries participating in the Bologna process. As a result, a number of changes took place in the national system of higher and secondary education of the Republic of Kazakhstan, where curriculum and teaching approaches had been also taken into consideration. In its turn, this new trend had a significant impact not only on the requirements for the professional skills of higher educational institutions and school teachers, as well as it affected to their personal qualities. The teachers had to comply with modern demands that include high level of professionalism and deep knowledge, awareness with current information technologies and soft skills acquaintance.

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Although, the term 'soft skills' is not a new concept in the world education system, and it has been successfully implemented in the educational process and intensively used by teachers throughout the world, it can be said that it is a new approach for teachers in Kazakhstan. Especially in the current era of globalization, teachers face difficulties in mastering soft skills while using information technologies in teaching process.

2. LITERATURE REVIEW

In recent years, the issue of teachers' soft skills development has been raised frequently in Kazakhstan and many studies are being conducted on this issue. Researchers give different descriptions of this term from different angles. It should be noted that all existing definitions of the concept are partially interrelated, and some of them are closely intertwined.The term "soft skills" is one of the trends in a dynamically changing world. However, despite its popularity, it hasn't got a universal understanding yet. According to the Oxford Dictionary, the soft skills are "personal qualities that enable to interact effectively and harmoniously with other people", in other words to master an effective communication skill. At the same time, the content side of the concept requires an integrative understanding of personal resource.

T. Tsquitaria explains soft skills as "human qualities, without which even the best professional will not be able to achieve a good result" [1]. L. Otarbaeva considers the development of soft skills within the framework of a competency-based approach and focuses on the fact that the competencies formed in students are an additional language of communication between the customer of specialists and the university, which undertakes the training of specialists with the qualities specified by the customer with the help of these competencies [2]. According to Antón-Sancho "soft skills" mean skills that allow people to find a common language with other people, establish and maintain connections with them, and be able to convey own thoughts [3]. Y. Portland, also defines "soft skills" as social skills that make it possible to establish interaction with different age categories of people [4]. A.I. Ivonina, O. L. Chulanova believe that "soft skills" should be considered as "soft competencies", which are characterized by development in professional activity and the presence of which causes "close attention of employers when hiring and when forming a competency model for specific positions" [5]. For O. Sosnitskaya, soft skills are communication and management talents, which, according to the author, include "the ability to persuade, lead, manage, make presentations, find the right approach to people, the ability to resolve conflict situations, public speaking" In other words, by these skills the author understands not the qualities and skills inherent in certain professions, but those that can be defined as universal [6]. According to researchers' descriptions it can be stated that "soft skills" can be unified skills and personal qualities that contribute to increasing the efficiency of work and interaction with other people, including among these skills personal development management, the ability to provide first aid, competent time management, persuasion, negotiation skills and leadership.

4. DISCUSSION

In 2016 at the World Economic Forum in Davos (Switzerland) the basic soft skills necessary for an individual in the 21st century for successful professional activities and everyday life were formulated. They represent a set of skills or competencies that could be called meta-subject or general for various types of activities, and include some characteristic features of cognitive and generally intellectual activity, emotional intelligence, managing one's own activities and constructive interaction with other people. In the transition from a resource economy to a knowledge economy, the personality of the teacher comes to the fore. Only with those teachers who are ready to develop and master so-called soft skills is it possible to build a progressive and competitive society. Consequently, the problem of developing both professional and non-professional skills of modern competitive teachers is strategically relevant and significant [5].

A.V. Gizatullina, O.V. Shatunova stress that a modern teacher should develop soft skills in addition to professional skills, and classify them into several groups as follows [7] :

Table 1. Skills

Soft skills	Content of advanced skills	Teacher's extra-professional skills	Competencies presented in the standard in the direction of "Pedagogical education"
1. Comprehensive multi-level problem solving	Independent identification of the problem and the entire complex of causes and sources that determine it; identifying and eliminating the cause of the situation, rather than	Comprehensive multi-level solution to pedagogical problems	To be able to determine the range of tasks within the framework of the set goal and choose the best ways to solve them, based on current legal

			norms, available resources and limitations
2. Critical thinking	Doubt about the reliability of all incoming information, existing rules, and even one's ideas about the world; choosing facts rather than information as the basis for decisions and actions	Critical thinking as a professionally oriented type of thinking that contributes to the productivity of teaching activities	To be able to search, critically analyze and synthesize information, apply a systematic approach to solve assigned problems
3. Creativity	A non-standard approach to thinking and behavior to everything, constant awareness and creative development of one's experience; innovation and modeling based on an integral approach and nonlinear solutions	Pedagogical creativity as the ability for creative search, non-standard solution of pedagogical problems, characterized by the criteria: speed (productivity) and flexibility of thought, originality, curiosity, accuracy and courage	
4. Collaboration	Building interaction with people at various levels from the exchange of information to the exchange of meanings; creation of a common field of activity for solving problems	Collaboration with others (colleagues, management, parents, students, external partners)	To be able to organize joint and individual educational activities of students, including those with special educational needs, in accordance with the requirements of federal state educational standards
5.Emotional intelligence	Recognizing emotions and understanding other people's intentions; managing your own emotions and states; influencing the emotions and state of others	Managing your own emotional state, influencing the emotions of students	To be able to carry out spiritual and moral education of students based on basic national values
6 Judgment and decision-making	Formation of your own opinion and courage in making independent decisions and their consequences	Judgment and decision-making in teaching activities	To be able to use psychological and pedagogical technologies in professional activities necessary for individualization of training, development, education, including students with special educational needs

Within the above mentioned skills the authors emphasis some of other skills that the teachers should master. One of them is skill of customer orientation, where a teacher develops interaction with others, paying attention on their values and needs, as well as carries out communication in oral and written forms in the state language. Negotiation skills are also crucial for teachers, where the teachers will be able to perceive the intercultural diversity of society in socio-historical, ethical and philosophical contexts. The skill of cognitive pedagogical flexibility impacts to the teacher's ability to interact with students within the framework of the implementation of educational programs. The next significant skill that tutors should master is self-management, which is considered as a multi-level process of self-organization and self-realization of personality. Every teacher should be able to manage his time, build and implement a trajectory of self-development based on the principles of lifelong education and to maintain proper level of physical fitness preparedness to ensure full-fledged social and professional activities.

For teachers, acquiring soft skills is crucial, particularly in order to improve the efficacy of their instructional strategies. The data, however, indicates that instructors' soft skills were still lacking [8]. The less successful learning management that instructors carry out frequently demonstrates the inadequate competency of the teachers' soft skills. Actually, students' learning outcomes will be more likely to be achieved when teachers use effective learning management techniques. Conversely, insufficient soft skill sets among instructors typically have a detrimental effect on the educational environment. As a result, this circumstance may eventually make it harder to meet the objectives of the school.

D Kalinin states that today teachers face with numbers of obstacles because of absence of necessary soft skills for conducting qualified lessons. They are low level of information culture by teachers, inability to organize effective interaction with students, inability of reorganization from traditional forms of education to new forms, inability of using active learning methods, conservatism, lack of the teacher's flexibility and rejection of new pedagogical technologies and absence of confidence, which causes low activity and the desire to avoid situations that can damage self-esteem [9].

In addition to the soft skills that every teacher should acquire, the most necessary skill according to current educational requirements is the high level of information technologies knowledge. It is known that today profound education is impossible without using information systems, because they allow a set of methodological, organizational, technical and software tools for the implementation and management of students' independent activities, regardless of their location.

In current education system, only a teacher who has acquired soft skills and information tools in equal basis can be successful and matches the educational goals, because it is known that the huge amount of information explosion flowing from the mass media day by day also affects to students' education, so soft skills are needed in the process of sorting them out and delivering to the student according to their need.

According to the researchers, in education, the teacher can use information technologies from the motivational, organizational and communicational view point. The motivational function is essential for teachers. It is associated with the capabilities of information and communication technologies to ensure comfort in learning, due to the accessibility and high speed of obtaining significant amounts of information. Positive motivation for independent activity among both students and teachers when using ICT is also created the variability of content and methods of teaching. The organizational function is related to ensuring the ability of the teacher to plan and manage students' independent activities. At the same time, management of the educational process becomes more flexible, based on the implementation of operational pedagogical correction and continuous, systematic and objective feedback. The communicative function of information and communication technologies is associated with providing the opportunity for a teacher, during network interaction, to briefly and clearly formulate own thoughts, be tolerant to the students' opinions, conduct a discussion, convincingly prove own point of view, as well as listen to the student's opinion on the network [7].

The integrated implementation of the above-described functions determines the variability of instructions for using information and communication technologies in organizing the educational process of students.

The main functions of using information and communication technologies can be highlighted as follows:

1. Joint project activities in various areas of knowledge of schoolchildren.
2. Distance learning in various target areas, various forms and types.
3. Working with electronic educational materials can be part of students' independent and classroom work.

Along with the advantages described above, the teachers also faces difficulties in the use of information technologies in the course of education. E Hodyrova differentiates them as organizational problems, technical problems and methodological problems.

The author describes the organizational problems faced by teachers when using ICT as follows:

- Lack of time and sufficient motivation of teachers for the development of educational programs based on information and communication technologies
- There is a need for teaching and auxiliary personnel, providing organization and control over technology.
- Inadequate moral and material stimulation of the teachers' activities for the implementation of ICT.

The technical problem can be attributed as:

- -Insufficient number of appropriately equipped classrooms and their weak technical equipment.
- Insufficiency of necessary funds, including unlimited Internet connection in classrooms, independent work halls, student dormitories.
- -Deficit of specialists in the field of information technologies capable of providing technical support for the organization of the educational process.
- Lack of technical capabilities to connect to some electronic educational resources.

Methodological problems include:

- Insufficient motivation of teachers in the use of potential information and communication technologies
- The necessity of appropriate correction of the methodical toolkit of students' mastery of educational courses.
- A small amount and low quality of ready-made educational materials for the organization of the educational process on the basis of ICT
- Absence of a multi-level system of advanced training for teachers who are ready to use information and communication technologies in the organization of the educational process.
- Low level of motivation among students to organize their own educational activities in an innovative mode, as many of them are oriented to traditional forms of education [10]. It should be noted that the low level of ICT proficiency of teachers also negatively affects the learning process

N.N. Krasovskaya, A.V. Ostap also note the following advantages of using ICT for teachers:

- ICT allows teacher to expand the possibilities of the educational process in terms of graphic and sound design: one can view multimedia lectures, participate in online conferences and seminars.
- ICT gives the opportunity to conduct virtual laboratory work, practical classes using training programs.
- It is convenient for the teacher to monitor the work of students: monitor attendance of school classes, analyze success of students, time spent on tasks.

Of course, learning with the use of ICT gives an opportunity to protect oneself (both students and teachers) from being infected with the virus in a pandemic situation.

As well as they do not deny problems in usage of software devices. First problem is a computer literacy for both teachers and students. Often there is a lack of necessary skills to work with educational portals, filling them with educational and methodological documentation and using it competently in order to improve their educational level.

Lack of necessary technical equipment in the workplace of both the student and the teacher, as well as the emergence of problems associated with the use of Internet resources also result in difficulties (it is not always possible to access the Internet).

Experience shows that there are problems of self-organization and self-discipline of students, reducing their motivation, inability adequately plan time for independent mastery of educational material and completion of assignments. Usually, teachers do not have the opportunity to carry out the current control over the work of students, hence there is no confidence in their independent completion of tasks [11].

To sum up the author's description, we would like to add to these problems the lack of face-to-face communication between teacher and student, where the student is able to discuss with the teacher questions or problems of interest to him. In addition, there are special disciplines that require exclusive face-to-face communication with a teacher (for example, classes in psychology, psychotherapy, etc.). Video conferencing only partially solves this problem. Only a teacher who has mastered skills like ethics, responsibility, patience, self-reliance, critical thinking, communication and tolerance will be able to give the right direction in the current flow of information.

4. CONCLUSION

Currently, there is a dynamic growth and development of knowledge in subject disciplines, in the field of modern methods of organization and information technologies in education, as well as in pedagogy and psychology. This trend will undoubtedly continue for the foreseeable future. In order not to find yourself hopelessly behind in the competitive struggle under these conditions, in addition to introducing promising means and methods of teaching technology, there is a need to bring the level of teacher training in line with the requirements of not even today, but tomorrow. Given the rate at which requirements change, faculty development must be a continuous and ongoing process. This is due to the constant updating of information training technologies. Accelerated progress in all areas of knowledge leads to the fact that a significant part of the information presented in current educational materials quickly loses its relevance and needs to be updated.

The advent of ICT to replace traditional methods of education certainly helps to enhance the effectiveness of the educational process. However, this does not mean that learning using ICT is guaranteed to be better and of higher quality. In our opinion, a fundamentally greater effect can be achieved with a reasonable combination of traditional (classroom) methods of teaching with classes using ICT. One also has to remember the need to mandatory include in the educational process training sessions organized on practical bases, classes with the participation of practitioners who is able to integrate soft skills as morality, accountability, tolerance, self-reliance, critical thinking, communication, cooperation with high level of ICT mastering. This integration of different forms of teaching contributes to the formation and development of professional competencies among specialists.

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Model of Organizing the Process of Distance Learning of Small Class School Teachers

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Abstract

The study is focused on the development and analysis of a distance learning model for teachers of small class schools (SCS). The first stage involved analyzing the practical needs and challenges faced by these teachers. The second stage adapted and tested the developed educational program based on the identified needs. The third stage included the implementation of the distance learning model on the Discord platform, incorporating peer-to-peer learning and mentorship elements. The research methodology combined online surveys, interviews, and analysis of participant activity in chat rooms, which allowed for a detailed assessment of the program's effectiveness and participant satisfaction. The results showed a high evaluation of the model's effectiveness: 84% of participants rated the program as highly effective, and 58% noted that the results exceeded their expectations. The support of the community and the opportunity for experience exchange were particularly valuable, helping to reduce the feeling of isolation among teachers and improving the practical application of developments in the educational environment. This study underscores the importance of adapting and implementing innovative educational methods that take into account the unique conditions of teachers in rural and small schools, providing them with the necessary resources and support for professional growth and enhancing the quality of education.

Keywords: small class school (SCS), distance learning, Internet platform, Discord, online learning

1. INTRODUCTION

According to UNESCO report, Kazakhstan has made major effort among all Central Asian republics to bridge the gap between urban and rural schools [1]. At the same time, the reports have shown that this is only the beginning of full-fledged development in this area. Despite the fact that within the framework of the state program "With a diploma - to the village! [2] there are significant bonuses for graduates of pedagogical universities, the majority of young teachers under 25 years of age prefer to work in the cities. During the last 5 years, this indicator is 9% of the total number. In rural areas during the same period the indicator has decreased from 8% to 7%.

In 2019, the "Rural school powered by NIS" program of the Fund for Sustainable Development of Education (FSDE) and Nazarbayev Intellectual Schools (NIS) started to operate, which was supplemented in 2022 by the program "Development of the potential of hub schools in rural areas" for hub schools, which covers 22 schools in 17 regions [3].

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The "Qazaqstan halkyna" Fund, the Fund for Sustainable Development of Education and NIS signed a Memorandum under which a grant of KZT 4.25 billion was allocated for the charitable educational Project on Developing the potential of hub schools in rural areas. This project is being implemented with the support of the Ministry of Education of the Republic of Kazakhstan and Y. Altynsarin National Academy of Education.

The main problem for rural SCS teachers, especially for young specialists, is still their qualification. The peculiarities of working in rural schools, such as physical isolation, technical inadequacy and lack of training materials, often make them unprepared for the realities of work. Additional difficulties are created by the presence of mixed-age classes, which aggravates the overall situation.

Although these problems can be solved theoretically through distance learning and support, in practice, the content of standard distance learning and professional development courses often does not meet the requirements and peculiarities of working at SCS. Also, the analysis of problems related to the professional competence of teachers of small class and hub schools using distance learning technologies does not meet modern requirements. These contradictions affect negatively the organization of the educational process in SCS and emphasize the need to create appropriate pedagogical conditions for effective professional education of future teachers. This, sets the task of training teachers capable of organizing a quality educational process and solving problems arising in the course of its implementation.

In this situation, the task of the research is to create a model of distance learning for teachers who will fully meet the requirements and challenges of teaching in small class schools. This model should take into account the peculiarities of working in such schools, including physical isolation, technical under-equipment, the presence of different-age classes and the lack of specialized educational materials.

In addition, the model has to use effectively available technology and software solutions to maximize access to quality education. This includes integrating platforms that support cross-platform and accessibility on both computers and mobile devices, as well as easy learning and usage, even for teachers with limited technological experience.

The model should also include specially customized training modules and courses that focus on the practical aspects of working in SCS, providing teachers with the necessary skills and knowledge to overcome the unique challenges of such schools. The main goal of the model is to provide teachers with the tools to create an educational environment promoting to active learning and development of students.

2. LITERATURE REVIEW

One of the problems is the heterogeneity in the choice of platforms for distance learning. The choice of Internet platform is crucial, as the quality and speed of the Internet connection can lead to certain risks. According to Lu Qingyi each school in Kazakhstan had chosen the Internet platform independently through which distance learning was organized in the context of the coronavirus pandemic. This choice was often made for subjective reasons of accessibility, ease of use, or in some cases on the recommendation of stakeholders. Parents and children were concerned about Internet connection and speed because Internet problems exist everywhere, both in urban and rural areas. The results of distance learning in Kazakhstan during this period have shown the lack of effectiveness of national telecommunication networks.

This has led to the fact that the used platforms vary considerably from one course to another, which means that in addition to transferring information and knowledge, teachers also need to master new tools. Also, a significant part of platforms do not have the necessary tools to solve actual distance learning problems, which leads to the use of several platforms for different purposes. Another problem is cross-platform - not all solutions are available both on computers and mobile devices, or have versions with limited functionality. In this regard, the authors consider it is necessary to use standard, publicly available, free, easy to learn and use, as well as cross-platform solutions [4].

According to Polish researchers, it is important to pay special attention to the issues and requirements for the educational process, including primary education, based on standards and rules of organization. In addition, in the distance mode one of the important components of the effectiveness of learning is the interpersonal contact between teacher and learner, which guarantees the perception of the content and quality of the educational process.

The use of interactive communication between teachers and students is becoming increasingly important in the distance learning process. Adjustment of educational programs in accordance with the needs of students and provision of intellectual resources, taking into account their preparedness, can improve the quality of education in the conditions of distance learning [5].

Several research works note the difficulties with the organization of online learning using webinar platforms, which, according to teachers, are primarily related to the limited technical capabilities of the Internet channel for mass use, the difficulty of control, the loss of attention of students, etc. [6].

Thus, distance learning can be carried out in synchronous and asynchronous mode, has its advantages and

disadvantages, contributes to the improvement of motivation, quality of knowledge and skills of learners, etc. However, it is necessary to determine the platform that will ensure accessibility for teachers and students of rural schools for productive and effective organization of the learning process in the distance format.

Thereby, we studied the literature and best distance learning practice, and as a result of our analysis we drew attention to the Discord platform used as an alternative to distance learning during the COVID-19 pandemic. The researchers found that Discord is an effective digital platform for online teaching and learning that creates a communicative and supportive learning environment for learners. The results of the observation also showed that online teaching using Discord application could successfully create a communicative digital learning environment that was interesting and enjoyable for students. The results of this study provide practical information for teachers and learners to assist them in online learning as the Discord application helps them experience new nuances of distance learning [7].

Other researchers, studying the historical background of the emergence and development of various distance learning platforms for organizing distance learning, compared Discord with other platforms such as MS Teams, Zoom US and Google Classroom and found that it is a cost-effective alternative that provides a high level of compatibility for both teachers and learners [8].

In one research work, the use of Discord at SCS for distance learning was highlighted as a means of creating a quality distance communication environment and confirmed the potential of Discord as an alternative online teaching platform that is not only effective, but also cost-effective. To this end, several English teachers who were teaching online on any of the above three platforms were asked to switch to Discord for a fixed period of time. Along the way, they received instruction and support from the research team regarding the platform and then were asked to participate in a survey. The paper notes that by using SPSS to analyze statistical data, Discord achieved a high level of compatibility for both parties, namely teachers and students. However, there is no specific mention of the organization of distance learning in small class schools on the Discord platform in the provided abstracts [9].

V. Kruglyak aimed at identifying the peculiarities of using the Discord platform as a means of creating a quality environment for remote communication. The authors present the results of the analysis of scientific developments of scientists in the issues of creation and use of distance learning tools, special attention is paid to the problems of distance learning and the structure of its functioning. The authors note that modern distance learning systems are not developed sufficiently for use in emergency situations. The main problem is the insufficient level of development in the field of creating communication channels of quality communication in the conditions of distance education, especially attention is emphasized on schools and other institutions of secondary education [10].

Indonesian researcher Barnad believes that distance learning is a variant of the learning process during the Covid-19 pandemic. The learning process implemented is basically the same as face-to-face learning, except for the change in the way the learning material is presented using information and communication technologies such as WhatsApp, e-mail, Zoom meetings or Google Meet. The study was conducted using a narrative research method based on a synthesis of student feedback on the implementation of distance learning conducted over two terms. The description in this paper aims to suggest alternative solutions to enhance the productivity of the distance learning process and the use of Discord software to support effective and efficient synchronous communication to achieve learning outcomes [11].

New research has drawn critical attention to the growing influence of digital platform architecture on learning across disciplines and contexts. In conjunction with such research, Bradley Robinson's study examines how the logic of social media platforms sets the stage for the emergence of new forms of literacy at the intersection of digital capitalism and expressions of literacy. Examining data collected at Giga-Games Camp (a pseudonym), a series of summer camps on video game design for teens, the author uses topological methodology to show how Giga-Games' interaction with Discord, a social network popular with gamers, fostered literacy. The author argues that uncovering the processes by which literacy becomes platformed in digital media environments can help educational researchers and practitioners better pay attention to the social, political, and economic underpinnings that shape learning and literacy in the platform era [12].

3. MATERIALS AND RESEARCH METHODS

The learning process in small class schools has its own characteristics and limitations that make most conventional distance learning resources useless. This is due to the general isolation, limited availability of technology and the unsuitability of a large number of standardized materials to meet the needs of small class schools. The organization of the educational process in such schools in distance learning has its own specifics, including the use of different technologies and tools.

Based on the results of qualitative and quantitative analysis, the authors of this paper have found that under these

conditions, some of the standard distance learning methodologies, such as videoconferencing or other video-based learning methods, as well as independent and individual learning, become less useful. As practice has shown, the creators of such materials have only a poor understanding of the peculiarities of working and teaching in small class schools, and their advice and recommendations have low practical impact.

At the same time, some other formats of training and professional development, such as mentoring, peer-to-peer learning, project work, have high practical value, but they are not involved practically in standard distance learning [13].

4. PARTICIPANTS

31 teachers from rural small class schools (SCS), of which 19 were male and 12 were female were invited to participate in this research. The age of the participants ranged from 27 to 48 years, with a mean age of 32.4 years. The teachers' work experience ranged from 4 to 25 years, with an average of 10.2 years. As part of our study, they participated in an online survey and an online interview. In addition, the teachers have participated in testing the implementation of an online community on the Discord platform for three weeks. This allowed for the collection of data on teachers' interactions and communication in a digital environment, as well as evaluating the effectiveness of this format for professional exchange and support.

Stage I. *Identification of needs and challenges of SCS teachers.*

In the first stage, a questionnaire called "Needs of SCS teachers" was developed. This instrument was created to collect data on the specific needs and challenges faced by teachers in small class schools. The questionnaire consists of 16 questions divided into four categories:

1. **Accessibility of distance learning materials.** In this category, questions seek to identify problems related to access to educational resources and technologies.

2. **Relevance of distance learning materials to the needs of the SCS.** Questions focus on how well current distance education materials meet the unique requirements and conditions of small class schools.

3. **Difficulties and challenges of working at SCS**. Questions in this category are designed to identify the main difficulties teachers face, such as teaching in multi-age classes, providing individualized attention in resource-limited settings, and keeping students motivated.

4. **Needs of SCS teachers.** This category aims to identify additional needs of teachers, such as professional development, psychological support, and ways to improve their professional performance in the unique context of SCS.

The survey was implemented using Google Forms, allowing participants to complete it at their convenience. The questions were designed to collect data as accurately as possible on specific aspects of teachers' work in small class schools. The format of the questions ranged from multiple choice to open-ended responses to allow for detailed descriptions of their experiences and opinions.

Stage II. *Designing and preparing a distance learning model for SCS teachers and selecting a platform for distance learning.*

Specialized teaching and learning materials for distance learning of these teachers were developed based on the results of the first stage of the study, which identified the specific complexities and challenges faced by teachers in small class schools (SCS). These materials were created taking into account identified needs and included the following resources:

- **Video and audio recordings:** Lectures, webinars and master classes designed to provide in-depth study of specific topics and methodologies relevant to working at SCS.

- **E-textbooks and tutorials:** Online tests and other interactive materials that facilitate self-study and knowledge testing.

- **Practical Assignments:** Tasks aimed at applying theoretical knowledge in practice, which is especially important for teachers working in multilevel and multidisciplinary SCS contexts.

- **Methodological recommendations and templates:** Leaflets and guidance documents that help teachers to organize the educational process and adapt teaching materials to the specific conditions and needs of their students.

Modern educational technologies were used in the preparation of these materials, which made the training not only more effective, but also interesting for teachers. These technologies provide interactive and multimedia learning, which increases significantly the level of teacher engagement and motivation.

Educational programs for distance learning were developed taking into account the unique characteristics of working at small class schools, such as small class sizes, a diverse student population of different ages, and the diversity of their educational needs. Special attention was paid to improving teachers' professional competence in the

use of information and communication technologies and distance technologies in the educational process. Education experts and teachers experienced in working in small class schools actively participated in the development of these programs, which ensured that the educational materials were realistic and practical.

Another key aspect was the selection of a suitable platform that would meet certain criteria necessary for the successful implementation of the educational process. One of the main requirements for the platform was its cross-platform nature, ensuring its availability on different devices and operating systems.

Discord was chosen as the main platform for distance learning after analyzing the advantages and disadvantages presented in Table 1:

Table 1. Advantages and disadvantages of Discord as a distance learning platform

Advantages	Disadvantages
Cross-platform: Discord is available on a multitude of devices, including desktops, laptops, tablets and smartphones running a variety of operating systems.	**Limited educational functionality:** Discord was originally developed not as an educational platform, but for gamers to communicate. This means that some necessary educational tools such as grading systems, logs, and specialized educational integrations are missing.
Voice and video communication: The platform provides opportunities for voice chats and video calls, which allows users to conduct classes in real time, organize individual and group consultations.	**Security and Privacy:** While there are security features, Discord may not be secure enough for use in a school environment.
Text Channels: Discord allows users to create text channels to communicate, post tutorials, assignments, announcements, and share files and other resources.	**Moderation issues:** Managing and controlling large groups on Discord can be challenging. Additional time and resources may be required to moderate adequately chats and ensure that a positive learning environment is maintained.
Collaboration features: The platform has collaboration tools, including file sharing and document editing capabilities that allow users to work together on projects or training materials.	**Interface and controls:** While Discord is fairly easy to learn for those who are used to gaming and social media, some users, especially those unfamiliar with such platforms, may find it difficult to navigate and use all the features.
Ease of use, which makes it quick and easy to set up for distance learning and makes it convenient for further use in pedagogical practice.	**Internet connection load:** Users need a stable and high-speed Internet connection to use effectively all Discord's features, such as video calls and voice communication, which may not be available in some locations, especially in remote or rural areas.
Security: Discord offers various security features that help protect educational participants from malicious content and unauthorized access, ensuring privacy and data security.	**Limit on number of participants:** The free version of Discord has limits on the number of participants in video conferencing, which can be a problem for large study groups.

The choice of Discord as a platform for distance learning for teachers in small class schools (SCS) was based on its wide range of features and ease of use, making it an ideal tool for creating an adaptive and engaging learning environment. The platform was used as a tool for professional education and professional development of SCS teachers, where the lack of integration with assessment systems or journals was not a problem due to the specificity of the tasks.

To ensure the safety of all participants, a cybersecurity awareness course was conducted to help raise awareness of potential threats and how to prevent them. This course also included an introduction to the functionality and interface of the platform, allowing participants to utilize effectively all of Discord's features for educational purposes.

Control over compliance with the rules of behavior on the platform was entrusted to the authors of our study, who acted as moderators. This ensured that order and academic discipline were maintained during all distance learning sessions. Each participant read and confirmed their agreement to the rules of conduct on the server before the course began, which contributed to a safe and respectful learning environment.

Stage III. *Implementation of the distance learning model for MKS teachers*

The implementation of the proposed model of distance learning for SCS teachers (Figure 1) was carried out in

stages using the Discord digital platform.

In **the first stage of the model implementation**, which was conducted over two months, March and April 2024, teachers of small class schools (SCS) were given access to a specially created channel with educational materials. These materials were developed on the basis of teachers' responses about the difficulties and peculiarities of working in SCS collected through a preliminary survey. The educational resources included 20 half-hour video lessons that covered various topics relevant to teachers of SCS. Examples of successful practices from global and national experience were also presented, as well as various training materials and manuals that contribute to improving the quality of education in small class schools.

During these two months, online Q-A sessions were held every Saturday, where teachers could communicate directly with the authors of the study and other teachers of SCS. These sessions were aimed at discussing issues that arose and integrating teachers' suggestions into further work on the teaching materials. This approach allowed not only to promptly respond to the needs of the program participants, but also contributed to the creation of a more holistic and adapted educational environment that meets the specifics of work in the SCS.

Fig. 1. Model of organizing the process of distance learning for SCS teachers

At the second stage of implementation of the model, which lasted three weeks and was carried out in May 2024, teachers of small class schools (SCS) received access to a common chat room. This platform provided them with the opportunity to communicate with each other in both text and voice formats. This was aimed at sharing knowledge and experience, as well as supporting each other in learning and professional development.

In the first week each teacher was required to write a brief description of their day in the general chat, including achievements and difficulties they encountered in order to encourage active communication and strengthen connections between participants. This activity helped teachers get to know each other better and understand the common challenges they face in their work.

After the first week, the requirement to be active in the main chat was removed and teachers were given the opportunity to create their own private text and voice chats. This allowed them to form smaller interest groups where they could discuss more specialized topics and develop professional connections on a deeper level. Thus, the platform facilitated the creation of a community of practicing educators who could collaborate and help each other within the framework of their professional interests and needs.

The third stage of implementation of the model was devoted to the introduction of mentoring tools, which was a key part of the process of professional training and development of teachers of small class schools (SCS). As part of this stage, a conditional division was made into individual mentoring and group mentoring, which made it possible to organize the transfer of experience more flexibly and purposefully.

According to the plan, private chats created as interest groups in the previous stage were often transformed into mentoring chats. In these groups, one or two more experienced SCS teachers acted as mentors, providing support and advice to less experienced colleagues. This allowed participants to explore specific areas of interest in greater depth, as well as develop important professional skills through dialogue and hands-on interaction.

At the end of the three-week test period, interviews were conducted with both mentors and mentees. These

interviews are aimed at assessing the effectiveness of mentoring interactions. The main focus was on identifying how participation in mentoring chats influenced teachers' professional development, their satisfaction with the process, and their ability to adapt to the challenges and working conditions at the SCS. These interviews helped to gather valuable feedback that will be used to further improve the distance learning program and support teachers in small class schools.

5. RESEARCH RESULTS AND DISCUSSION

Within the 1st stage of the research, the following results were obtained regarding the accessibility and effectiveness of distance learning, as well as its practical application by teachers of small class schools (SCS).

The availability of distance education was confirmed by 92% of participants, indicating stable access to the Internet both at home and at work. This highlights the successful implementation of technology in the educational sector. About 86% of teachers had completed distance learning programs in the past six months, with 62% participating in such programs at the time of the survey. The quality of available educational materials was rated as high or very high by 65% of respondents.

However, only 43% of participants noted the usefulness of the latest courses for their practice at the SCS, and only 25% implemented most of the recommendations in their practice. Among the main reasons for the insufficient applicability of materials, participants indicated technological backwardness and difficulties in mastering the necessary recommendations for real learning conditions in small class schools.

Among the main difficulties faced by teachers in small schools were overwork and difficulties with time management, the need to adapt and develop unique educational programs, as well as physical distance and associated psychological stress. Participants also expressed a desire to improve opportunities to network and share experiences with colleagues who understand the unique challenges of teaching at SCS. Reducing physical isolation and the need to introduce inappropriate innovations were also identified as priority areas for improvement.

Thus, the results of the study highlight significant progress in the availability and quality of distance education for small class school teachers in Kazakhstan, but also point to a number of problems that require further attention and solutions as part of the adaptation of educational programs and practices.

At the second stage of the research, the results and responses of the participants were analyzed, which led to the necessary adjustments being made to the distance learning model. The updated model consists of 80 academic hours in an online format. To adapt the model of distance learning for teachers of small class schools (SCS) to the specific challenges of rural schools, the **following adjustments** were offered:

• Provide content in formats that can be viewed offline, such as downloadable videos, interactive PDFs, and hard copies.

• Inclusion in the program of courses aimed at specific skills necessary for work in a small class schools, for example, teaching methods in multi-age classes.

• Organization of practical webinars and master classes demonstrating successful practices and technologies that can be applied in rural SCS.

• Ensuring access to ongoing technical support and consulting services to resolve emerging issues.

• Adopting a modular course structure (and credit system) that allows teachers to select only those modules that are most relevant to their current needs.

• Introducing a flexible training schedule, allowing teachers to undergo training at a time convenient for them, taking into account their workload and work responsibilities.

• Inclusion in teaching materials of examples and cases specific to rural and small class schools so that the teacher can easily adapt the acquired knowledge to his/her work context.

• Conducting trainings on adapting general education programs to the specifics of rural small class schools.

• Ensuring that all learning technologies are compatible with the basic equipment of rural schools.

• Train teachers to work effectively with limited technological resources.

The implementation of this distance learning model made it possible to increase significantly the level of professional competence of small class school teachers and their readiness to use distance technologies in the educational process, which contributed to improving the quality of education in small class schools. The proposed model has become an effective tool for improving the professional competence of SCS teachers, allowing them to acquire the necessary knowledge and skills in the field of using ICT in the educational process, regardless of their place of residence and level of training.

The effectiveness of the model is evidenced by the following indicators:

• 92% of teachers highly rated the tested model.

• The implementation rate of recommendations in practice increased from 25% to 67%, indicating a significant improvement in the applicability of acquired knowledge.

Experience has shown that the proposed model can be adapted to specific conditions and needs. It is necessary to develop uniform standards that will take into account the specifics of work in small class schools and organize methodological support for teachers in matters of distance learning in order to develop further and improve distance learning for small school teachers.

The results of **the third stage of the research** demonstrated the high effectiveness of the peer-to-peer learning model, which combines elements of exchange of experience and knowledge with mentoring tools. This approach was considered successful by all participants. Among them, 84% (26 of 31) rated the results as "high" or "very good," and 58% (18 of 31) mentioned that the results exceeded their expectations.

An interesting aspect regarding the age of the participants showed that younger teachers preferred text chats, while older colleagues preferred voice chats. In the mentoring process, the same participant could act as both a "student" and a "mentor." Young teachers often shared knowledge on the use and adaptation of information and communication technologies, while experienced teachers helped with techniques for working in complex classes and adapting curricula.

Participants noted the significant psychological support that chat rooms provided. For example, participant №9 said: "This chat serves as psychological support for me. This is the first thing I open when I come home after a hard day. The feeling that you are not alone, that somewhere out there are people like you who are facing the same problems... helps you not to give up."

The chats provided not only a source of materials and experiences for self-study, but also a place to discuss difficult cases, which improved the teaching practice of the participants. Participant №12 noted the moment when he was helped in solving a complex problem thanks to tips from the chat: "And after half an hour they wrote me several options, after reading one of which I thought, 'Well, how did I not think of this before...'"

It is important to note that after the experiment was completed, the majority of participants (26 out of 31) remained in the chat and even invited new participants. At the time of writing, the number of members on the server has increased to 44, which indicates the creation of a sustainable and valuable community for teachers of SCS.

6. CONCLUSION

Several important conclusions can be drawn on the implementation and analysis of the effectiveness of the distance learning model for teachers of small class schools (SCS). The use of a model based on a combination of peer-to-peer training and mentoring tools has shown a high degree of effectiveness. This is confirmed not only by quantitative indicators of participant satisfaction and the success of implementing recommendations into practice, but also by qualitative feedback on the importance of community support and the opportunity to exchange experiences.

The study emphasized the importance of creating an adaptive and engaging educational environment that is able to take into account the specifics and needs of teachers at small class schools. Teachers not only increased their professional competence, but also found real support and understanding among colleagues who faced similar challenges through active participation in specialized chats.

This study also showed that the successful implementation of distance technologies requires not only technical solutions, but also the creation of conditions for constant professional communication and mentoring, which becomes especially relevant in conditions of geographical and professional isolation of teachers in small class schools.

The end result was the formation of a sustainable and expanding community of teachers that continues to function and develop after the end of the formal experiment. The experience gained from this study can serve as a basis for the development of new distance learning and professional development strategies that will be focused on meeting the needs of teachers not only in Kazakhstan, but also in other countries with similar educational contexts.

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The Influence of Parent-Child Alignment and Parental Overestimation of STEM Occupational Expectations on Children's Math Achievement: A Study across 15 Countries

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Abstract

Research has shown that the influence of parents' expectations on children's achievements also depends on the expectations of the children themselves, though studies in that regard are limited. Based on this, this study examined how different combinations of parent-child occupational expectations—alignment and overestimation—in science, technology, engineering, and mathematics (STEM) influence the achievements of children in math across 15 countries. The study utilised data from the 2015 round of the Programme for International Student Assessment. Based on proportions, the study found that parent-child alignment in expectations ranges from 54% to 77%, with the highest found in four Western European countries. The proportions of parental overestimations ranged from 6% to 39%, with the highest found in East Asian and Latin American countries. Aligned expectations were found to increase the achievements of children in only seven countries, whereas overestimated expectations increased achievements in nine countries. The study concludes with a recommendation for further research regarding the influence of aligned and overestimated STEM expectations on achievements in a domain less related to STEM, to help clarify whether alignment and overestimation of parental expectations are driven by children's performance in mathematics specifically or if similar patterns are observed across other academic domains.

Keyword: occupational expectations; alignment; congruence; achievement.

1.   INTRODUCTION

Expectations are individuals' subjective probabilities that they will attain some outcomes (Dominitz & Manski, 1997). For adolescents' and their parents, these outcomes can be educational—such as college attendance (Kim et al., 2019; Reynolds & Pemberton, 2001)—and careers (Oliveira et al., 2020). As important sociocognitive variables, the educational and occupational expectations of adolescents and their parents influence several other outcomes, including educational and occupational attainments as well as academic performance (Kim et al., 2019; Lai et al., 2022; Lu et al., 2021; Marsh et al. 2023). These impacts of expectations on achievement-related outcomes have been established in both cross-sectional and longitudinal studies, where critical variables that affect achievement outcomes are controlled for (Pinquart & Ebeling, 2020), adding credence to the suggestion that expectations rank high among the strongest determinants of educational outcomes (Jacob & Wilder, 2010). The expectations of parents affect educational and occupational outcomes in children because they motivate children to learn, leading to higher achievements (Buchmann et al., 2022).

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Research has shown that the expectations of children are influenced by the expectations of their parents (Marcenaro-Gutierrez & Lopez-Agudo, 2017; Rimkute et al., 2012). The relationship between the expectations of parents and their children is also regarded as bidirectional or transactional. That is, the expectations of parents influence the expectations of children, and the expectations of children in turn influence the expectations of parents, as a result of the shared context and ongoing interactions between the two (Buchmann et al., 2022). Because of the interdependence of parental and child expectations, studies are increasingly examining the congruence (alignment) and discrepancies that exist between the two. This emphasis on concordance and discrepancies in expectations is a significant research endeavour, given that biases, overestimations, mismatches, alignments, etc. in parental and child's expectations may have different impacts on children's psychological and achievement-related outcomes. For example, higher parental expectations can result in heightened academic pressure for some students (Buchmann et al., 2022). For some students' this may result in negative consequences on their physical and mental health (Hystad et al., 2009), subjective wellbeing (Lu et al., 2021), decreased academic achievement and attainment (Murayama et al., 2016; Schoon & Burger, 2022), and poor engagement with learning (Song et al., 2024). Thus, different combinations of parent and child expectations may produce different learning outcomes for the child. This raises questions regarding the linear effects of expectations' on children's achievement-related outcomes and whether high expectations are a good thing after all (Marsh et al., 2023). Understanding alignments and discrepancies in expectations and aspirations[1] is thus critical, as parents' and adolescents' aspirations and expectations can play joint roles in determining children's career trajectories (Lee et al., 2022). There are, however, few studies that investigate the alignment of parental and child expectations (Schoon & Burger, 2022). This study expands on previous research by investigating the alignment and overestimation of parental occupational expectations with respect to their children's in science, technology, engineering, and mathematics (STEM) across 15 countries, as well as their impacts on children's math achievement. The alignment, overestimations, and discrepancies between parental and child occupational expectations, particularly in STEM and from a comparative perspective, are rarely examined in research. Using data from 15 countries from the 2015 wave of the Programme for International Student Assessment (PISA), the study contributes to closing this knowledge gap.

1.1. Parent-child educational and occupational alignments and discrepancies: conceptualisations in the literature

Different interchangeable terminologies are used to describe the degree to which parents' and children's expectations are the same, including congruence, concordance, alignment, misalignment, discrepancies, and mismatch, among others (Chavira et al., 2016; de Boer & van der Werf, 2015; Khattab, 2014; Rutherford, 2015; Schoon & Burger, 2022; Song et al., 2024)—in this study, we use this terms interchangeably. Expectations discrepancy, for example, has been characterised as the mismatch between the expectations of a parent and that of a child (Rutherford, 2015). The degree of alignments or misalignments between parental and children's expectations may differ from context to context; they may also be driven by factors unique to individual contexts. For example, a qualitative study of rural students in China found that children were emphatic about their duty to realise their parents' aspirations or to avoid disappointing them (Chen et al., 2023). This strong parental influence may be linked to East Asian cultural values, which emphasise "intergenerational interdependence and parental authority," where "filial piety socializes children to prioritise their parents' expectations" (Lee & Kang, 2018, pp. 3673–3674). This may therefore contribute to greater alignments between the expectations of parents and children in statistical analysis in such contexts.

How the terminologies are defined or measured varies from study to study—in most cases, it is based on the objectives of the studies (Schoon & Burger, 2022). de Boer and van der Werf (2015), for example, used data from students' talents and achievements, as well as parents' educational aspirations, to determine misalignment in aspirations. From this, they defined misalignment in aspirations as the difference between parents' educational aspirations (the level of education indicated by parents) and the level of education that children's talents and achievements qualify them for. They assigned values to levels of education and used the difference between parents' aspirations and the level of education suitable for the child, given their academic capabilities, to determine alignment in aspirations. They interpreted a positive score of one (1) as a misalignment of aspirations—that is, the parent's aspirations are higher than the capabilities of the child. Negative scores meant that parents' aspirations were lower than the capabilities of children. Finally, a score of zero signified realistic aspiration—this can also be considered aligned, congruent, and matched aspirations, among others. Lv et al. (2018) measured the educational aspirations of mothers and children using the same scale (a 5-point response scale). They identified different types of discrepancies

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[1] The study draws on the literature related to both expectations and aspirations, while acknowledging the subtle cognitive and conceptual differences between them (Bohon et al., 2006; Khattab, 2015).

in aspirations by comparing the ratings of mothers and children. Their focus was on whether there was a match between the aspirations of a given parent and child. They derived three categories from their data: mother's aspirations equal to the child's aspirations, mother's aspirations less than the child's aspirations, and mother's aspirations greater than the child's aspirations. Song et al. (2024) also measured the expectations of parents and children with the same rating scale. From their data, they considered expectations discrepant if the difference between the scores of parents and children exceeded half a standard deviation of the difference scores.

1.2. The current study

The current study investigates the alignment or discrepancies between parents' STEM occupational expectations for children and the expectations that children have for themselves in 15 countries representing different sociocultural contexts. It does take a comparative perspective, as it aims to understand how these alignments and discrepancies vary across countries. The study determines the alignments and discrepancies using a categorical variable, STEM occupational expectation (STEM vs. non-STEM). As a result, it differs from previous studies that measured expectations or aspirations on scales. The study also examines the influence of aligned and discrepant expectations on students' achievements in mathematics. It specifically determines four types of alignments and discrepancies:

1. Aligned (congruent/concordant) expectations within each country—when parents expectations in STEM correctly aligns with children's in each country,

2. Overestimation of expectations—when parents expect children to pursue STEM occupations whereas children themselves are not interested in pursuing STEM (this may be an indication that parents overestimate children's interest in STEM or have unrealistic or overly ambitious expectations),

3. Underestimation of expectations—when children expect STEM careers whereas parents do not expect them to have STEM careers, and

4. Discrepancy (misalignment/non-alignment) in expectations—discrepancy between what parents' expect of children and what children themselves expect (this includes overestimation and underestimation of expectations).

2. METHODS

2.1. Data and participants

The study used parents' and children's data for 15 countries from the 2015 PISA wave. The data is publicly available at the OECD (n.d.). The PISA 2015 round of surveys included over 70 countries. However, only 18 countries administered the parent questionnaire. We examined 15 of the countries with sufficient data in this study. This included the United Kingdom, France, Korea, Mexico, Hong Kong, Georgia, Malta, Macao, Portugal, Croatia, Germany, Luxembourg, Chile, Spain, and the Dominican Republic. The excluded countries were Belgium, Italy, and Ireland.

The STEM expectations of parents (STEM vs. non-STEM). This was based on the following question from the parental questionnaire: *Do you expect your child will go into a < science-related career>?* The responses to this question were "Yes" and "No". In this study, "Yes" was assigned STEM (1) and "No", non-STEM (0).

The STEM expectations of children (STEM vs. non-STEM). In the student questionnaire, there was an open-ended question measuring students' occupational expectations. The question was: *What kind of job do you expect to have when you are about 30 years old*? The expectations of students was derived from their responses to this question. It should be noted that the occupations of students were coded in the PISA survey based on the International Standard Classification of Occupations coding scheme. The three major occupations that are considered STEM within this scheme by the International Labour Organisation (ILO) are science and engineering, health, and information and communications technology. All STEM occupations in this study were recoded to STEM (1) while other occupations were recoded to non-STEM (0).

2.2. Analysis

All analyses were conducted using the student weights (W_FSTUWT) provided in the dataset. All analyses were also conducted in the R programming environment using base R functions and the *dplyr* package (Wickham et al., 2023).

To facilitate the analysis, three new variables were created by comparing the codes for the expectations of parents (1 and 0) with those of children (1 and 0). One of the variables was labelled *aligned expectations*. For the column containing this variable, 1 was entered when a parent and their child each have STEM expectations. Zero (0) was entered when a parent and child do not share the same (STEM) expectations. The next variable was *overestimated expectations*. In the column for *overestimated expectations*, 1 was entered when a parent's response was 1 and the child's was 0. The third variable was *underestimated expectations*. In the *underestimated expectations* column, 1 was entered when the parent's response was 0, whereas the child's was 1. These three new variables were essentially categorical, having values of 1 and 0.

Aligned (congruent/concordant) expectations: This was calculated as a proportion for each country (the same was done for the other variables):

(1)

$$\textit{Proportion of aligned expectations} = \frac{\textit{Sum of weighted aligned expectations}}{\textit{Total sample weight}} \; x \; 100$$

Overestimation of expectations:

(2)

$$\textit{Proportion of overestimated expectations} = \frac{\textit{Sum of weighted overestimated expectations}}{\textit{Total sample weight}} \; x \; 100$$

Underestimation of expectations:

(3)

$$\textit{Proportion of underestimated expectations} = \frac{\textit{Sum of weighted underestimated expectations}}{\textit{Total sample weight}} \; x \; 100$$

Discrepancy in expectations:

(4)

$$\textit{Discrepancy in expectations} = \frac{\textit{Total sample weight} - \textit{Sum of weighted aligned expectations}}{\textit{Total sample weight}} \; x \; 100$$

2.2.1.   Effects of alignments and discrepancies in expectations on children's achievements in mathematics

Regression analysis was conducted to determine the effects of aligned and overestimated expectations on children's performance in mathematics while controlling for children's gender and parents' reported socioeconomic status. Discrepancy (misaligned) expectations were not included in the regression model because they were derived from both overestimated and underestimated expectations. Underestimated expectations were not included in the regression model because, as would be shown in the results, there were very few observations for this variable in all countries. Achievements in mathematics consisted of 10 plausible values, as a result, 10 different regression analyses were performed, and the average was presented as the result.

3. RESULTS

The results in Table 1 below shows the proportions (percentages) of the four aligned and discrepant STEM occupational expectations for the 15 countries.

Table 1. The proportions (percentages) of aligned and discrepant STEM occupational expectations for 15 countries.

Country	Proportions of aligned expectations	Proportions of overestimated expectations	Proportions of underestimated expectations	Proportions of discrepancies in expectations
Chile	61.60%	21.00%	17.46%	38.40%
Croatia	69.30%	16.50%	14.19%	30.70%
Dominican Rep.	55.20%	32.90%	11.93%	44.80%
France	77.10%	13.60%	9.35%	22.90%
Georgia	66.00%	24.90%	19.58%	34.00%
Germany	74.20%	6.20%	9.20%	25.80%
Hong Kong	58.90%	30.60%	10.53%	41.10%
Korea	66.80%	22.60%	10.60%	33.20%
Luxembourg	69.70%	12.60%	17.75%	30.30%
Macao	54.20%	38.80%	6.98%	45.80%
Malta	73.50%	13.90%	12.56%	26.50%
Mexico	57.50%	33.10%	9.38%	42.50%
Portugal	65.20%	26.40%	8.34%	34.80%
Spain	69.60%	22.30%	8.08%	30.40%
United Kingdom	73.90%	16.80%	9.24%	26.10%

For easier comparison of the proportions across countries, the proportions are further presented in graphs in Figures 1 and 2. Overall, the results show a relatively high degree of alignment between parental and children's expectations in most countries. The proportions of alignment exceed 70% in about four countries (France [77%], Germany [74%], the United Kingdom [74%], and Malta [74%]). The lowest proportions of alignments are observed in Macao, the Dominican Republic, and Mexico. Discrepancy in expectations is essentially the difference between aligned expectations and total expectations; as a result, countries with the highest alignments in expectations are those with the least discrepancies in expectations, and vice versa. Thus, the countries with the largest proportions of discrepancies are Macao (45%), the Dominican Republic (45%), and Mexico (43%). The countries with the lowest discrepancies in expectations are (23%), Germany (26%), the United Kingdom (27%), and Malta (27%).
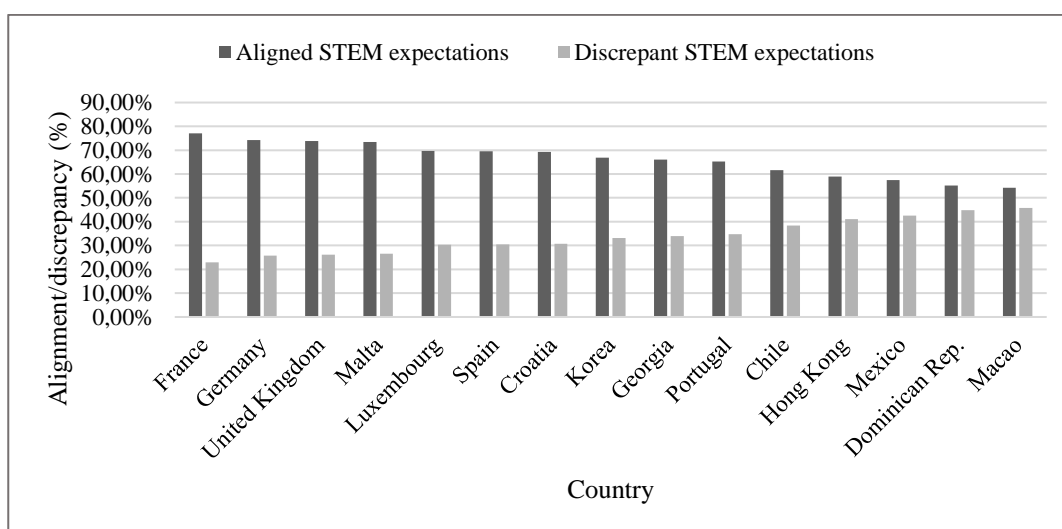
Fig. 1. Proportions of alignment/discrepancies in STEM occupational expectations for 15 countries.

The proportions of overestimated STEM occupational expectations are largest in Macao (39%), Mexico (33%), the Dominican Republic (33%), and Hong Kong (31%). The countries where parents' have the least tendency to overestimate their expectations for children are Germany (6%), Luxembourg (13%), France (14%), and Malta (14%). For underestimation of expectations, the highest proportions are observed in Georgia (20%), Luxembourg (18%), and Chile (17%). In six countries, the proportions of underestimated STEM expectations are less than 10% (Macao, Portugal, Korea, etc.). Only in Germany and Luxembourg do more parents underestimate rather than overestimate their children's STEM occupational expectations. Overall, Macao in particular and the other countries that have more parents overestimating their expectations tend to have the highest proportions of discrepancies between parental and children's STEM expectations.
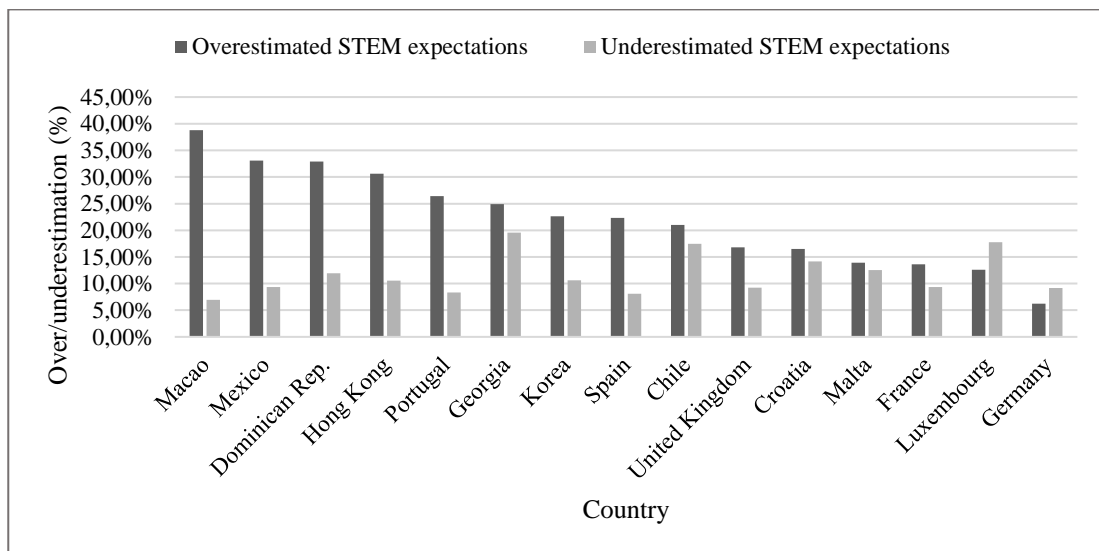
Fig. 2. Proportions of overestimations/underestimations in STEM occupational expectations for 15 countries.

3.1. Impact of aligned/discrepant STEM expectations on children's achievements in mathematics

Table 2 details the regression analysis results for predictor variables affecting students' mathematics performance. Figures 3 and 4 visually represent the coefficients for the key variables (aligned and overestimated expectations) across countries for easier comparison. Gender and socioeconomic status were included in the analysis as control variables and are therefore less emphasised compared to the primary variables of interest. However, generally, gender had relatively small and mixed effects (both positive and negative) on achievements across countries. In contrast, socioeconomic status showed strong positive effects on students' performance across all countries.

Table 2. Regression analysis coefficients and standard errors of predictors on students' achievements in mathematics.

Country	Intercept	Gender of child (Male) Estimate (Std. Error)	Overestimation of STEM expectations Estimate (Std. Error)	Aligned STEM expectations Estimate (Std. Error)	Socioeconomic status (high income) Estimate (Std. Error)
Chile	393.25	17.38*** (2.13)	-8.39* (3.52)	0.43 (2.89)	72.88** (2.21)
Germany	501.87	18.84*** (3.49)	6.02 (7.95)	-18.31*** (4.42)	58.8*** (3.55)
Dominican Republic	337.62	-5.39 (2.17)	-18.6*** (3.68)	-5.98 (3.47)	55.9*** (2.77)
Spain	468.9	17.02*** (2.5)	14.49** (5.17)	6.86 (4.71)	45.47*** (2.69)
France	451.89	5.59* (2.54)	53.34*** (5.39)	18.28*** (4.4)	63.83*** (2.57)
United Kingdom	458.86	8.75 (4.86)	43.21*** (9.9)	*15.75 (8.45)	41.66*** (4.87)
Georgia	394.33	-7.3 (3.39)	11.85 (6.58)	1.59 (6.01)	46.75*** (3.6)
Hong Kong	540.43	4.82 (2.55)	-9.44 (4.54)	-7.78 (4.22)	30.18*** (2.6)
Croatia	454.4	9.58*** (2.46)	2.71 (4.43)	-16.95*** (3.55)	58.55*** (2.71)
Korea	487.46	-7.39** (2.7)	26.21*** (4.97)	9.77* (4.4)	49.74*** (2.73)
Luxembourg	465.34	13.24*** (3.56)	-10.04 (6.54)	-18.15*** (4.72)	75.94*** (3.56)
Macao	547.59	-7.44** (2.56)	-13.01* (5.26)	-12.17* (5.14)	26.39*** (2.56)
Mexico	402.05	8.84*** (1.89)	2.3 (3.43)	11.61** (3.26)	34.64*** (3.28)
Malta	478.55	-2.23 (4.18)	-5.3 (8.12)	-7.18 (6.4)	60.87*** (4.13)
Portugal	443.47	7.44*** (2.35)	17.46*** (4.81)	14.78*** (4.47)	73.63*** (2.5)

The results show that aligned STEM expectations do not have a consistent impact on children's mathematics performance across all countries. However, in seven countries, children whose expectations align well with their parents have higher scores in mathematics compared to their counterparts with misaligned expectations. The largest positive impacts of aligned expectations among these countries are in Portugal (19 points), France (16 points), and the United Kingdom (16 points), among others. On the other hand, in the remaining eight countries, aligned expectations are associated with decreased scores in mathematics. Especially in Germany and Luxembourg, the decrease is about 20 points, while in Croatia and Macao, the decreases are approximately 16 and 12 points, respectively.

Fig. 3. Impact of aligned STEM occupational expectations on children's math achievement: Regression coefficients by country.

The results also show that the impact of overestimating STEM expectations on children's mathematics performance also varies across countries. In nine countries, children whose parents overestimated their STEM expectations score higher in mathematics compared to children whose parents do not overestimate their expectations. Notably, the largest positive impacts are observed in France (56 points), the United Kingdom (43 points), and Korea (29 points). On the other hand, in six countries, overestimated expectations are associated with lower mathematics scores. Specifically, the decrease is about 24 points in the Dominican Republic, 22 points in Luxembourg, and approximately 16 and 12 points in Chile and Hong Kong, respectively.
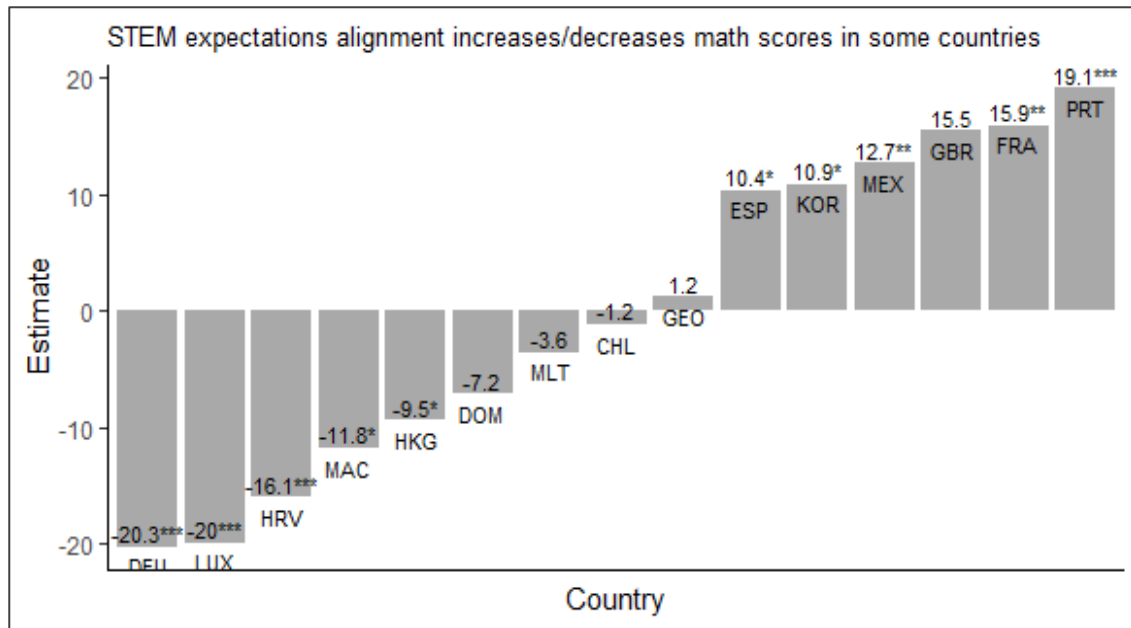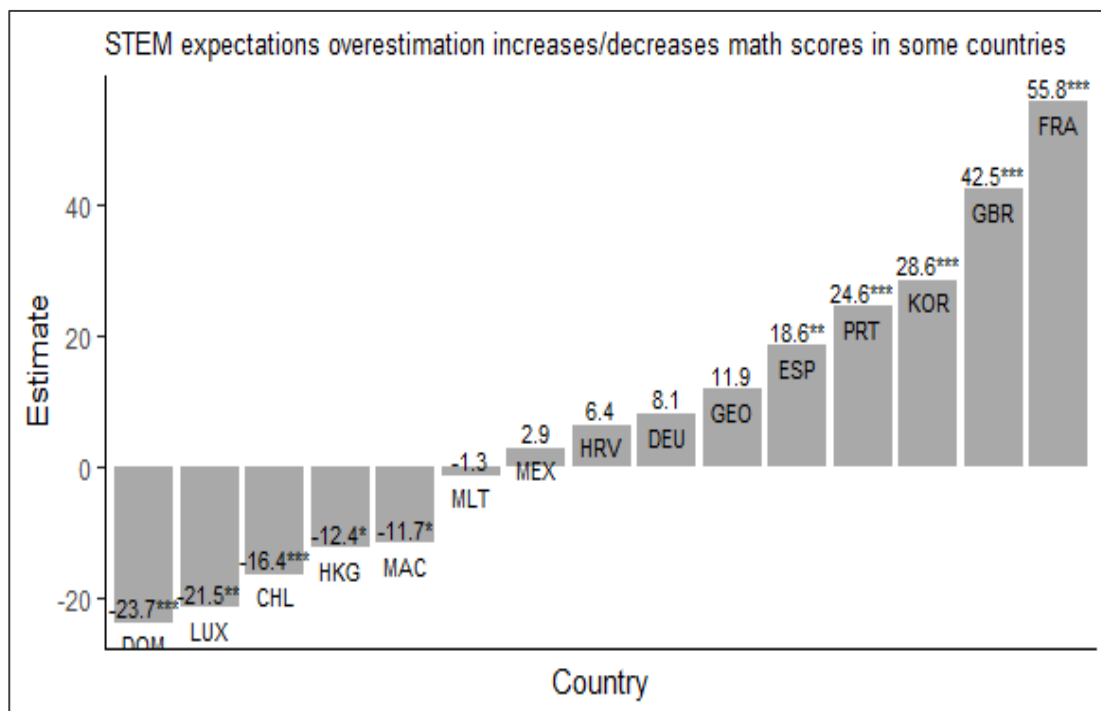

Fig. 4. Impact of overestimated STEM occupational expectations on children's math achievement: Regression coefficients by country.

4. DISCUSSION

The study examined the alignment and overestimation of parental occupational expectations with respect to their children's in science, technology, engineering, and mathematics (STEM) across 15 countries, as well as the impacts of these factors on children's math achievement. Overall, a high degree of alignment between the expectations of parents and children was found across all countries, with the greatest proportions of alignment occurring in the Western European countries included in the study—France, Germany, and the United Kingdom. The alignment between parental and children's expectations has several implications. It suggests that across the 15 countries, the expectations of parents and children are more related than they are not. This is related to the position that the relationship between parental and children's expectations is reciprocal (Buchmann et al., 2022). It could also be argued that the congruence in expectations reflects shared values and communication within families. Within that context, the results of the study could be an indication of a good understanding between parents and children regarding children's STEM interests or future STEM educational and career paths, since some parents and children often engage in open communication about aspirations and expectations (Chavira et al., 2016). Also, parental values, beliefs, and educational and occupational attainments influence children's expectations and aspirations (Kewalramani & Phillipson, 2020). It is thus possible that both parental and children's expectations are driven by parental social status and beliefs, resulting in the congruence in expectations.

Some discrepancies, overestimations, and underestimations in STEM occupational expectations were also found in some degrees across countries. The results suggest that majority of parents are likely to overestimate their STEM expectations for children rather than underestimate, given that there were very few cases of underestimation in expectations. Thus, overestimation of STEM expectations are behind the discrepancies in expectations found across countries in this study. Discrepancies in expectations could be an indication of a lack of understanding of children's interests or inaccurate perceptions of children's interests (not understanding children's interests could lead to both overestimation and underestimation of expectations). This could be due to communication gaps between parents and children or lower parental involvement in the education of children. Discrepancies can also occur when parents have excessively high demands for their children. This could mean that some parents may be pushing their children to take STEM educational and occupational paths in which children themselves are not interested, or rather, some parents may be projecting their aspirations or the expectations of the public on their children, which may not align with children's actual interests.

4.1. The effects of aligned and overestimated expectations on achievements in math

The results show that when parents' expectations in STEM are higher than those of children, children in several countries perform well in mathematics. Also, when there is an alignment between parent's expectations and children's, children in some countries would perform well in mathematics, although this is comparatively less than what is observed in overestimated expectations situations. There were more countries where overestimating parents' expectations rather than alignment in expectations increases children's mathematics test scores. The actual effect sizes were also greater when parents overestimated their expectations. In France for example, the coefficient for overestimated expectations was larger than aligned expectations by about 40 points, in Britain, it was about 27 points, and in Korea, 18 points. In countries like Croatia and Germany, the negative impact of aligned expectations became positive when parents overestimated their expectations, though this was not statistically significant.

The results of the analysis of the effects of expectations alignment and overestimations on achievements in math can be summed in Marsh et al's. (2023) characterisation of parental aspirations and expectations as a double-edged sword, as they increased children's achievements in mathematics in some countries while they also decreased the same in other countries. There is no one-size-fits-all explanation for the results observed in this study, given the multiplicity of countries and the mixed results. Indeed, both the negative and positive impacts of expectations on achievements seem to find support in the literature. The results for each country thus needs to be interpreted by considering individual countries' sociocultural, educational, and economic peculiarities driving educational development and change. Nevertheless, some general explanations can be made, particularly, regarding the positive impacts of aligned and overestimated expectations on achievements in math.

When parents' and children share the same STEM career vision, it results in children achieving higher scores in mathematics, a crucial subject that is required if the child is to major in STEM. The shared expectations between parents and children may act as an endorsement of children's expectations or a form of parental support and involvement in children's schooling, motivating them to put more efforts or develop interest in mathematics, leading to increased performance. This positive relationship between aligned expectations and students' achievements has been reported in other studies (Chavira et al., 2016; Lee et al., 2022). However, as stated, this is not for all countries,

suggesting that the negative impact of aligned expectations on math achievements in other countries may be theorised differently. Overestimation of STEM expectations generally better improved children's scores in mathematics. This is consistent with studies showing that increases in parental expectations are associated with increases in children's academic performance (Jeynes, 2011; Porumbu & Necşoi, 2013). It could be that since mathematics is a critical requirement for students' progression in STEM, when children perceive their parents as having higher expectations for them in STEM, it results in them putting in more efforts in math, resulting in increased performance in mathematics. It is also possible that children's higher mathematics achievements can cause parents to set higher expectations for them in STEM or overestimate their future educational and occupational trajectories. If that is the case, there may thus be a reciprocal relationship between parents overestimating their STEM occupational expectations for children and children's performance in mathematics. It is important to note that although parental overestimation of STEM expectations as found in this study is associated increased performance in mathematics, it may come at a cost to children's psychological and physical well-being (Hystad et al., 2009; Lee et al., 2022; Lu et al., 2021), which should not be ignored.

5. CONCLUSIONS

The study examined the degree of alignment between parents and children's occupational expectations in STEM across countries. The extent of alignment, measured in proportions, ranged between 77% and 54% across the 15 countries studied, with Western European countries having the highest proportions. Overestimation of parental expectations was also common, with some East Asian and Latin American countries reporting proportions as high as 30%. The effects of aligned and overestimated expectations on children's math achievement were positive in some countries and negative in others. Why overestimated and aligned expectations negatively affects children's achievements needs to be investigated in detail, as by 'conventional wisdom', they should have had positive impacts on achievements (Marsh et al., 2023, p. 48) in all countries. It would also be important to examine the effects of aligned and overestimated STEM expectations on achievements in a domain less related to STEM, such as languages (reading in PISA). Since achievements in math are generally more positively associated with students' expectations and aspirations in STEM than achievements in reading, this analysis could help clarify whether alignment and overestimation of parental expectations are driven by children's performance in mathematics specifically, or if similar patterns are observed across other academic domains.

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Innovative Multimedia Methods for Teaching and Learning English Literature

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Abstract

This abstract highlights the significance of contextual reading in American literature, emphasizing how historical and social contexts enhance understanding of texts. By exploring the societal dynamics during an author's life, students gain insights into character motivations and thematic elements, transforming reading into an active exploration of the complexities of human experience. Integrating print media and multimedia resources into the curriculum allows students to deepen their research skills and discover parallels through comparative analysis. This approach encourages the creation of media products to effectively showcase research findings, fostering critical thinking and interactive learning while illuminating the intricate relationships between literature, society, and history.

Keywords: English literature, multimedia methods, comparative analyses, contextual reading

1. INTRODUCTION

In the ever-evolving landscape of education, the teaching of literature presents both challenges and opportunities for engaging students with complex texts and diverse contexts. Understanding the nuances of a particular writer's work or era is essential for fostering critical thinking and analytical skills. Traditional methods of literary analysis, while foundational, often fall short in capturing the rich interplay between literature and its historical and social contexts. As technology continues to reshape educational practices, there is a growing need to incorporate innovative methodologies that enhance literary engagement. This paper explores the implementation of a comprehensive approach to literature education that integrates new technologies and journalistic mechanisms. By embracing multimedia resources and fostering comparative analysis, this method aims to deepen students' understanding of literature while equipping them with the skills necessary for effective communication and critical inquiry. Ultimately, this approach not only enriches the study of literature but also prepares students to navigate the complexities of the modern world.

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2. LITERATURE REVIEW

The analysis of scientific literature, research, and other sources on the use of new technologies and multimedia tools in the teaching and learning of literature has convinced us that, in modern pedagogy, the integration of the Internet and various platforms into the literature teaching process is increasing daily. However, we have not encountered an innovative approach that involves students in creating and disseminating media content about literature using journalism and multimedia journalism genres, and which is actively employed in teaching and learning in this manner.

Nevertheless, it is important to highlight several significant sources, which we will review below. The use of multimedia technologies in the study of English literature is a proven method that enhances comprehension, particularly for students with strong audiovisual memory. Recent studies in this area demonstrate the effectiveness of this approach.

Richard E. Mayer, in his work *Multimedia Learning*, emphasises the effectiveness of using audiovisual material in the teaching process. Mayer's work is intended for readers interested in the foundational theories and research in cognitive psychology, who wish to understand how learning can be enhanced through the combination of words and images. He also discusses principles for creating effective multimedia presentations (Mayer, 2009).

Mark Prensky's book *Digital Game-Based Learning* focuses on the role of multimedia technologies, particularly games, in the teaching process. This approach represents a new direction in pedagogy that can be adapted to the teaching of literature (Prensky, 2007). Dr. Marsela Turku, in her article "Teaching and Learning English Literature Through Multimedia," discusses how the use of multimedia can be a valuable medium in literature education, enhancing students' motivation to engage with literary texts. She indicates that research shows multimedia aids students in understanding literature, focusing on the target language and its culture, as well as learning new terminology and phraseology and their appropriate usage. The advantages of multimedia are significant, as it effectively facilitates knowledge transmission. Turku's research presents findings on how multimedia technologies, particularly the use of the YouTube platform, improve the quality of literature study and make the process more engaging (Turku, 2024).

Dr. S. Victoria Alan, in her article "Digital Storytelling and Multimedia Tools for Teaching Language and Literature," states: "The traditional oral storytelling method has evolved into visual digital media stories featuring video, audio, and 3D objects, which helps readers engage with stories in a contemporary way." This clearly highlights the effectiveness of the method. However, this study places particular emphasis on the effectiveness of using multimedia technologies in the narrative process, which has gained popularity, especially in distance learning contexts (Alan, 2023). In the work *Multimedia Technologies and Familiar Spaces: 21st-Century Teaching for 21st-Century Learners*, the authors underscore the importance of integrating multimedia technologies into the teaching and learning process in this era of technological advancement. They argue that doing so is crucial for fostering student reflection and achieving better educational outcomes. Educators are presented with compelling arguments to demonstrate that these new approaches genuinely enhance learning results (Judy Lambert, 2016).

In the article "Teaching Literary Analysis with Digital Storytelling: An Instructional Approach," the author describes how student-created digital stories focused on S.E. Hinton's novel *The Outsiders* (1967) were particularly impressive. "The aim of the study was to work closely with the participants, allowing teaching and learning to unfold naturally, while providing opportunities for participants to describe their experiences and share their insights to reveal the essence of the phenomenon" (Maddin, 2013).

This study is particularly relevant to our method, as it involved students creating their own content, albeit within a specific piece of work and a single type of task. In contrast, our method integrates both traditional and multimedia journalism genres into the teaching and learning process of English literature, making our approach unique.

3. METHODOLOGY

In the English literature classroom, an interdisciplinary approach enhances student engagement through various methodologies. Students utilize **deductive reasoning** to explore broader historical contexts before applying these insights to specific texts, while also employing **inductive reasoning** to identify themes within individual works. The **comparative method** enriches their analysis of British and American literature. Hands-on **experiential learning** encourages the creation of multimedia presentations, complemented by **collaborative learning** that fosters diverse perspectives. Finally, **critical pedagogy** prompts students to question societal norms reflected in the literature, creating a dynamic environment that deepens literary engagement and cultivates essential skills.

4. METHODS- AMERICAN LITERATURE

4.1 Contextual Reading

Observing contextual reading, we found the following: Before studying the authors and their masterpieces, it is important for a student to get acquainted with specific techniques, namely: investigating the historical and social contexts of a text. Understanding these contexts provides a richer, more nuanced appreciation of the work and its themes. For instance, a novel written during a time of social upheaval often reflects the struggles and aspirations of its characters against the backdrop of societal change. A student should first delve into the era in which the author lived—exploring key events, cultural movements, and prevailing ideologies. This not only contextualizes the narrative but also helps illuminate the author's intentions and the challenges they faced in expressing their ideas. Moreover, examining the social dynamics of the time can reveal underlying tensions that inform character development and plot progression. For example, understanding the class structure, gender roles, or racial dynamics can unlock layers of meaning that might otherwise remain obscured. A character's decisions and motivations may be deeply influenced by these societal norms, providing a more comprehensive understanding of their actions. Additionally, students should explore the author's own background, including their personal experiences and beliefs. An author's life story often intertwines with their work, revealing how their environment shaped their perspectives. By engaging with biographical information, students can gain insight into how personal and historical contexts inform literary themes and styles. Finally, encouraging students to engage in discussions about these contexts can foster a more interactive learning environment. Group analyses can uncover differing interpretations, prompting students to consider multiple viewpoints. This collaborative approach not only deepens their understanding but also cultivates critical thinking skills essential for any literary analysis.

A a thorough investigation of the historical and social contexts surrounding a text enriches a student's engagement with literature. It transforms reading from a passive activity into an active exploration, enabling students to appreciate the complexities of human experience as captured through the written word. Through this lens, literature becomes a mirror reflecting the multifaceted nature of society and history, inviting readers to draw connections between the past and their present lives.

When learning Whitman!

Consider the impact of the American Civil War on Walt Whitman's "Leaves of Grass." Published initially in 1855 and expanded throughout Whitman's life, this collection of poetry reflects profound shifts in American society, particularly influenced by the tumultuous years of the Civil War (1861-1865).

The Civil War was a defining moment in American history, one that tested the nation's ideals of democracy, equality, and unity. Whitman, who witnessed the war firsthand as a volunteer nurse in military hospitals, infused his poetry with the raw emotions and stark realities of the conflict. The trauma of war, the suffering of soldiers, and the deep divisions within the country permeate his verses, adding a layer of urgency and sincerity to his work.

In "Leaves of Grass," particularly in poems like "Drum-Taps," Whitman captures the collective grief and valor of those who fought. His use of vivid imagery and free verse reflects both the chaos of battle and the hope for healing and reconciliation. He writes about the physical and emotional scars of war, often blurring the lines between the soldier and the civilian, emphasizing a shared humanity that transcends the battlefield. For instance, the intimate portrayal of wounded soldiers serves not only as a tribute to their bravery but also as a poignant reminder of the costs of conflict.

Moreover, the Civil War catalyzed Whitman's exploration of themes such as democracy and the individual's role within society. He grappled with the idea of what it meant to be an American during such a fractious period. His poetry often celebrates the diversity of voices that make up the nation, promoting an inclusive vision that reflects the democratic ideals that were under threat during the war. Whitman's embrace of the body, nature, and the everyday experiences of individuals in "Leaves of Grass" can be seen as a counterpoint to the dehumanizing aspects of warfare, highlighting the beauty of life amidst destruction.

The war also prompted Whitman to consider mortality and the transient nature of life. This is evident in his meditations on death, loss, and the cycles of existence that recur throughout his work. The realities of death on the battlefield forced Whitman to confront his own beliefs about the human experience, prompting a philosophical exploration of life's meaning and the interconnectedness of all beings.

In essence, the American Civil War profoundly shaped Whitman's "Leaves of Grass," imbuing it with a depth of feeling and a sense of urgency that resonates throughout the collection. The war not only influenced the themes and subject matter of his poetry but also reinforced his belief in the power of literature to capture the complexity of the

human experience. Whitman's work ultimately serves as a powerful testament to the enduring impact of historical events on art, reminding readers of the intricate tapestry of life that is woven from both joy and sorrow.

Table 1. Before learning social and historical background, the understanding of Walt Whitman was:
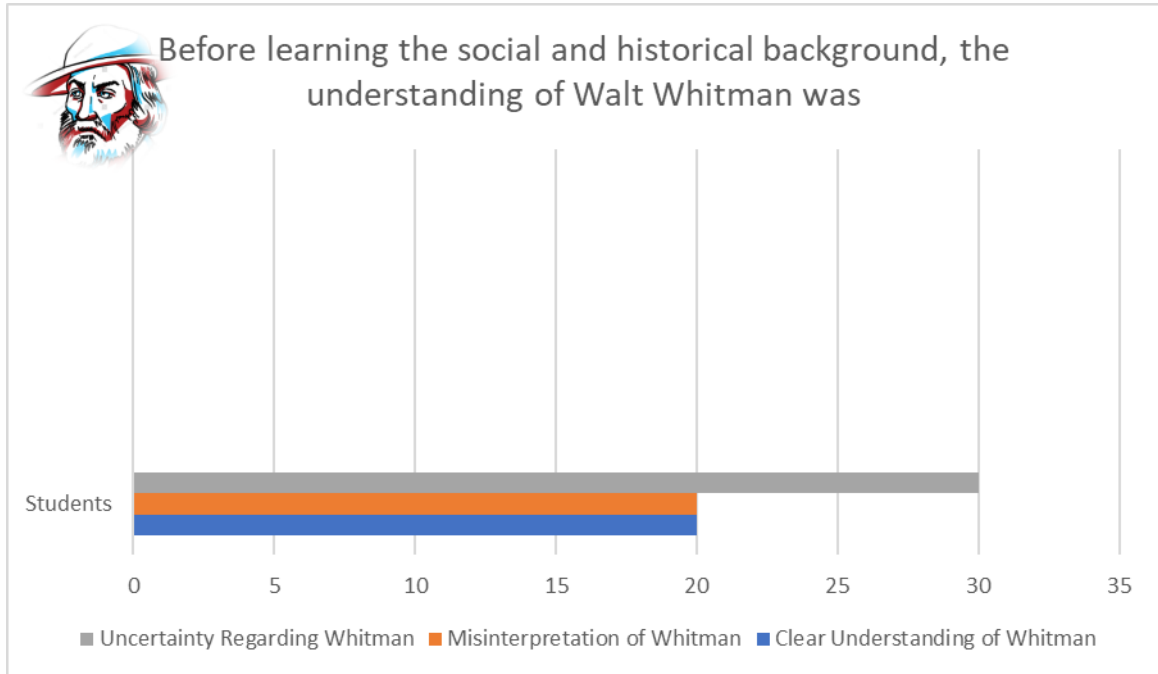
(a) first picture

Table 2. After learning social historical background, the understanding of Walt Whitman is:
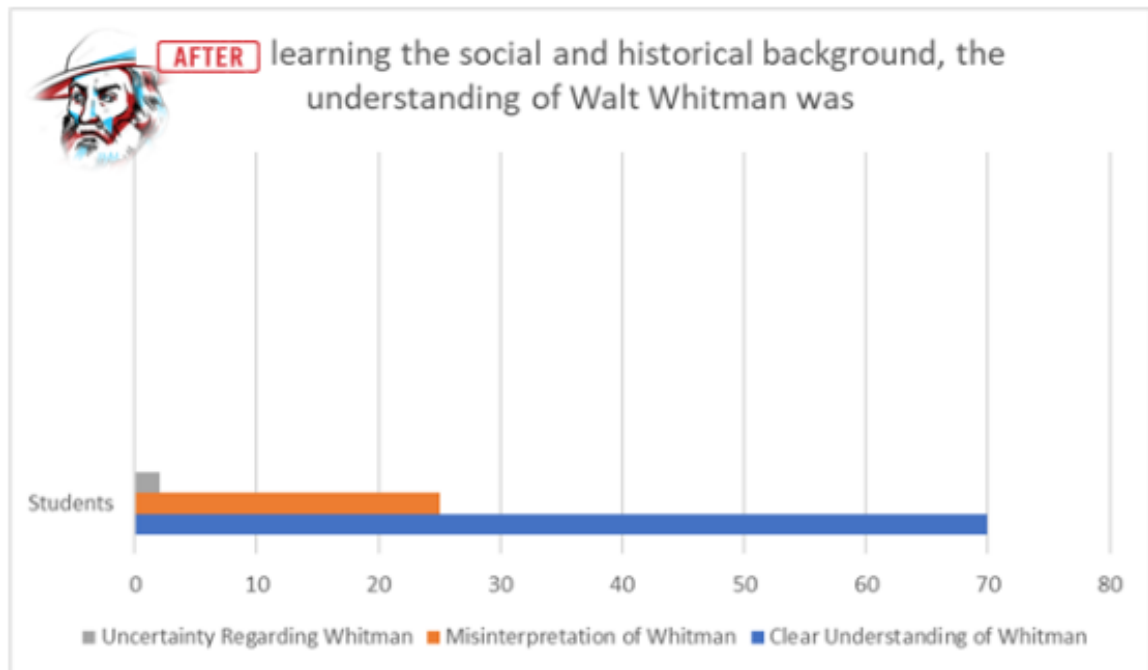
(b) Second picture

This technique does not work all the time. Here is what it happens when…

You learn Dickinson!

In contrast, Dickinson's work during this period often dealt with themes of death and loss but from a more personal lens. Her poems frequently explore the inner life, touching on solitude, faith, and the nature of existence. While she was deeply affected by the war—both through the loss of loved ones and the pervasive atmosphere of grief—her response was more introspective. Poems like "I heard a Fly buzz—when I died" illustrate her contemplation of mortality and the intimate, private experiences of life and death, rather than the collective experience of war.

This time I do thematic workshops and prepare multimedia presentations, focusing on key themes in Dickinson's poetry—such as death, nature, and identity—and encourage students to create their own poems or artworks in response. This personal engagement fosters deeper understanding and connection. Incorporating multimedia elements like music, film, or visual art also resonates with Dickinson's themes. This approach enhanced emotional engagement and make her work more accessible and relatable to students.

Comparative analysis does makes sense!

Techniques of comparing thematic elements in works is a thing of great importance.

Emily Dickinson's poetry often delves into the theme of isolation, presenting it as an intricate and multifaceted experience. In many of her poems, such as "I felt a Funeral, in my Brain," Dickinson explores the internal dimensions of solitude. Her use of vivid imagery and metaphor conveys a profound sense of mental and emotional isolation. The funeral imagery suggests a mourning of the self, where isolation becomes both a source of anguish and a space for introspection. Dickinson's voice resonates with a delicate sensitivity, reflecting how her solitude is intertwined with creativity and contemplation. Her famous line, "The Soul selects her own Society," encapsulates the notion that isolation can be a deliberate choice, allowing for personal authenticity and self-discovery.

In contrast, J.D. Salinger's The Catcher in the Rye portrays isolation through the character of Holden Caulfield, whose alienation is largely reactive and deeply intertwined with his disillusionment with the world around him. Holden's isolation is marked by a struggle against the superficiality he perceives in society. His frequent withdrawal from social interactions, whether it's skipping school or pushing away friends, highlights a painful, almost desperate desire for connection that is thwarted by his cynicism. **Unlike Dickinson's nuanced exploration of solitude as a source of personal reflection, Holden's isolation is depicted as a barrier to understanding and acceptance.** His famous fantasy of being the "catcher in the rye," protecting children from the harsh realities of adulthood, underscores his longing to preserve innocence while grappling with his own profound sense of loneliness.

While both Dickinson and Salinger highlight isolation, their portrayals differ significantly. Dickinson's isolation often allows for a contemplative space where the self can flourish creatively, albeit in a solitary manner. In contrast, Holden's isolation serves as a source of conflict, representing his inability to reconcile his longing for connection with his fear of the adult world. This contrast reflects broader themes in literature about the nature of isolation— whether it serves as a refuge for introspection or a prison that exacerbates feelings of alienation and despair.

4.2 Storytelling… Literary Rubric

In the study of literature, the traditional use of multimedia technologies gained a new direction through our developed methodology, which we named "Literary Rubric." This method integrates print media and multimedia journalism into the teaching of English literature.We introduced specific genres to the experimental group, including portrait essays and features for print media, along with long reads and storytelling for multimedia platforms. During the course, students were tasked with creating media content using their chosen journalistic forms while engaging with the literary works included in the syllabus.

Storytelling is a multifaceted approach that combines text, photographs, video clips, audio, and other resources, allowing for a rich, non-linear narrative. Long reads enable a deeper exploration of material, with the portrait long read focusing on the biography of a specific character and their creative essence. Features provide in-depth insights into human interests and cultural trends.

Using these tools, students in the experimental group researched extensively about the writers and their works, articulated their own viewpoints, and produced comparative analytical texts. They incorporated photos, audio, and video materials to enhance their verbal content and shared their work on free multimedia platforms. Students interested in print media contributed articles to the student magazine, which were published (see appendices). This process required thorough research, leading to better outcomes than traditional methods.

A significant benefit of this innovative approach was that students could explore each other's multimedia products, gaining new perspectives on specific authors. At the end of the course, a meeting was held to assess student satisfaction, where they unanimously agreed that the method was engaging and beneficial. It not only deepened their understanding of literature but also equipped them with journalistic skills. The need to produce in-depth texts fostered greater involvement in writing comparative analyses, with a healthy sense of competition enhancing their reflective practice.

The "Literary Rubric" method is unique in its applicability across different languages, ensuring that the products created are diverse and interesting. This offers an excellent opportunity to stimulate students' creative potential and demonstrate their analytical skills.

წარუმაცვებლობა
წარმაცების სახინდარია

ნინო ვარდიაშვილი

ჯოან როულინგი მსოფლიომ „ჰარი პოტერის" მეშვეობით გაიცნო. მომავალი ბესტსელერის გამოქვეყნებაზე თორმეტმა გამომცემლობამ უთხრა უარი. მწერალი 1965 წლის 31 ივლისს იეტში, გლოსტერშირი, დაიბადა (ინგლისი). (წიგნის მიხედვით, ჰარი პოტერსაც სწორედ ამავე რიცხვში აქვს დაბადების დღე)

ჯოანი პატარაობიდანვე მწერლობაზე ოცნებობდა, „მე წიგნებისთვის ვცხოვრობდი",— ამბობს ერთ-ერთ ინტერვიუში. მან ექვსი წლის ასაკში დაწერა თავისი პირველი მოთხრობა „კურდღელი", თორმეტი წლისამ კი პირველი რომანი, სახელწოდებით — „შვიდი დაწყევლილი ბრილიანტი". „დარწმუნებული ვიყავი, რომ ერთადერთი, რისი კეთებაც მინდოდა, რომანების წერა იყო. თუმცა, ჩემი მშობლები, რომლებსაც

ლიტყსი   27

(c) Third picture

(d) The fourth picture

4.3. Films and Adaptations serve as a vital tool in understanding literature

Learning British literature!

Watch Pride and Prejudice and observe how they interpret the original texts.!

1995 BBC Miniseries: Starring Colin Firth as Mr. Darcy and Jennifer Ehle as Elizabeth Bennet, this adaptation is highly regarded for its fidelity to Jane Austen's novel. The series captures the nuances of character development and social commentary inherent in the text. The slow pacing allows for a deeper exploration of the characters' motivations and relationships, particularly the tension between Elizabeth and Darcy. 2005 Film Adaptation: Directed by Joe Wright, this version features Keira Knightley as Elizabeth and Matthew Macfadyen as Darcy. It takes a more cinematic approach, emphasizing visual storytelling and emotional intensity. While it remains true to the core themes of love and societal expectations, some purists critique its deviation from certain plot elements and character nuances. The lush cinematography and dramatic score create a romantic atmosphere, appealing to a modern audience.

Modern Retellings is a valuable contribution….

"Bridget Jones's Diary" (2001): This romantic comedy draws parallels between its protagonist, Bridget, and Elizabeth Bennet. Set in contemporary London, the film reinterprets Austen's themes of social pressure, self-discovery, and romantic misadventures through a humorous lens. While it diverges significantly from the plot of Pride and Prejudice, it captures the essence of Elizabeth's character—a relatable, flawed woman navigating love and societal expectations.

"Pride and Prejudice and Zombies" (2016): This adaptation combines Austen's classic story with a zombie apocalypse. While it retains much of the original dialogue and character interactions, it infuses the narrative with action and horror elements. This mash-up challenges traditional interpretations of the text, exploring themes of gender and empowerment in a unique and modern context.

We do not have overlook the role of stage Adaptations. "Pride and Prejudice: A New Musical": This adaptation translates the novel into a musical format, using song and dance to convey the characters' emotions and relationships. The musical retains the core story but often emphasizes the romantic aspects, making it accessible to new audiences. The use of music allows for a different emotional resonance and offers fresh interpretations of beloved characters.

Last but not least- Literary Adaptations

"Death Comes to Pemberley" by P.D. James: This novel acts as a sequel to Pride and Prejudice, blending elements of mystery and detective fiction with Austen's characters. It explores the lives of Elizabeth and Darcy several years after their marriage, delving into themes of loyalty, morality, and the consequences of past actions. This adaptation reinterprets the original text by situating Austen's characters in a new genre, while maintaining their core traits.

And now….

Interpretation Across Adaptations! Adaptations of Pride and Prejudice illustrate how the themes of love, social class, and personal growth can be reinterpreted for different audiences and contexts. While some adaptations stay true to Austen's dialogue and character arcs, others take creative liberties to resonate with contemporary issues or genres. Each adaptation invites viewers and readers to engage with the text in new ways, reflecting the timelessness and adaptability of Austen's work. Through these various interpretations, Pride and Prejudice continues to inspire and challenge, demonstrating its enduring relevance across different mediums and cultural contexts.

After incorporating this method into the syllabus an important observation emerged! 78% of the students got to understand Austen style and the nature of her characters.

Creating podcast…

Literature in 5 minutes

The method I found to be one of the most challenging involves dividing students into teams, each of which works on a specific author. They then create an audio file as an assignment. The podcast is dedicated to that particular author and their literary output.

See the link

Filming….

Literature in 11 minutes

Students undertake the project "Literature in 11 Minutes," where they create a short film about a writer's life and literary works, accompanied by images. All they need is a smartphone and the CapCut app, which allows them to edit the movie and insert text or necessary remarks. This project encourages creativity and enhances their understanding of the writer's contributions to literature.

Finding Georgian Analogue…

When comparing Poe to Baratashvili

When it comes to Edgar Allan Poe, the first name that comes to mind is Nikoloz Baratashvili, with "The Raven" juxtaposed against "Merani." Nikoloz Baratashvili and Edgar Allan Poe share several thematic and stylistic elements:

Exploration of the Human Psyche…
Romanticism
Themes of Death and Loss

Symbolism and Imagery

At the end of the course, we consolidate the material covered in the project "Litcafe." Students discuss the writers and works that have made the biggest impression on them. They engage in debate, argue their positions, and express their feelings, which helps them comprehend the entire course. This process allows them to learn not only by expressing themselves but also by listening to others and confronting differing viewpoints.

5. CONCLUSIONS:

A comprehensive approach to teaching literature is highly effective for understanding the nuances of a writer's work or era and for developing comparative analysis skills. The integration of new technologies, particularly audiovisual content, has proven beneficial in this context. To further enhance these outcomes, we have developed an innovative method that incorporates journalistic mechanisms into literature education. This approach offers several key benefits: improved knowledge of literature, enhanced comparative analysis skills, and effective presentation of observations using multimedia technology.

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ChatGPT and Writing Classes: Students' Views on Its Effectiveness

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Abstract

The 21st century has ushered in a remarkable era of Artificial Intelligence (AI), presenting a fertile ground for educators to explore innovative approaches within the realm of education. This study aimed to discuss students' perceptions of the use of ChatGPT in teaching writing in EFL classrooms. In total 43 university students took part in a questionnaire after experiencing the application during one semester at Constantine the Philosopher University in Nitra, Slovakia. Overall, the students' agreement with the positive aspects displayed in the questionnaire prevailed over their disagreement or neutral opinions. The chatbot helped students prepare for their tests, students appreciated the corrective feedback and would opt for the implementation of ChatGPT in other courses. On the other hand, according to our findings, the students reported that the AI application was not very supportive regarding communication performance. The findings of this study contribute to the existing knowledge of students' perceptions of the use of AI for learning purposes.

Keywords: Artificial Intelligence, ChatGPT, EFL, Education, Writing

1. INTRODUCTION

In today's educational environment, the integration of artificial intelligence technologies has revolutionized various aspects of teaching and learning, including the teaching of writing. In the midst of this technological transformation, educators face countless methodological challenges in effectively using artificial intelligence tools to improve writing instruction. This study serves as a preliminary exploration of the complex intersection of teaching writing with ChatGPT. As writing assistants powered by artificial intelligence such as ChatGPT become increasingly prevalent in the educational environment, educators are tasked with navigating the complexities of integrating these tools into their pedagogical practices. From designing learning activities that effectively use AI-generated feedback to ensuring the ethical and responsible use of AI technologies in the classroom, educators must grapple with a range of methodological considerations.

In addition, the dynamic nature of AI technology presents unique challenges in adapting traditional teaching methodologies to support AI-driven writing. Central to the discussion is the recognition that while AI technologies hold promise for improving writing instruction, their effective implementation requires careful attention to

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methodological principles. This includes considerations such as the validity and reliability of AI-generated feedback, alignment of AI-supported activities with learning objectives, and equitable access to AI resources for all students. In addition, ethical considerations of data privacy, algorithmic bias, and learner autonomy must be addressed to ensure the responsible use of AI tools in teaching writing.

This study paves the way for a comprehensive examination of the methodological challenges associated with teaching writing using ChatGPT. By delving into these challenges, educators can gain valuable insights into how to harness the potential of AI technologies. At the same time, to navigate the methodological complexities that accompany their integration into the teaching of writing. Through this research, we aim to contribute to the ongoing dialogue about the effective use of AI in education and provide practical guidance for educators seeking to optimize writing instruction in the digital age.

2. THEORY

Teaching English as a foreign language using ChatGPT redefines language learning by leveraging state-of-the-art AI capabilities. Through customized lessons, interactive conversations, and personalized feedback, ChatGPT serves as an invaluable tool for language learners seeking to improve their proficiency (Baskara, 2023). Its adaptability suits individual learning styles and allows students to practice conversational English, improve grammar an expand vocabulary in a natural conversational way (Hong, 2023). In addition, ChatGPT's extensive knowledge base provides access to a wide range of cultural nuances and idiomatic expressions and offers a comprehensive and immersive learning experience that goes beyond traditional language instruction (Harunasari, 2023).

Chatbots have been a focus of attention for language educators because these AI-powered applications can instantly and realistically communicate with students in the students' target language (Fryer et al., 2020; Lee et al., 2024). These chatbots can offer synchronous support and tutoring (Kerly et al., 2007). The only essential element for their proper functioning in foreign language acquisition is rich data input and daily conversational practice (Huang et al., 2022). Additionally, these tools can reinforce important knowledge and even answer students' questions to help them notice and understand language features (Nobles, Paganucci, 2015). They can also identify the meaning of a word in context, explain grammatical errors, create texts in different genres and prepare tests, dictionary definitions, translations and example sentences.

In recent years, the integration of AI tools such as ChatGPT has greatly influenced the field of education, especially in the teaching of writing (Harunasari, 2023). In her study, Harunasari (2023) investigated the applicability of ChatGPT for teaching writing in EFL (English as a Foreign Language) classes. Sixteen university students participated in the experiment. The age group was from 20 to 25 years. For the study, the author used both qualitative and quantitative methods. Quantitative data came from grading student papers (from post-test scores), while qualitative data was obtained from questionnaire feedback and chat history data from students with ChatGPT. Based on student feedback and collected data, Indonesian students are not comfortable using apps like ChatGPT as a learning tool and do not consider a chatbot as a possible option as a writing aid. One of the advantages of using ChatGPT to teach writing is its ability to provide immediate feedback to students (Halaweh, 2023). In addition, ChatGPT is also able to identify typing errors, thereby improving typing skills and language skills (Algaraady et al., 2023).

Algaraady et al. (2023) sought to determine whether ChatGPT could identify writing errors and ChatGPT's ability to analyze EFL errors compared to EFL instructors. They used a mixed methods approach in their studies, combining qualitative and quantitative methods. They also used two different strategies, the first of which was to have human instructors analyze written texts to identify errors. The second strategy was based on using ChatGPT to analyze the same written texts by asking different questions regarding grammatical errors and writing style. All texts were written in English. The participants of the experiment were 88 university students. Of these students 54 were men and 34 were women. The age of the students was 20-25 years.

However, using ChatGPT to teach writing is not without problems. Algaraady et al. (2023) state in their study that ChatGPT should not be the only measure of error analysis. Harunasari (2023) also argues that there are risks of over-reliance whereby students may become too dependent on AI for corrections and ideas. This dependency can hinder the development of critical thinking and independent problem-solving skills, which are key aspects of effective writing (Henderson et al., 2022). This is why educators play a key role in mitigating these risks and maximizing the benefits of ChatGPT (Reedy et al., 2021). They need to emphasize the importance of using AI as a tool, not a crutch. Teachers can design activities that encourage students to engage thoughtfully with AI-generated feedback, promoting a deeper understanding of language nuances and writing principles (Baskara, 2023).

3. METHODS

In our study, conducted during the summer semester of the academic year 2023/2024, from February 19 to May 18, we examine the impact of ChatGPT on students' writing development over a 10-week period. The research is designed to gain insights into how students perceive and engage with AI-driven tools in academic writing tasks. We aim to answer key questions about the effectiveness of ChatGPT in supporting students' learning process and whether AI tools like this can become a valuable resource in education.

Participants were split into two groups to assess the impact of ChatGPT. One group (Group A) interacted with the chatbot during specific writing exercises, while the other group (Group B) completed identical tasks without assistance from the chatbot. This division allowed us to evaluate how ChatGPT influences students' outcomes in writing, critical thinking, and engagement compared to traditional methods. The students also participated in pre- and post-tests, allowing us to quantitatively measure changes in writing abilities and the potential value ChatGPT adds to their learning experience. The tests involved multiple stages: three pre-tests and three post-tests, all designed to monitor progress over the course of the experiment. The group using ChatGPT had the opportunity to interact with the chatbot for writing tasks, receiving real-time feedback and suggestions, while the control group worked independently. Through this methodology, our study sought to understand how students feel about integrating AI into their learning environments.

Group A, the experimental group, consisted of 22 students who used ChatGPT during lessons. These students engaged with various writing tasks leveraging the chatbot's assistance to enhance their writing process. ChatGPT was integrated into their learning environment as a tool for generating ideas, structuring essays, receiving feedback on grammar, and improving overall coherence and clarity in their writing. The goal for this group was to evaluate how AI tools like ChatGPT influenced the students' approach to writing and whether it fostered better learning outcomes compared to traditional methods.

Group B, the control group, comprised 21 students who continued with traditional methods of writing instruction. This group tackled the same set of writing tasks but without any AI assistance. Instead, they relied on standard resources such as textbooks, peer feedback, and guidance from instructors. This setup ensured that we can compare the experiences and performance of students using ChatGPT to those following conventional learning paths. By doing so, we aimed to reveal the impact, that AI tools might have on their writing skills development.

Why ChatGPT?

In today's rapidly evolving technological landscape, AI-powered tools like ChatGPT have emerged as innovative resources in various fields, including education. One of the primary reasons for incorporating ChatGPT into our research on teaching writing is its ability to handle basic conversations and generate human-like text. ChatGPT excels at engaging in basic conversation, simulating interactions that are strikingly similar to human dialogue. This capability makes it ideal for supporting students in their writing tasks, as it can provide real-time feedback, suggest alternative phrasings, and assist in brainstorming. While it cannot replace a human tutor, the AI's conversational abilities make it a useful supplement to traditional instruction, giving students the chance to engage with an interactive system that helps them think critically about their writing choices.

At its core, the AI operates on a system that imitates human-like conversations. This design is based on vast amounts of data that enable the AI to generate responses that are contextually relevant, coherent, and appropriate for various tasks. However, it is important to note that ChatGPT lacks the capacity to evaluate its own answers. While it can provide responses that seem accurate and logical, it does not have an internal mechanism to assess the correctness or quality of its outputs. This limitation is crucial for students to understand; they must learn to critically assess the suggestions provided by ChatGPT rather than accept them at face value. This element of self-evaluation becomes a key learning objective when integrating AI tools into the classroom.

In our study, students used the free version of ChatGPT (GPT-3.5), which provides them with access to fundamental features of the tool. By opting for this version, we ensured that students are interacting with the same level of AI that is available to the public, thus reflecting a realistic scenario of how ChatGPT might be used in actual educational settings. The free version offers basic conversation and text-generation functionalities, which were sufficient for supporting students in tasks such as writing essays, improving sentence structure, and exploring approaches to composition.

Questionnaire

This study focuses on an anonymous questionnaire, which was designed to gather data about students' experiences, preferences, and attitudes related to their academic environment and linguistic development. The questionnaire consists of 18 carefully designed questions. All the participants (43 students) completed the anonymous questionnaire. Nevertheless, since anonymity prevents follow-up or in-depth exploration with the same individuals, it does place some limits on the potential richness of the data.

4. FINDINGS

One key point to keep in mind is that the findings discussed here represent only a portion of the overall experiment. The analysis is still in its early stages, and more time and research are needed to ensure that any patterns or trends identified are reliable and valid. As such, while the data collected thus far is useful for making initial observations and guiding further investigation, it should not yet be viewed as definitive.
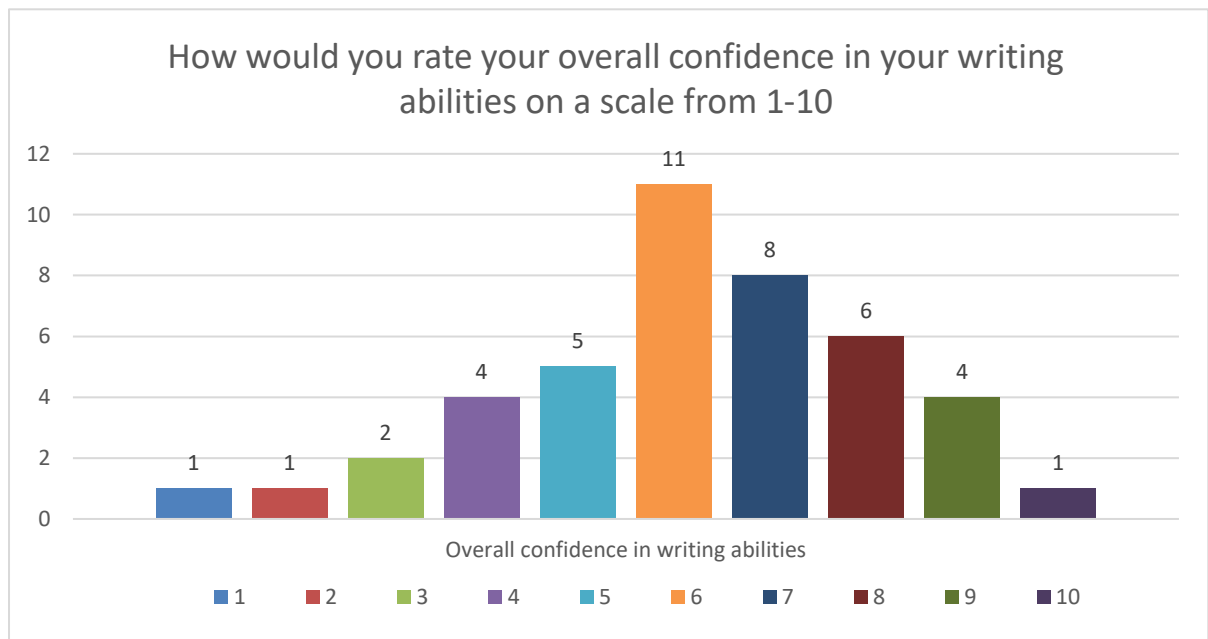
Figure 1. How would you rate your overall confidence in your writing abilities on a scale from 1-10 (1-Not confident at all, 10 – Most Confident

What types of writing assignments do you find the most challenging? (Essays, Motivation Letters, Letters requesting more information)

- All types of formal letters
- Essays
- Letter of Motivation
- Letter requesting more information
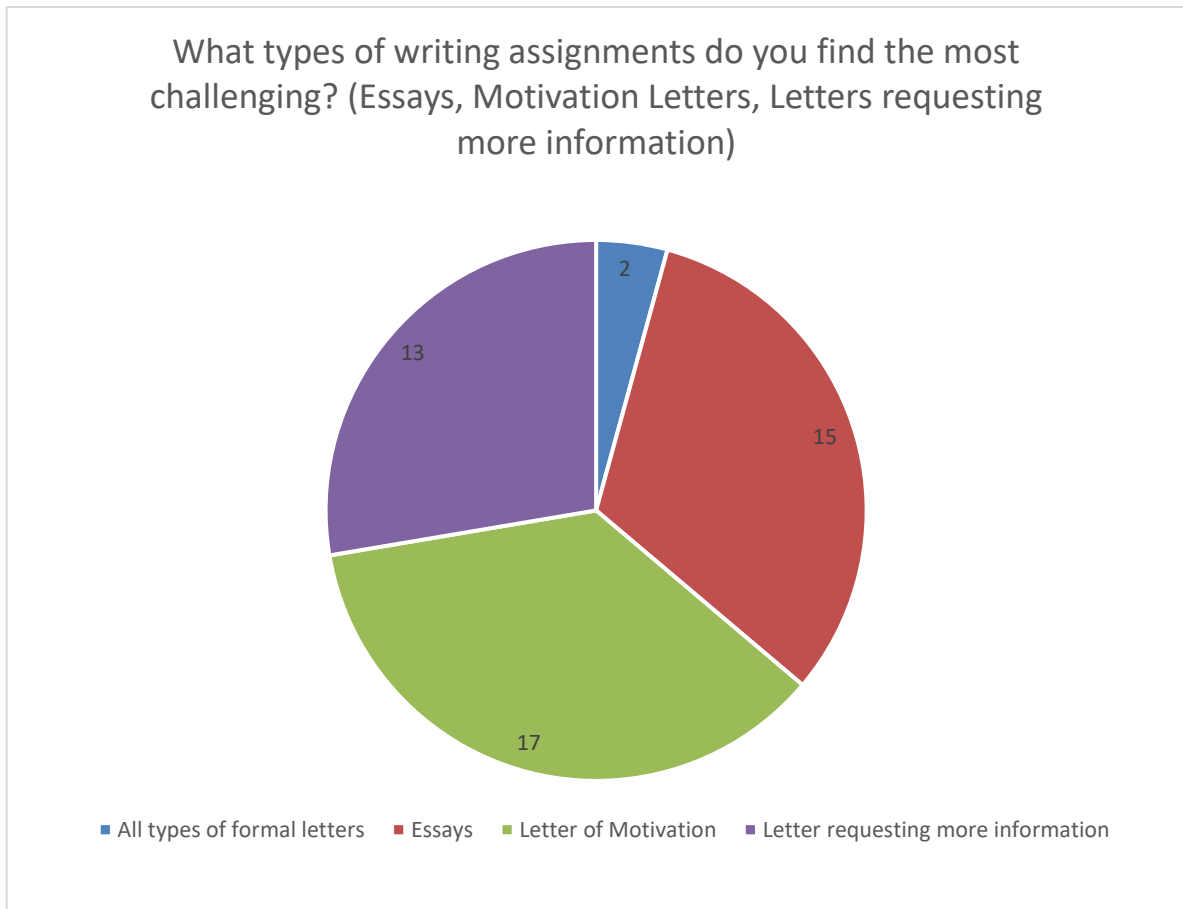
Figure 2. What types of writing assignments do you find the most challenging?

How do you typically approach the pre-writing phase of your assignments?

- Brainstorming
- Making notes
- Outlining
- No preparation
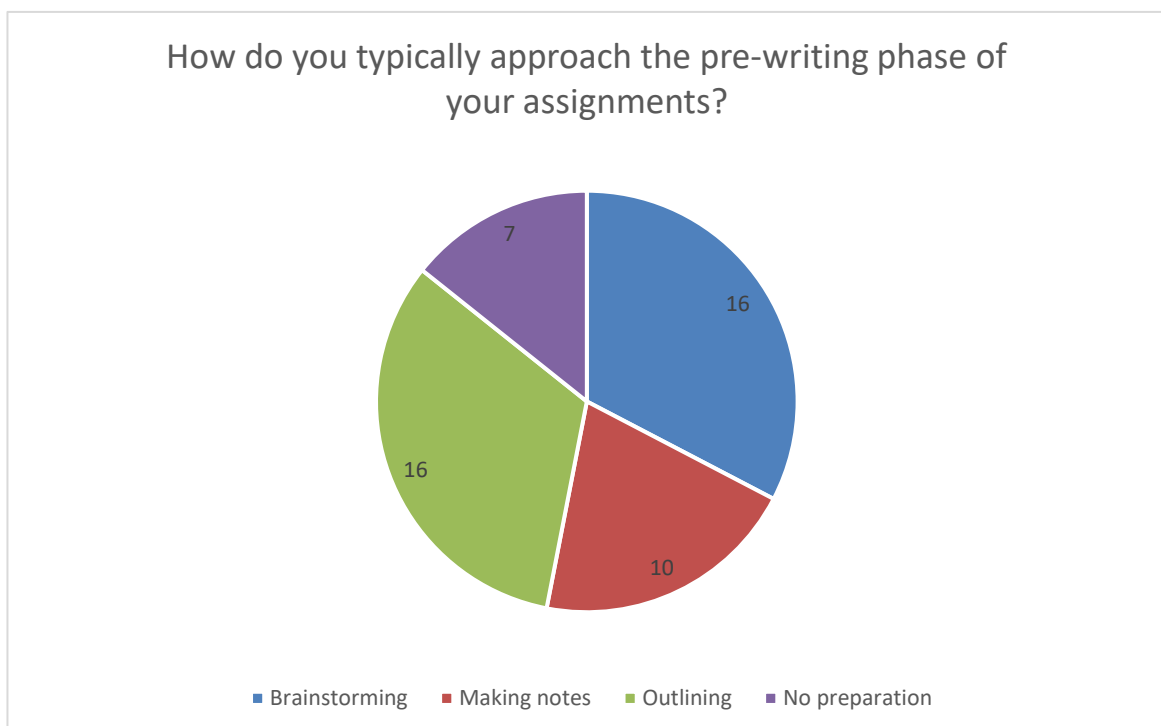
Figure 3. How do you typically approach the pre-writing phase of your assignments?
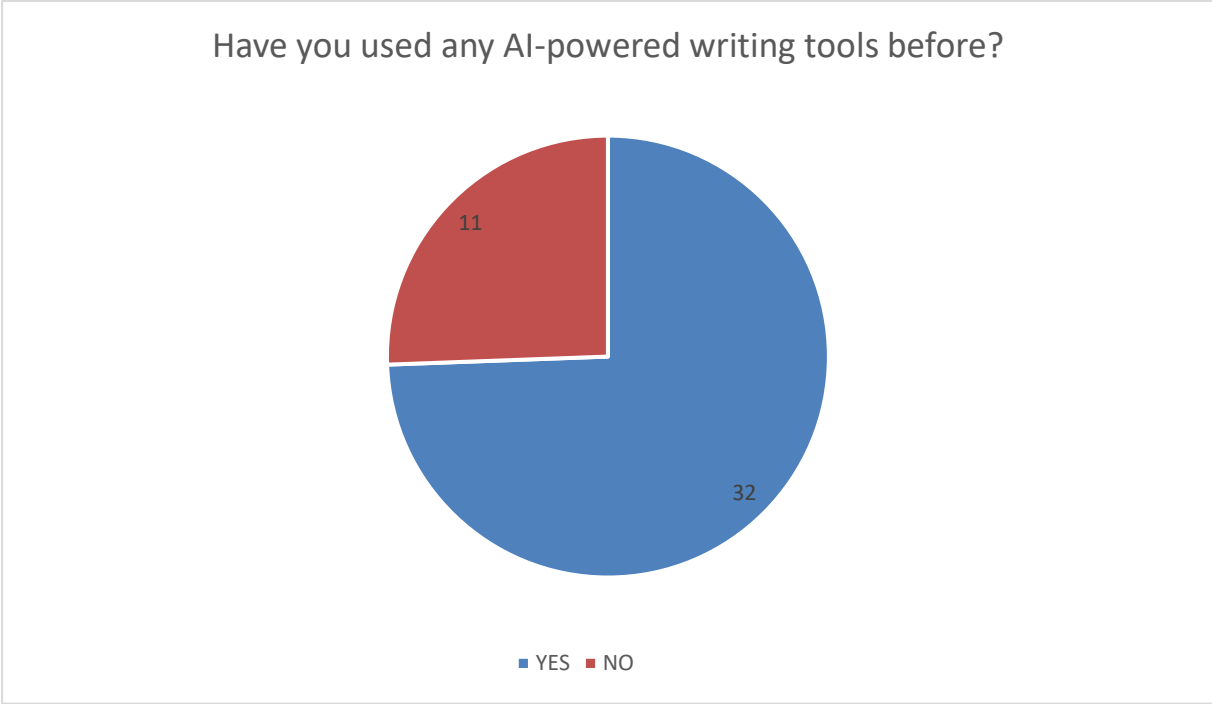
Figure 4. Have you used any AI-powered writing tools before?
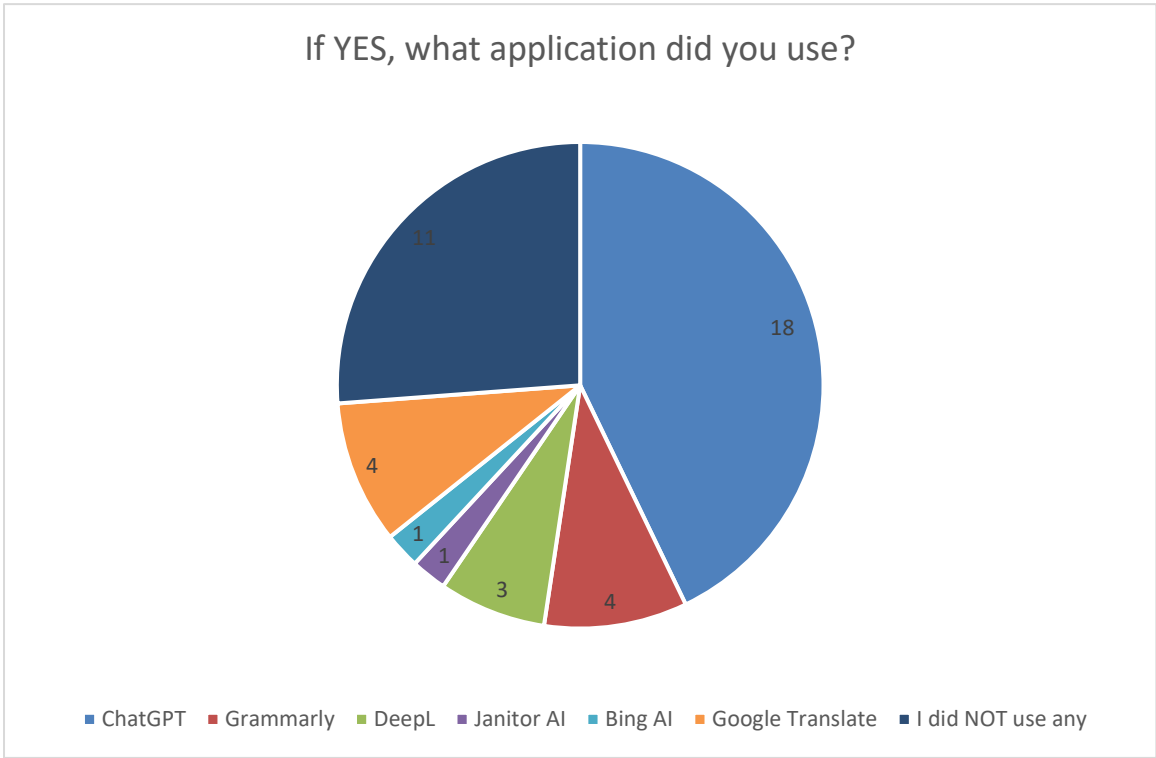
Figure 5. If YES, what application did you use?

How frequently do you use these tools?

Legend: Once a month, Once a week, Multiple times a week, Once a day, Multiple times a day, Never

Pie chart values: 10, 6, 16, 2, 2, 7
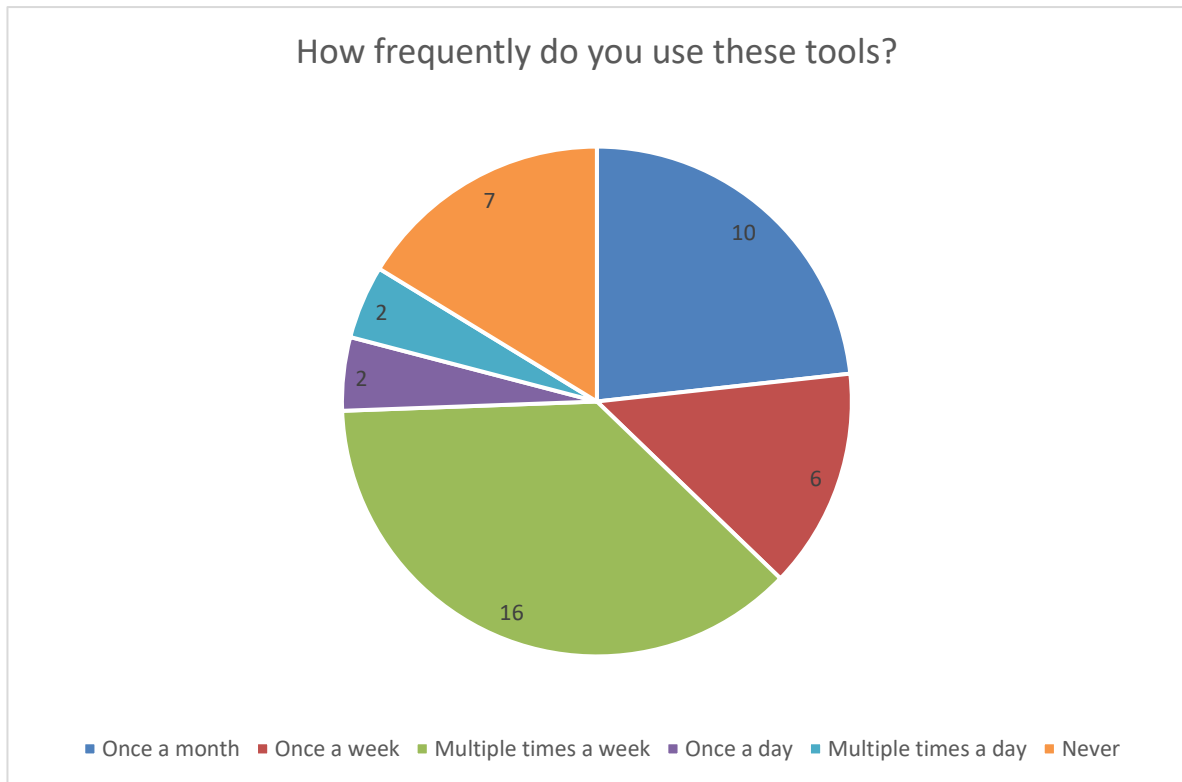
Figure 6. How frequently do you use these tools?

How likely are you to recommend the use of AI-powered writing tools to your peers for academic purposes ? (1-Not likely at all, 10-Most likely)

Bar chart values: 1=1, 2=1, 3=3, 4=10, 5=9, 6=2, 7=9, 8=5, 9=1, 10=2
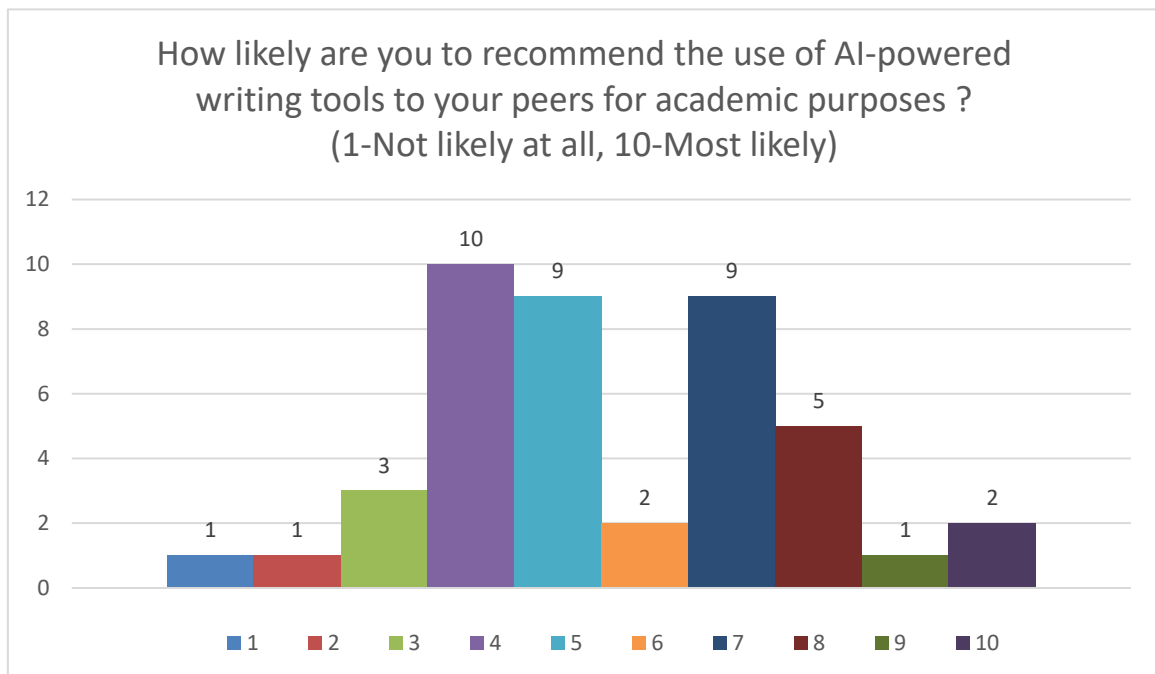
Figure 7. How likely are you to recommend the use of AI-powered writing tools to your peers for academic purposes? (1 – Not likely at all, 10 – Most likely)
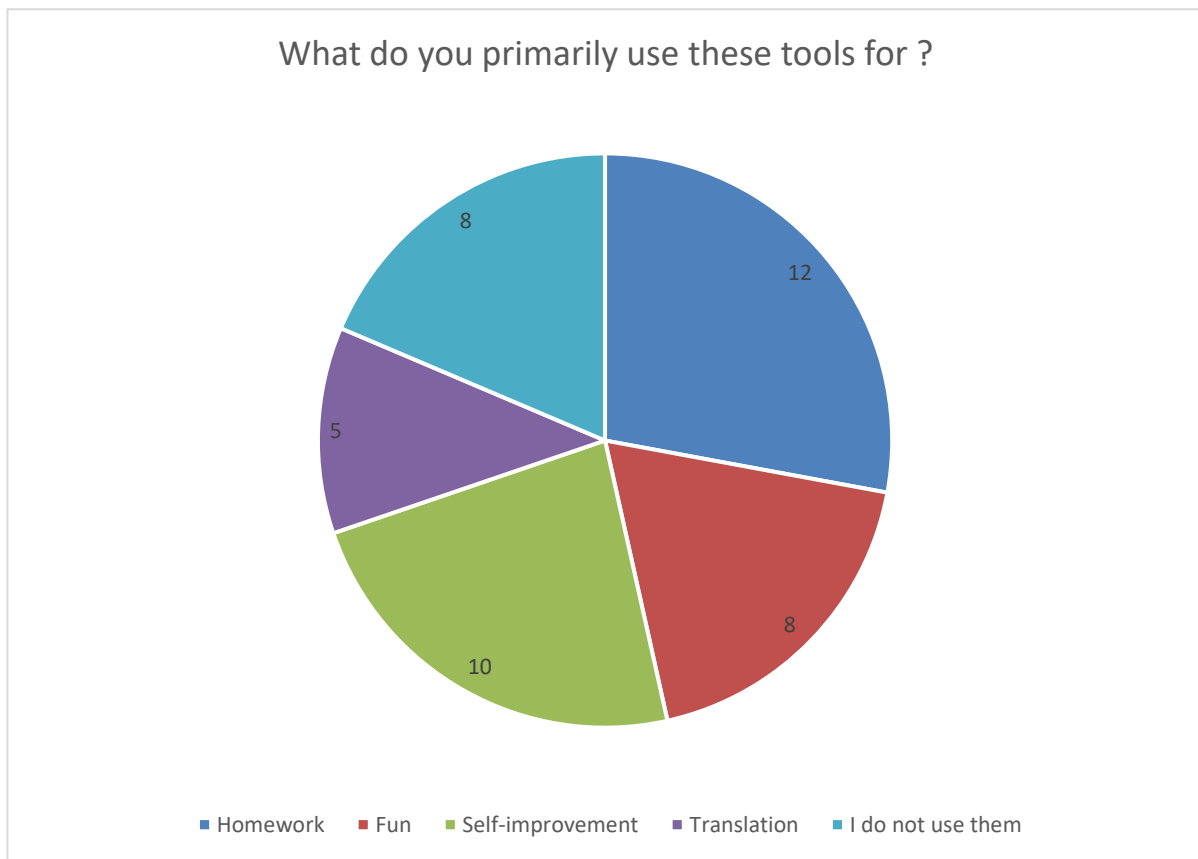
Figure 8. What do you primarily use these tools for?
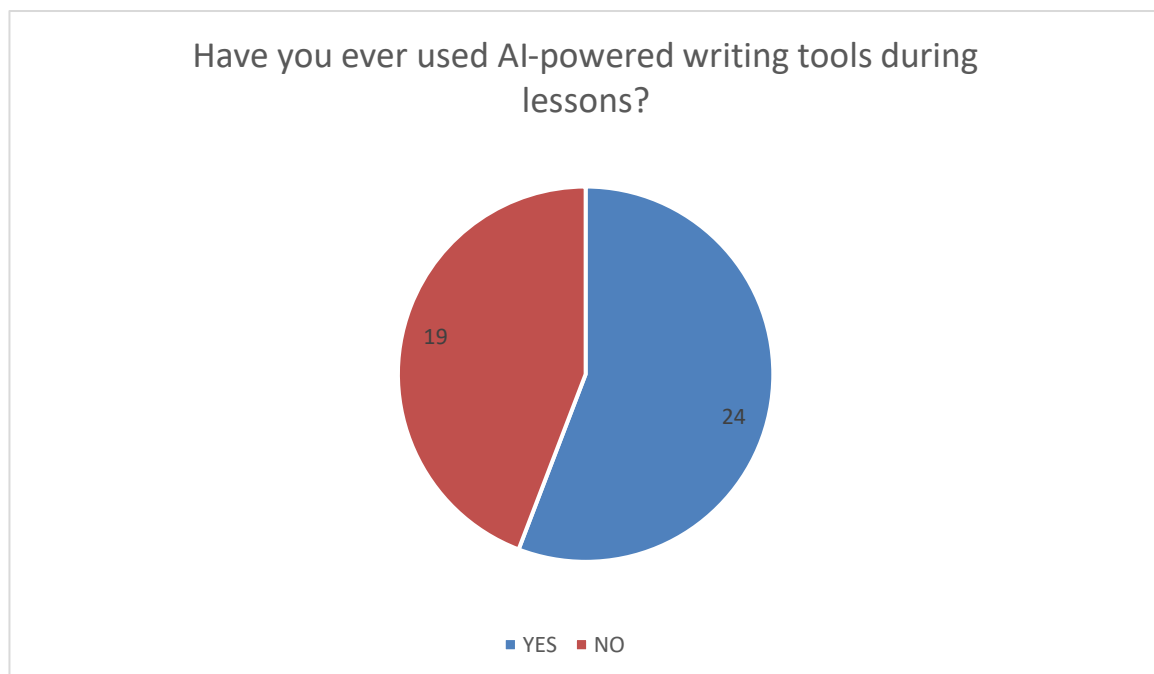
Figure 9. Have you ever used AI-powered writing tools during lessons?
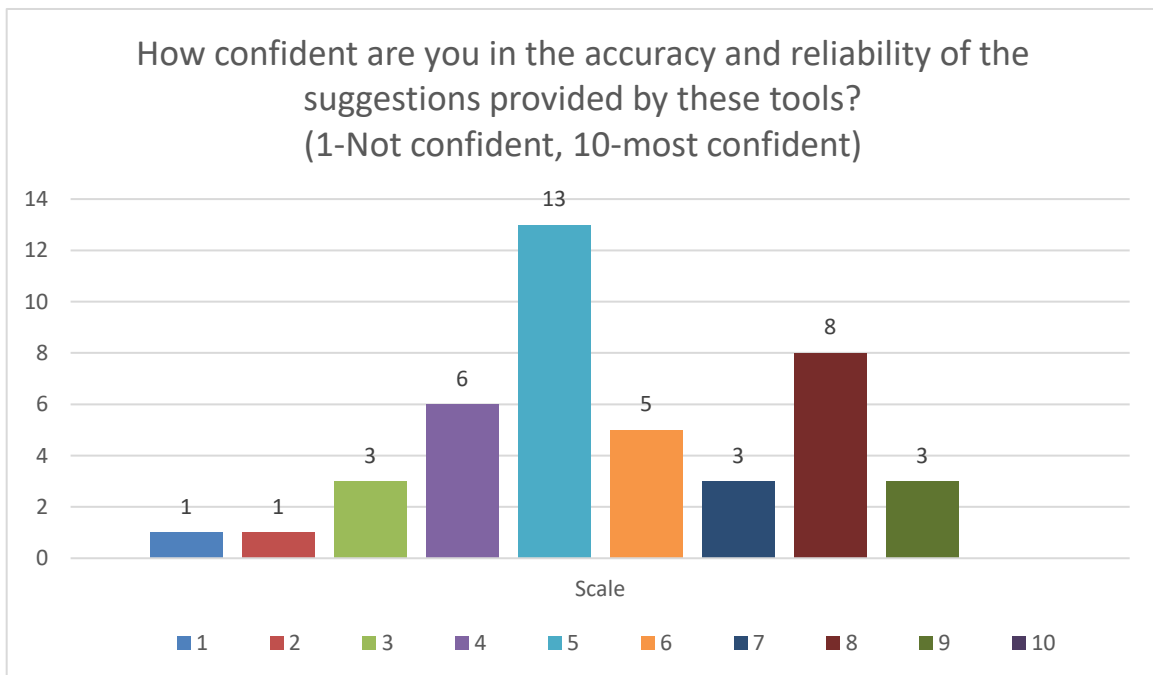
Figure 10. How confident are you in the accuracy and reliability of the suggestions provided by these tools on a scale from 1-10? (1-Not confident at all, 10 – Most Confident)
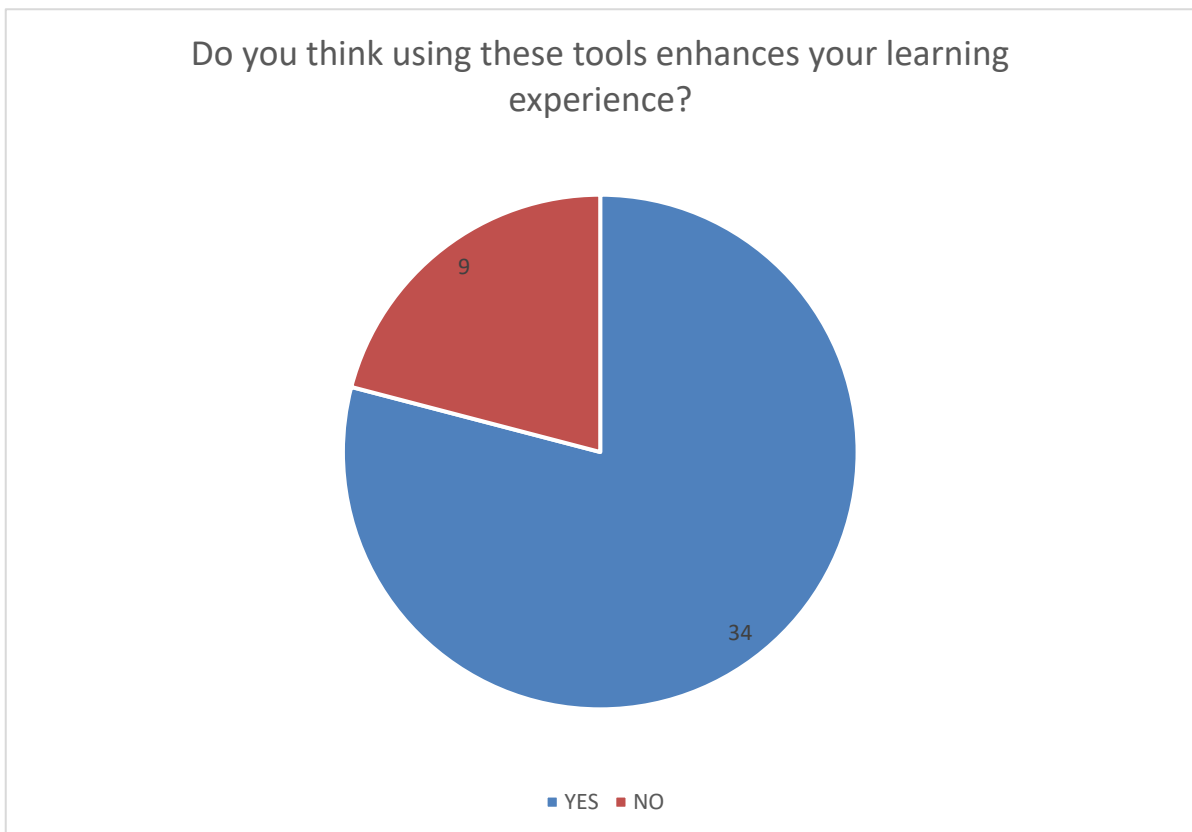
Figure 11. Do you think using these tools enhances your learning experience?
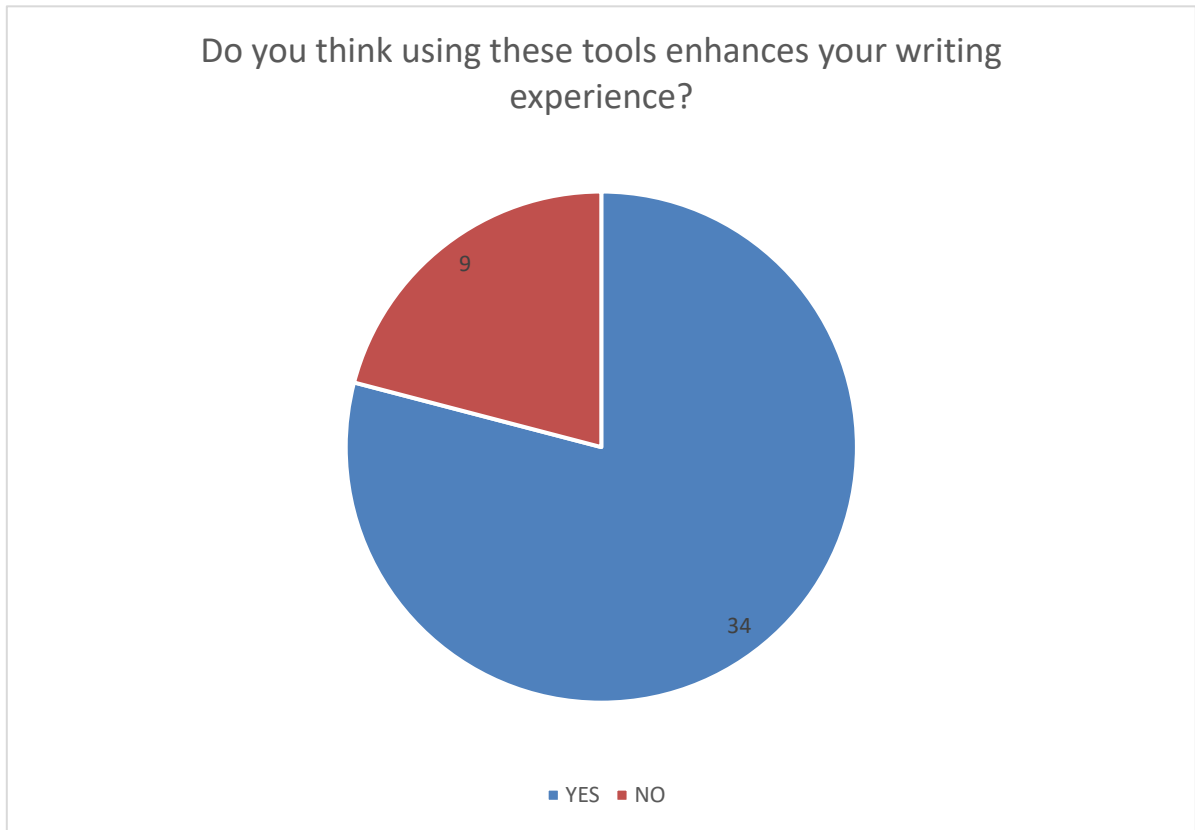
Figure 12. Do you think using these tools enhances your writing experience?
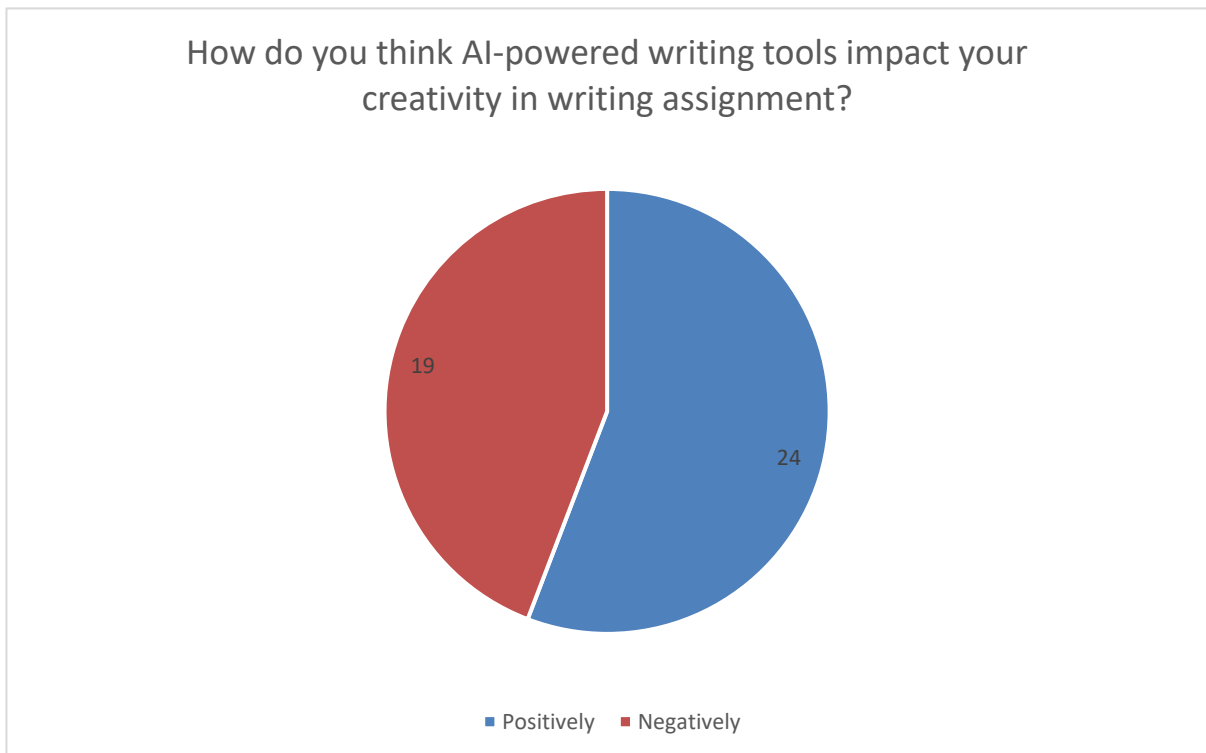
Figure 13. How do you think AI-powered writing tools impact your creativity in writing assignment?

In what ways could AI-powered writing tools be integrated into classroom instruction more effectively?
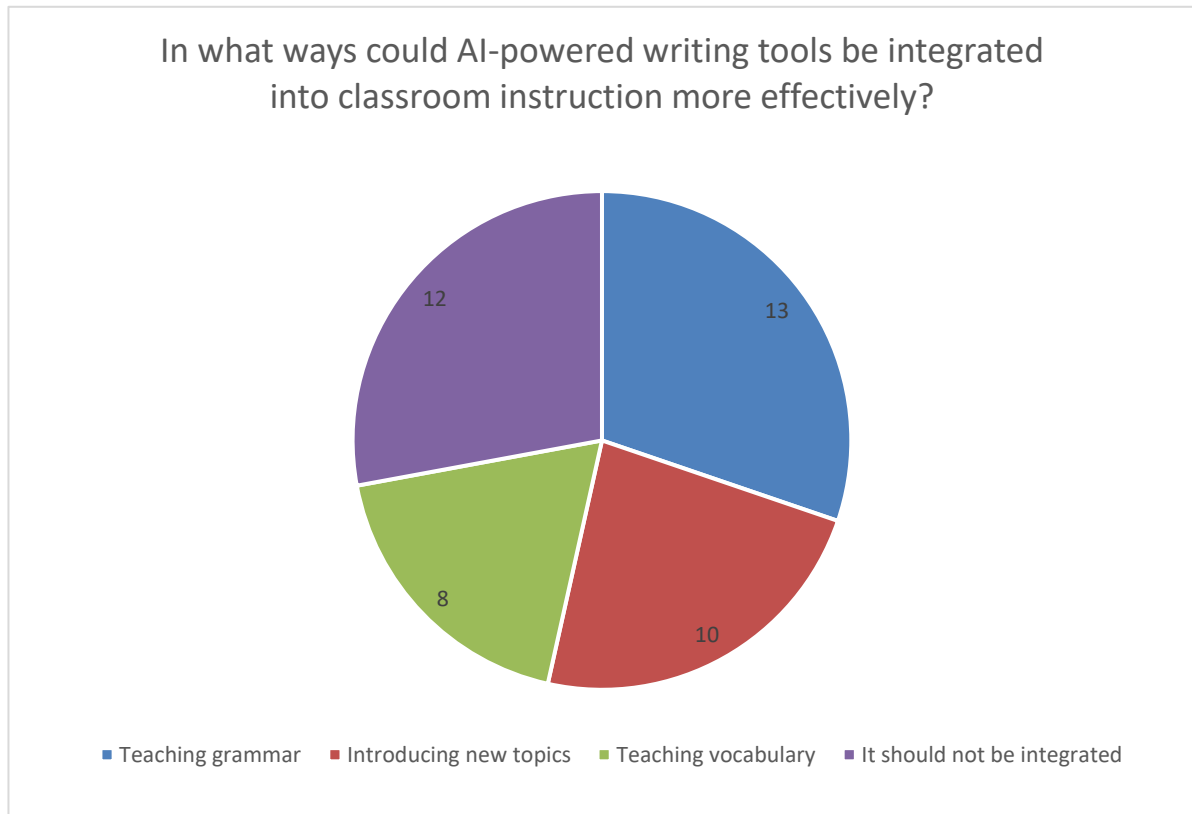
Figure 14. In what ways could AI-powered writing tools be integrated into classroom instruction more effectively?

Do AI-powered writing tools affect your engagement during lessons?
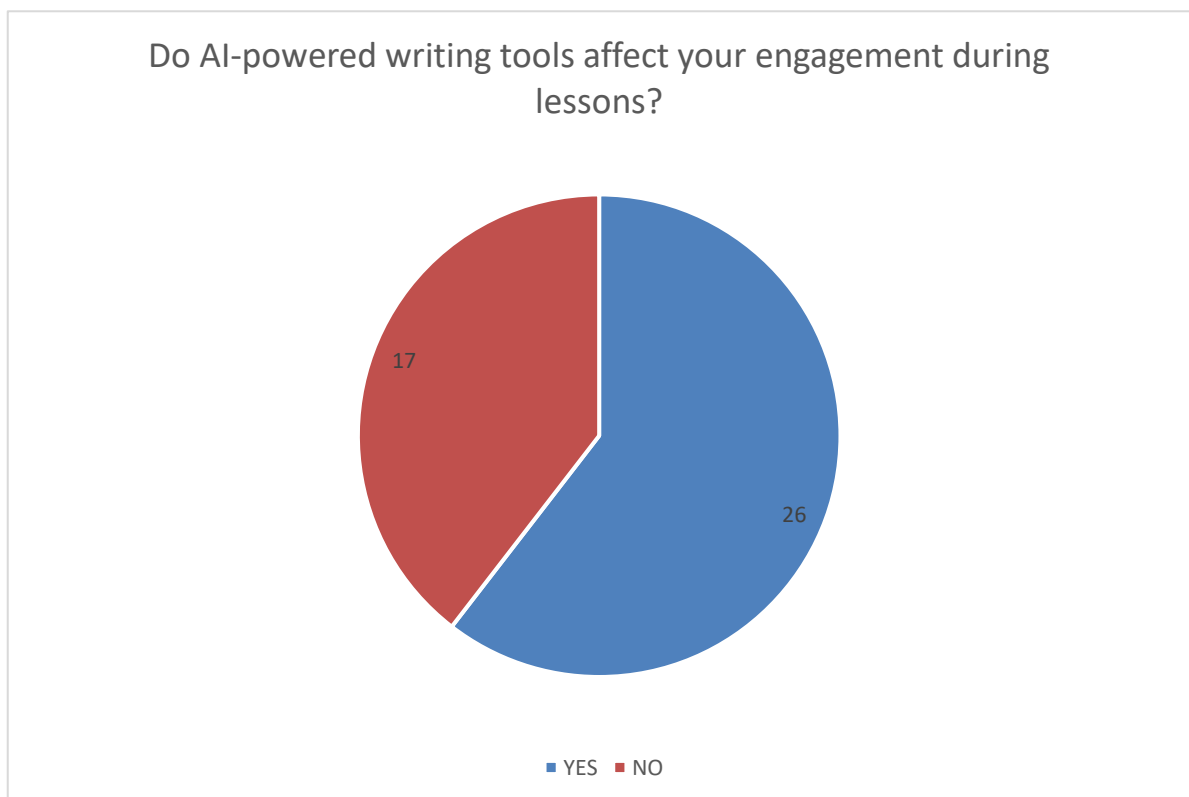
Figure 15. Do AI-powered writing tools affect your engagement during lessons?

Would you prefer using AI-powered writing tools over traditional methods for completing writing assingments?

17

26

■ YES ■ NO
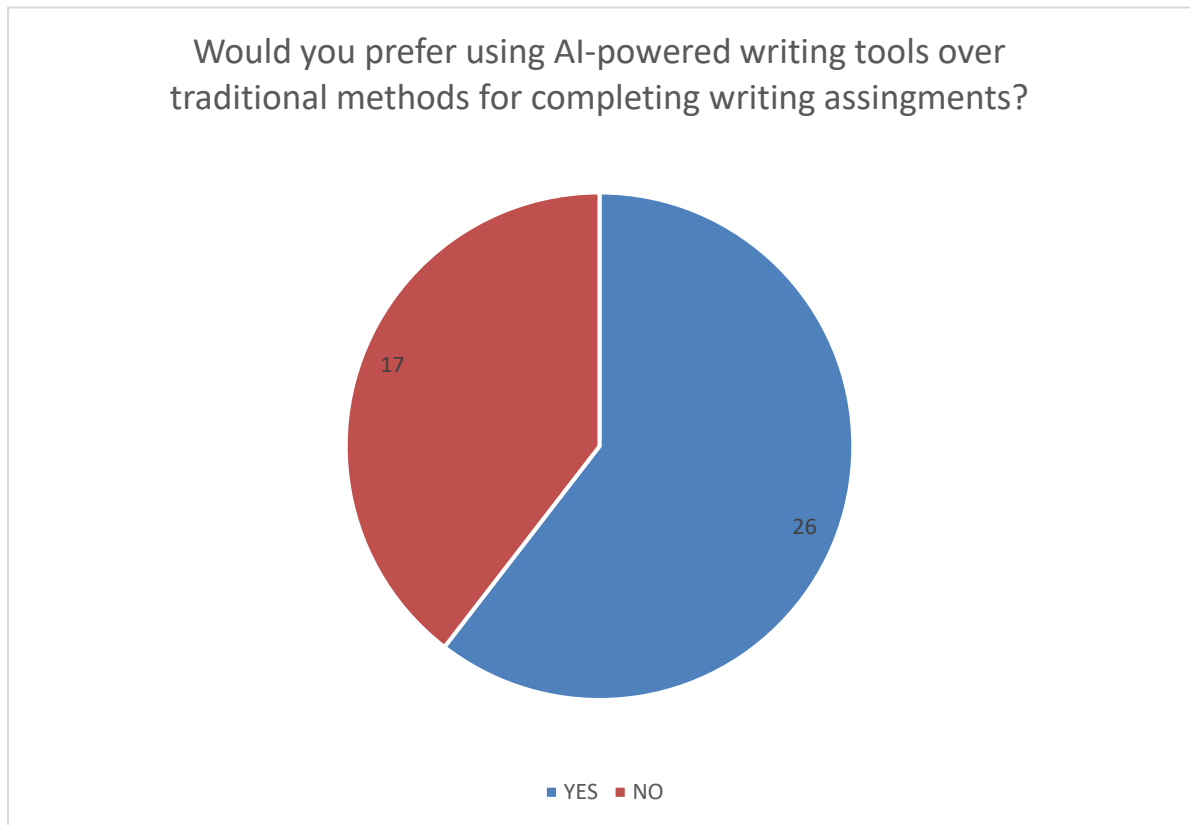
Figure 16. Would you prefer using AI-powered writing tools over traditional methods for completing writing assignments?

How do you think AI-powered writing tools could be improved?

13

8

22

■ I do not know ■ It does not need improvement ■ Fine tuning/updates
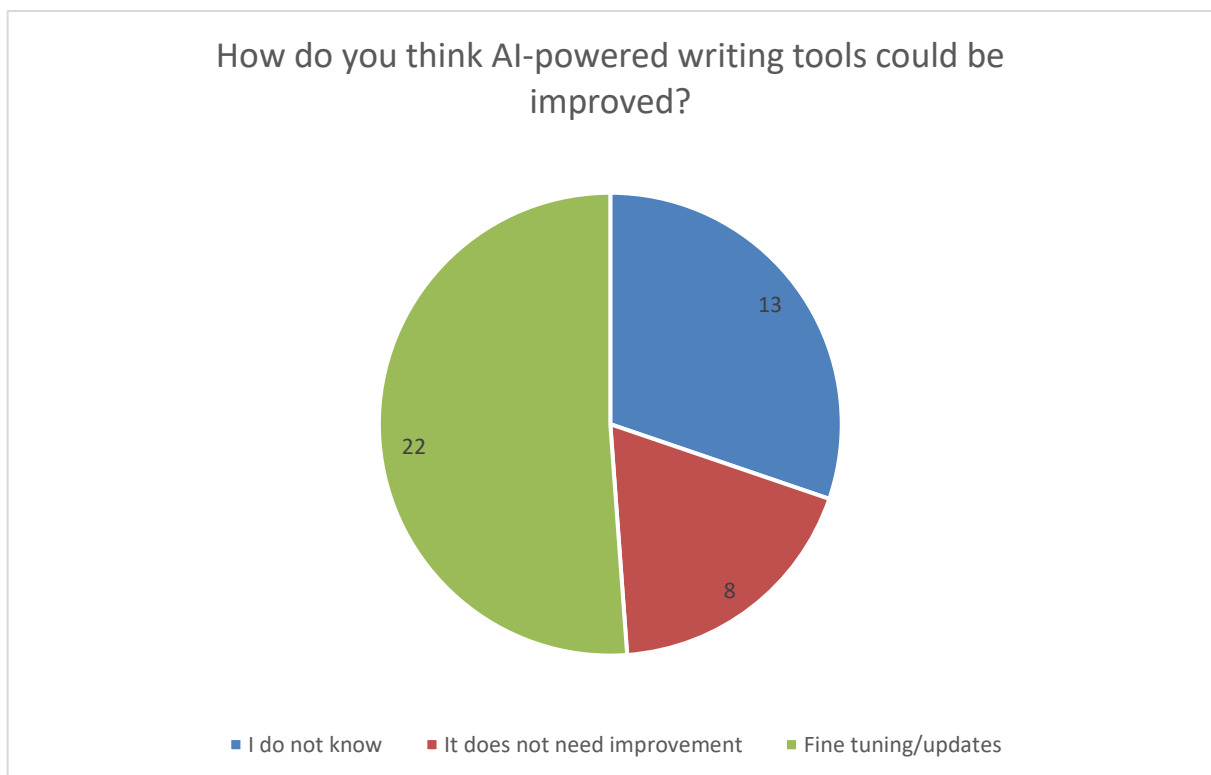
Figure 17. How do you think AI-powered writing tools could be improved?
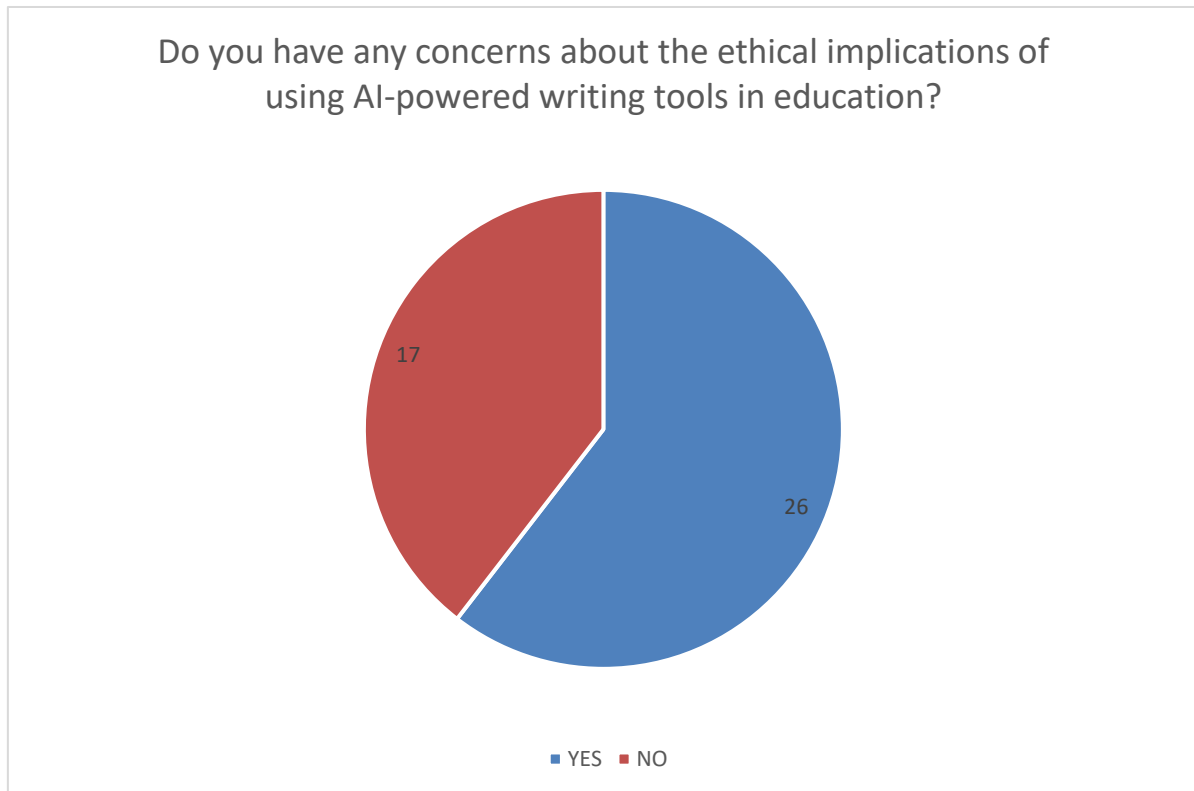
Figure 18. Do you have any concerns about the ethical implications of using AI-powered writing tools in education?

5. DISCUSSION

A total of 43 respondents, all first-year students majoring in English, participated in an anonymous questionnaire designed to assess their experiences and attitudes towards using AI-powered writing tools like ChatGPT in academic settings. The questionnaire contained 18 questions, and the data presented represents partial findings from the overall experiment.

Confidence in Writing Abilities

When asked to rate their overall confidence in their writing abilities on a scale from 1 to 10, the students gave a wide range of responses, providing insights into their self-perception of writing proficiency. This variability suggests that while some students feel competent in their writing, others may struggle with specific aspects of their writing process. This data serves as a valuable baseline for understanding how the introduction of AI-powered tools, like ChatGPT, may impact students' confidence over time as they engage with the technology in a learning environment.

Among the 43 students, the rating likely spanned across the spectrum, from students who felt less confident in their writing abilities to those who were more self-assured. This diversity in responses underscore the fact that within any academic cohort, there will always be variations in skill levels, even among students pursuing the same major. Confidence in writing is a crucial indicator of how receptive students might be to adopting AI tools like ChatGPT to enhance their writing. For example, students with low confidence in their writing might see AI as a way to get instant feedback or structure while more confident students may view it as a supplementary tool rather than a primary source of assistance.

The questionnaire also asked students about the types of writing assignments they found most challenging. The results showed that motivation letters were seen as the most difficult, with 17 students selecting it, following by essays (15 students) and letters requesting more information (13 students). These are all forms of formal writing, which are often central to academic and professional life. Motivation letters, in particular, require students to present themselves persuasively and concisely, a task that can be daunting.

Understanding the students' challenges with writing assignments allows us to see how AI tools could be integrated more effectively into their academic routines. For example, ChatGPT could assist with brainstorming and structuring essays, or even help generate ideas for the content of a motivation letter. However, it is equally important for students

to learn how to critically evaluate and refine the suggestions provided by AI, as over-reliance on technology can hinder the development of independent writing skills. The challenge for educators will be to find a balance between allowing students to use AI as a tool while still encouraging them to develop their own critical thinking and writing abilities.

Pre-Writing Approaches and AI Usage Among Students

The next significant finding from the questionnaire relates to how students approach the pre-writing phase of their assignments. The data revealed that 37% of the students favored brainstorming as a pre-writing strategy, while an equal percentage opted for outlining. Another 23% of students focused on writing structure and taking notes, and only 3% reported that they skipped the preparation entirely. This distribution demonstrates that the majority of students understand the importance of pre-writing strategies and engage in some form of preparation before starting their assignments.

The data also indicated that 74% of respondents had prior experience using AI-powered writing tools before participating in this experiment. Among these students ChatGPT was the most frequently used tool (42%), followed by Grammarly (9%) and Google Translate (10%). This high percentage of AI tool users is not surprising, given the increasing availability and accessibility of such tools in educational settings.

In terms of frequency of use, 37% of students reported using AI-powered writing tools multiple times a week, while 23% used them once a month. This frequency data suggests that AI tools are becoming a regular part of students' writing processes, particularly for those who use them multiple times a week.

Perceptions of AI-Tools' Impact on Learning and Writing Skills

A critical section of the questionnaire focused on students' perceptions of how AI-powered tools like ChatGPT impacted their learning experience and writing skills. The responses revealed that 79% of students believed that these tools enhanced their learning, and an equal percentage felt that they improved their writing skills. These findings highlight a strong positive reception towards AI tools.

The belief that AI tools enhance learning is particularly significant, as it suggests that students are recognizing the value of these tools beyond mere convenience. AI tools like ChatGPT can provide real-time feedback, suggest improvements, and offer new ways of thinking about a problem, all of which can contribute to a deeper understanding of the writing process. This immediate, accessible feedback is often not possible in traditional classroom settings, where instructors have limited time to provide individualized feedback to every student. Moreover, the improvement in writing skills reported by 79% of students underscores the potential of AI tools to be more than just a crutch for weak writers. Even students who feel confident in their writing abilities may find value in using AI to polish their work or to explore alternative ways of expressing their ideas. It is also important to consider the 21% of students who did not feel that AI tools enhanced their learning or writing skills. These students may have different learning preferences or may struggle to integrate AI tools into their writing process effectively. For example, students who are more accustomed to traditional methods of writing and revision might find the sue of AI tools to be distracting or counterproductive.

One of the more nuanced aspects of the survey was the question about how AI tools impacted students' creativity. Here the responses split, with 56% of students reporting that AI tools had a positive impact on their creativity, while 44% felt that these tools had a negative impact. This division reflects the complexity of the relationship between technology and creativity. For some students, AI tools like ChatGPT can inspire new ideas, provide alternative ways of phrasing thoughts, or help overcome writer's block. For others, the structured formulaic responses generated by AI might feel restrictive, leading to a perceived reduction in creative freedom.

Ethical Concerns and Future Implications for AI-Powered Writing Tools

Ethical considerations are becoming increasingly important as AI technology becomes more integrated into educational practices, and it is encouraging to see that 53% of students expressed concerns about the ethical implications of using AI in academic writing. This indicates that students are not only aware of the capabilities of AI tools but are also thinking critically about the broader consequences of their use.

Additionally, the use of AI tools in education raises questions about fairness and equity. Not all students may have access to the same AI tools, and those who do may have varying levels of proficiency in using them. This disparity could create an uneven playing field, where students who are more adept at using AI tools have an advantage over their peers.

Despite these concerns, nearly half of the students (47%) did not express ethical reservations about using AI in education, suggesting that they view these tools as a natural extension of the technological advancements already

present in modern academic environments. For these students, AI-powered tools may be seen as no different from other forms of technology, such as grammar checkers or online research databases, that have been used for years to assist with academic work.

When asked how AI tools could be improved, 54% of students suggested that these tools need more time and fine-tuning, while 18% felt that no improvements were necessary. The desire for further improvement likely stems from the recognition that while AI tools are helpful, they are not yet perfect.

6. CONCLUSIONS AND IMPLICATIONS

The integration of ChatGPT into the EFL classroom represents a significant advance in modern pedagogy, redefining the field of language education. This symbiotic connection between technology and education offers countless opportunities for both educators and students. Our research on the use of ChatGPT among first-year English major students at our university provides important insights into how these tools are perceived and utilized in an academic context. A majority of students expressed confidence in their ability to improve their writing skills and enhance their learning through the use of AI, particularly in areas where they face challenges such as writing motivation letters and essays. The data indicates that ChatGPT offer practical benefits in assisting students with pre-writing tasks such as brainstorming and outlining, helping them organize and structure their work more effectively. Additionally, students demonstrated a broad familiarity with AI tools, with a notable portion incorporating them into their writing processes on a regular basis.

The results also highlight the importance of addressing ethical concerns. With over half of the students expressing worries about the implications of using AI in education, there is a clear need for establishing guidelines that promote the responsible and ethical use of these tools. As AI continues to play an increasing role in academic life, these ethical considerations must be addressed to ensure fairness, academic integrity, and the development of independent writing skills.

The data gathered from this study presents several key implications for educators and institutions looking to incorporate AI-powered writing tools into their curricula.

1. **Support for Struggling Writers:** AI tools like ChatGPT can help students who struggle with writing tasks by providing guidance and feedback, but they should be used to complement, not replace, independent skill development.

2. **Enhancing Engagement and Creativity:** While AI tools can stimulate creativity for some students, educators should encourage critical engagement with AI-generated content to ensure creativity is enhanced, not constained

3. **Ethical Awareness and Instruction:** Institutions should implement clear guidelines on responsible AI use, focusing on academic integrity and original work, to address students' ethical concerns

4. **Addressing Over-reliance on AI:** To prevent over-reliance on AI, educators should emphasize manual editing and critical thinking, encouraging students to engage with writing beyond. AI-generated feedback.

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Evaluating Critical Thinking in Higher Education: An Analysis of University Students Using the CThQ

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Abstract

Critical thinking is one of the most important skills in tertiary education, which allows students to effectively articulate, assess, and combine information. It is also imperative to work on their critical thinking aspect for them to be able to make sound decisions, address problems as well as critically participate in academic as well as encountering the profession. Critical thinking, as a complex and multifaceted capacity, incorporates various processes such as analysis, evaluating, creating, remembering, understanding, and the application of knowledge which are critical to achieving academic goals and lifelong education as well. This research focuses on the levels of critical thinking exhibited by a sample of 160 student university students performed the Critical Thinking Questionnaire (CThQ). In our analysis, we utilized Jamovi software to measure the Cronbach's Alpha reliability coefficient as well as to examine the intercorrelations between individual input variables. We aimed at establishing the degree of internal consistency and reliability of (CThQ) in relevance to our study. Our results demonstrated that all variables in the questionnaire showed positive intercorrelations. Each ability showed a strong correlation to total CThQ. These findings confirm the robustness of the CThQ in measuring distinct dimensions of critical thinking with reliable internal consistency. In addition, our results revealed critical thinking skills of the respondents: 54% of students fall into the high achievers' category, along with the rest of the sample who got scores that are considered to average. The study confirms CThQ applicability in evaluation of thinking and provides an understanding of the level of critical thinking among the university students demonstrating the utility of the instrument in various educational settings.

Keywords: Critical Thinking, CThQ, University Students, Analysis,

1. INTRODUCTION

In the era of innovation and digitalization, critical thinking has become one of the most valuable skills in the labor market. As a key skill, it contributes not only to enhancing individuals' professional prospects and improving the quality of their personal lives (Vincent-Lancrin, 2023) but also to benefiting society as a whole (Aouaf et al., 2023).

Critical thinking is often defined as the ability to think logically and rationally, involving the assessment of arguments and evidence to arrive at relevant problem solutions (Ennis, 2018). This definition primarily focuses on

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* Corresponding author.

analytical thinking; however, the comprehensive concept of critical thinking also includes the dimension of critique and examination of various perspectives (Vincent-Lancrin, 2023), as well as the ability to justify one's claims and decisions based on available information (Hitchcock, 2018) and the capacity to recognize assumptions and limitations, including those that may appear superior to others (Thompson, 2011).

Chen (2017) expands the definitions of critical thinking to include cognitive abilities, such as logical reasoning, problem-solving, and intellectual independence, characterized by using sound judgment to support ideas.

Based by D'Alessio et al. (2019) critical thinking is not only about logical reasoning but also involves the integration of attitudes, knowledge, and skills. Thus, critical thinking encompasses not only cognitive abilities but also the capacity for analysis, inquiry, objective evaluation of evidence, and making the most appropriate decisions (Hitchcock, 2017).

The American Dental Education Association highlights the importance of critical thinking in healthcare and expands the concept with "intellectually engaged, skilled, and responsible thinking" (Jauregui et al., 2024). This definition emphasizes that critical thinking requires the application of assumptions, knowledge, competencies, and the ability to question one's own thinking to reach sound judgment.

Despite varying definitions, there is a consensus that critical thinking is a metacognitive skill that involves logical reasoning and is essential to develop through educational programs.

We consider critical thinking to be crucial in the context of higher education. Critical thinking allows students to engage in deeper and more analytical learning, enabling students to critically evaluate complex information. In this regard, we can talk about the opposite of simple and often meaningless memorization of facts. Critical thinking becomes a skill that gives students a competitive advantage - with critical thinking they can make quality decisions, which we consider essential for their professional success and responsible citizenship. This contribution aims to assess the level of critical thinking of our university students, based on Critical Thinking Questionnaire (CThQ) developed by Kobylarek et al. (2022). The obtained results will allow us to better understand their analytical skills and identify areas for improving the educational approach. We believe that thanks to these findings, we will be able to change our education system and better prepare our students for the demands of the modern workforce.

2. LITERATURE REVIEW

The concept of developing critical thinking has proven to be a significant element of contemporary modern education (Walter & Walter, 2018), serving as an essential tool for fostering effective learning (Kavenuke et al., 2020; Saldıray & Doğanay, 2024). For this reason, it is necessary to purposefully shift the emphasis on critical thinking development to the academic environment.

A broad range of studies confirms the positive impact of critical thinking on students' academic achievements (Bagdasarov et al., 2017; Belda-Medina, 2022; Hu et al., 2016; Manganelli et al., 2019; Pieterse et al., 2023). In addition to academic success, critical thinking contributes to various personal variables, such as perseverance, attitudes (Arisoy & Aybek, 2021), self-esteem (Bonnette et al., 2001), and also has a positive impact on overall success in professional life (Dwyer et al., 2015).

The development of students' critical thinking directly correlates with the improvement of their socialization skills, increased interaction, as well as building better relationships and the development of communication skills (Batdı et al., 2024). These findings emphasize the need for actively employing student-centered teaching methods that support their ability to independently discover knowledge and develop critical thinking.

To fully leverage the potential of students' critical thinking, educational practices must be fundamentally shaped to enable and allow students to think critically. Individuals who actively use these skills are more open to innovation (Ennis, 2018) and driven by a desire to analyze the causes of the problems they encounter (Shehab & Nussbaum, 2015).

Critical thinking is becoming an increasingly essential skill that enhances career prospects and quality of personal life. It supports academic success and the development of personal skills, such as perseverance and self-esteem, while also improving socialization and communication skills, leading to more effective interactions and relationships. Teaching focused on the development of critical thinking enables students to discover new knowledge more effectively and think independently. Educational approaches should be structured to cultivate these skills.

2.1. Development of Critical Thinking in the Academic Environment

Given the growing importance of critical thinking in modern education, critical thinking has been emphasized as a core 21st-century competency across many educational domains worldwide. Likewise, most curricular documents within OECD countries identify critical thinking as one of the key competencies that students should acquire through public education (Vincent-Lancrin, 2023). This reality necessitates the integration of critical thinking into the curricula of various subjects across primary, secondary, and tertiary levels of education (Yuan et al., 2022).

Many educational systems have begun to focus on revising their curricula, adopting a competency-based approach that highlights the importance of holistic education. The New Zealand Ministry of Education has incorporated increased expectations regarding critical thinking for high school students within its curriculum (Davies et al., 2023). Since 2016, critical thinking has been mandated as a competency for dental students by the Commission on Dental Education (Jauregui et al., 2024), and in the field of nursing, critical thinking education has been part of the curriculum since 1989 (Doyon & Raymond, 2024).

Similarly, the Thai government has established critical thinking as one of the essential skills for students' future success and included it in its national education plan (Setyowati et al., 2018). Overall, the development of critical thinking through well-designed curricula and teaching strategies is seen as essential for preparing students for their future careers and personal lives, as it supports their overall development.

In most countries, society agrees that schools should teach students creativity and independent thinking. However, implementing competency-based curricula faces practical obstacles. The main issue is not resistance to change, but rather uncertainty about how exactly to develop critical thinking in practice. Teachers and curriculum designers may struggle to envision specific ways to foster critical thinking (Vincent-Lancrin, 2023). There is also the question of monitoring whether curricula adequately address and enhance critical thinking skills (Jauregui et al., 2024). This process can be challenging, as critical thinking is a complex skill that is difficult to quantify and objectively measure, adding difficulty not only to implementation but also to assessing the effectiveness of teaching methods aimed at developing critical thinking.

To address this issue, it is necessary to provide clear guidelines and examples of practical teaching methods that promote critical thinking. These methods should be incorporated into educational programs and should be appropriately adapted to schools to enable their effective use in the classroom. The development of critical thinking should be supported not only theoretically but also through suitable methods such as discussion, problem-solving, and reflective thinking.

3. METHODS

For our research, we used the Critical Thinking Questionnaire (CThQ) developed by Kobylarek et al. (2022). The questionnaire is a critical thinking test tool designed for adolescents and adults. The basis for creating the questionnaire was classifying the educational goals proposed by Benjamin Bloom and spread by critical thinking practitioners. The questionnaire consisted of 25 statements. Each statement was rated by respondents on a 5-point Likert scale from 1 = strongly disagree to 5 = strongly agree. The questionnaire was focused on respondents' ability to Analyse (A), Create (C), Evaluate (E), Remember (R), Understand (U), and Apply (X). The overall critical thinking score (TC) was calculated as the sum of individual abilities – TC = A+E+C+R+U+X. We sent the questionnaire electronically to students at the University of Economics in Bratislava and received 160 responses. We processed the results in Jamovi - an open-source statistical software. The sample distribution and the results of the overall critical thinking score are shown in Table 1.

Table 1. Descriptives

		Sex	*A*	*C*	*E*	*R*	*U*	*X*	*Total Score*
N	W	82	82	82	82	82	82	82
	M	78	78	78	78	78	78	78
Missing	W	0	0	0	0	0	0	0
	M	0	0	0	0	0	0	0
Mean	W	15.2	23.2	15	9.99	13.7	15.6	92.7

	M	15.4	23.3	15.4	10.2	14.7	15.4	94.5
Median	W	15	23	15	10	14	16	93
	M	16	23	15	10	15	16	94
Sum	W	1245	1903	1234	819	1127	1276	7604
	M	1204	1821	1198	796	1149	1201	7369
Stand. Dev.	W	1.89	2.04	1.99	1.72	2.14	1.85	7.83
	M	1.82	2.22	1.97	1.87	2.02	2.08	7.97
Minimum	W	11	17	10	6	7	9	71
	M	11	18	10	6	11	9	78
Maximum	W	20	28	19	15	20	20	117
	M	20	28	20	14	20	20	116
Skewness	W	-0.158	-0.397	-0.5	0.182	-0.389	-0.642	-0.0276
	M	-0.146	0.119	-0.268	-0.135	0.137	-0.469	0.448
Std. error skewness	W	0.266	0.266	0.266	0.266	0.266	0.266	0.266
	M	0.272	0.272	0.272	0.272	0.272	0.272	0.272
Kurtosis	W	-0.397	1.47	0.247	0.155	1.07	1.9	0.891
	M	0.31	-0.221	0.265	-0.61	-0.248	0.0683	0.364
Std. error kurtosis	W	0.526	0.526	0.526	0.526	0.526	0.526	0.526
	M	0.538	0.538	0.538	0.538	0.538	0.538	0.538

Source: Own processing in Jamovi

As it is shown in table 1, 82 responses were women and 78 men. Women had a mean total critical thinking score of 92.7, while men had a mean score of 94.5. The median values for the total score are 93 for women and 94 for men. The standard deviations for total scores are approximately 7.83 for women and 7.97 for men, indicating a similar amount of variation within gender. The minimum total critical thinking score is 71 for women and 78 for men. The maximum score is 117 for women and 116 for men. Skewness for individual abilities is mostly moderate, with values close to zero, indicating an almost symmetrical distribution of the data.

4. RESULTS

Scale Reliability Statistics – the value of Cronbach's alpha α=0.766 indicates good internal consistency. Item Reliability Statistics demonstrate acceptable reliability, with Cronbach's alpha values ranging from 0.721 to 0.755. The overall critical thinking score (TC) also indicates good internal consistency with a value of 0.751. These results suggest that the CThQ is a reliable tool for assessing critical thinking abilities among adolescents and adults, as administered to the sample of students at the University of Economics in Bratislava. For more details see Table 2 and Table 3.

Table 2. Scale Reliability Statistics

	Cronbach's α
scale	0.766

Source: Own processing in Jamovi

Table 3. Item Reliability Statistics

	If item dropped
	Cronbach's α
A	0.725
C	0.721
E	0.755
R	0.742
U	0.726
X	0.748
TC	0.751

Source: Own processing in Jamovi

To assess the internal validity of the instrument, the Pearson correlation coefficient (r) was employed (see Tab. 4). The findings reveal positive correlations among the different scales of the CThQ test, as well as between each scale and the total score. Notably, the correlations among the individual scales are significantly lower than those between the scales and the overall score. This indicates that the scales exhibit satisfactory homogeneity and internal consistency within the test.

Table 4. Internal CThQ (N=160) correlations between individual categories and the overall score

Correlation Matrix

	A	C	E	R	U	X	TC
A	—						
C	0.489 ***	—					
E	0.340 ***	0.293 ***	—				
R	0.411 ***	0.383 ***	0.219 **	—			
U	0.549 ***	0.472 ***	0.197 *	0.331 ***	—		
X	0.334 ***	0.347 ***	0.058	0.320 ***	0.288 ***	—	
TC	0.774 ***	0.756 ***	0.525 ***	0.648 ***	0.720 ***	0.583 ***	—

Note. * $p < .05$, ** $p < .01$, *** $p < .001$
A-analysing, C-creating, E-evaluating, R-remembering, U-understanding, X-Applying, TC – Total score

Source: Own processing in Jamovi

Based on the correlation matrix, we can conclude that the individual variables (A, C, E, R, U, X) exhibit positive correlations with each other, indicating a certain level of connection between these aspects of critical thinking. The highest correlation with other abilities is shown by Analysing (A), particularly with the ability to Understand (U) (r = 0.549), which may suggest that the ability to analyse is closely related to comprehension and understanding of information. Application (X) generally has weaker correlations with other abilities, especially with Evaluate (E) (r = 0.058), which implies that the ability to apply knowledge to problems is somewhat independent of the ability to evaluate.

All abilities positively correlate with the overall critical thinking score (TC), confirming that each ability contributes to the overall critical thinking construct. Analysing (A), Creating (C) and Understanding (U) show the strongest correlations with the overall critical thinking score (A: r = 0.774; C: r = 0.756 and U: r = 0.720), suggesting that these abilities may be particularly important for the respondents' overall level of critical thinking.

The lowest but still significant correlation is found between Application (X) and the overall score (r = 0.583), indicating that while application contributes to overall critical thinking, it may do so to a lesser extent than other abilities.

The correlations between individual abilities and their higher degree of correlation with the overall score TC indicate adequate internal consistency of the questionnaire. The scales measure distinct yet related aspects of critical thinking, which confirms that the questionnaire appropriately covers various dimensions of critical thinking without excessive redundancy. The results suggest that the questionnaire has good internal consistency, as individual abilities significantly correlate with the overall score, which is essential for reliably measuring critical thinking.

Table 5 documents the results of our sample across individual parameters. According to the original study by Kobylarek et al. (2022), the scores for each input variable were evaluated as follows:

In Analysing (A) the results of the various areas of cognition, interesting trends emerge that indicate different levels of mastery of specific competencies. The results show that 69% of respondents achieved high results in this category, which indicates a strong ability to analyse information. This high score can be interpreted as high sophisticated individuals displaying analytic characteristics in their preference for establishing links between ideas or distilling the "essence" from textual materials. Such individuals are usually in search of interconnections among various sources of information.

In the category of Creating (C), 64% of respondents achieve high results, demonstrating that most participants are capable of effectively generating new ideas. Creators do not mind combining different ideas together and making new links among them and presenting ideas in various forms. They seek blue ocean strategies during the analysis of old texts and are eager to take risks fiercely to create something new.

In the category of Evaluating (E), 66% of respondents achieve high results. High evaluators investigate such information deeply while ensuring they have explored all aspects of the message and consult several resources. They support their arguments during discussions and disputes and try to understand why other people think differently. However, in this category, we also see 4% of respondents classified as Low Results, indicating a need to deepen evaluating skills through training.

In the category of Remembering (R), individuals scoring high are capable of the remembering function. They can easily recall key concepts and relevant knowledge from previous experiences. They can accurately reproduce the main ideas after a text has been read and remember important details from previous lessons. Interestingly, 57% of respondents achieve average results, while only 37% fall into the high category. Here too, we note the need to improve memorization techniques and increase student motivation to remember important information.

In the area of Understanding (U), the results show a distribution of 45% (high) and 53% (average). We observe that participants generally feel comfortable with comprehending the content, but there is still room for improvement. High scorers here give meaning to information from multiple sources, appreciate differences, and go beyond literal statements. They possess good skills in figurative language and pay attention to context and nuances.

For the category of Applying (A), those who are advanced in applying knowledge can demonstrate that they are able to transfer knowledge to real-life problems, often during debates or discussions, providing examples and knowledge to the audience. The 73% of respondents achieving high results in applying knowledge indicates strong skills in transferring theoretical knowledge into practice, which is a positive sign.

Overall, the results are encouraging 54% of students achieved high results in the Total Score, and no student fell into the Low Results category. Excellent results are particularly evident in the areas of analysing and applying. Nevertheless, some areas, such as remembering and understanding, require additional attention and resources for development. In the future, we propose preparing programs focused on improving these skills to achieve a more balanced development of competencies among participants. For more details, see Table 5.

Table 5. Results of CThQ (N=160)

	Low Results	Average results	High Results	Total
A-Analysing	0	50	110	160
A %	0%	31%	69%	100%
C-Create	0	57	103	160
C- %	0%	36%	64%	100%
E-Evaluating	6	49	105	160
E%	4%	31%	66%	100%
R-Remembering	10	91	59	160
R-%	6%	57%	37%	100%

U-Understanding	4	84	72	160
U-%	3%	53%	45%	100%
X-Applying	3	41	116	160
X-%	2%	26%	73%	100%
TC score	0	73	87	160
TC%	0%	46%	54%	100%

Source: Own processing

5. CONCLUSION

The results of our research confirm the effectiveness of the Critical Thinking Questionnaire (CThQ) as a reliable tool for assessing critical thinking skills among university students. This assertion is also supported by robust internal consistency results (Cronbach's α = 0.766) and significant positive correlations between individual abilities and the total critical thinking score. The findings suggest that skills such as analysis and comprehension play a particularly strong role in contributing to overall critical thinking skills, while application, while correlated, is somewhat more independent. Gender differences were minimal, with males showing slightly higher mean scores in overall critical thinking. The positive correlations between the different scales indicate that while each ability (Analyse, Create, Evaluate, Remember, Understand, Apply) measures a unique aspect of critical thinking, together they contribute to a cohesive construct. This study reaffirms the utility of the CThQ for assessing critical thinking in a variety of educational contexts and provides valuable insights into students' abilities to critically analyse, understand, and apply knowledge in an academic setting.

Acknowledgements

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The Influences of AI-Enhanced Learning on Student Engagement in English Classes

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Abstract

This research assesses the role of AI incorporated learning platforms and applications on student engagement in English lessons in terms of behavioral, cognitive, and emotional. The participants were 138 non-English studies students studying in a multidisciplinary university that has implemented AI in the teaching and learning activities. A questionnaire adapted from Li et al. (2024) and Sadegh-Zadeh et al. (2023) was used as the primary data gathering tool since quantitative approach was adopted. The findings indicated a positive effect on behavioral engagement as the AI enhancement boosted on time completion of tasks and practice. Another aspect which benefited from cognitive activation included problem solving capacity thus was more enhanced and, as for emotional engagement the results were surprisingly positive where some of students exhibit positive sentiments of joy and low rate of anxiety. However, the study also found that there were foreseeable issues that needs to be addressed, for instance improving the feedback systems in the use of Artificial intelligence. Suggestions include seeking a large sample in other studies, testing effects over time, and improving the AI applications that might help the student in building confidence.

Keywords: AI-enhanced learning, behavioral engagement, cognitive engagement, emotional engagement, English classes.

1. INTRODUCTION

AI has turned into an innovative tool in Education, the purpose of which is to optimize the educational process (Bernacki et al., 2021). In language acquisition in the English language specifically, Hashim et al., (2022) assert that the application of AI yielded intelligent tutoring, personalized learning, and intelligent feedback systems. They have been developed to satisfy the preferences of each student, thus enhancing the effectiveness of language learning. For example, students can now practice English autonomously and at their convenience due to the availability of AI chatbots, speech recognition software, and language learning applications such as Duolingo, Quizzes, Kahoot, or Grammarly. Hashim et al. (2022) point out that as AI evolves and accustomed to school systems, education would constantly undergo change and offer possibilities to students and teachers to enhance learning proccesses.

According to Phillips and O'Flaherty (2019), the significance of the student's involvement in any educational intervention lies at the core of its success. Engaged learners tend to be more active participants, have a more meaningful understanding of content, and have better academic performance (Bakare & Jatto, 2023). AI-led learning is crucial and requires better use of these tools since their effectiveness depends on the learner's engagement with the tools. In fact, In the absence of adequate engagement, adopting most AI programs may not lead to meaningful language advancement. As a result, it is equally important to study the impact of AI on the different components of student engagement for its wider use in education. Fredricks et al. (2004) emphasize a broad model of student

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engagement, mainly there are three namely behavioral, cognitive, and affective. Outcomes of behavioral engagement are students contented, motivated, and actively participating when learning is taking place. Cognitive involvement is the extent to which material content and the strategies for processing this material have been incorporated by the learner. Students' enjoyment, interests, or even anxiety towards the learning process is referred to as emotional engagement, which is also one of the three forms of engagement. This three-part model is beneficial as a guide in evaluating the effects of AI-enhanced learning on student engagement in English language education.

Despite the advantages these tools could offer, scant literature discusses the third, fourth, or even fifth force effects of AI tools on the different dimensions of student engagement (behavioral, cognitive, and emotional) within the language learning context. Further, many of these studies have been inclined to the technological dimensions of AI or the academic outputs, but only some deal with the aspects of students' motivation, participation, and emotional reaction shown in the course of learning. This is important because even the best AI tools might only serve their purpose if the students are engaged. As a result, there has been a gradual increase in the need to examine what effect AI-supportive technologies have on the student's overall engagement in learning English. This research aims to investigate the dynamics of student engagement in English language learning, which is enhanced with AI technologies, with a particular focus on behavioral, cognitive, and emotional engagement. Concerning the engagement model developed by Fredricks et al. (2004), this study will advance our understanding of how AI tools shape students' participation and effort (behavioral engagement), their deeper processing and strategic thinking (cognitive engagement), including positive and negative emotions such as enjoyment and anxiety (emotional engagement) and anticipation for an English course featuring AI tools. As such, this study seeks to answer the following questions:

  - To what extent does AI-enhanced learning influence students' behavioral engagement in English classes?
  - To what extent does AI-enhanced learning influence students' cognitive engagement in English classes?
  - To what extent does AI-enhanced learning influence students' emotional engagement in English classes?
  - What are the students' expectations for AI-enhanced further English courses?

2. LITERATURE REVIEW

2.1. AI in education and language learning

2.1.1. Overview of AI tools in language education

In the context of AI- revolutionary, the AI tools take the learning languages and turn them into something more personal, fun, and backed by statistics (Hashim et al., 2022; Sun 2021). An aspect that has received little research attention and implementation in this regard is the use of technology by the learners. Bernacki et al. (2021) state that AI tools should be able to provide other functions that the learners require to learn a language at their speed while providing them mastery. Language learning apps like Duolingo or Babbel consist of advanced rudimentary artificial intelligence system that records the efficiency of the learner and adapts the difficulty of the level in the application.

AI-based chatbots also contribute to this aspect because they act out like real-life exchanges, which give log learners the possibility to practice communication in a non-biased context (Song & Wang, 2020). Similarly, the intelligent tutoring systems that are AI-generated can develop the environment wherein they are able to determine what area the student needs improvement in and then assign the corresponding task (Sun, 2021). The integration of features of natural language and the machine-based learning system enhances the effectiveness of the language teaching aids in language acquisition. The prospects for teachers and students are vast because they employ AI tools, and AI tools become more sophisticated. With the addition of these aspects, language learning process can turn into a more self-initiated and collaborative process (Paek & Kim, 2021).

2.1.2. AI's effectiveness in English teaching and learning

Higher education is rapidly developing thanks to AI, which increases student participation and changes learning and teaching methods in new ways. New technology trends, including generative AI, make it possible to design learner-centered environments (Nguyen et al., 2024). These technologies facilitate individualized learning, encompassing intelligent tutoring and adaptive systems for different learners (Zawacki-Richter et al., 2019). In the classroom, teachers using AI can provide more interactive resources, such as visual illustrations of complex scientific texts, enhancing understanding and information retention for these learners. Moreover, AI technologies that analyze large amounts of educational data through learning analytics allow educators and scholars to identify trends regarding students' use of the content and their interaction engagement (Whitehead et al., 2024). As a result, it aids in designing

appropriate learning interventions that meet particular needs and improve teaching and learning effectiveness. The example of academic writing given by Nguyen et al. (2024) shows how humans and AI cooperate to enhance human performance in writing to make it more efficient and creative in its outcome is a good illustration of what AI can do to ease writing for human without cutting on its creativity.

2.2. Student Engagement

2.2.1. Definitions and dimensions of engagement

Student engagement is not a new concept; it is a multidimensional phenomenon of critical significance in the context of achievement. It includes students' interests and efforts, their inner sense and behavior concerning school and its activities, which the students undertake (Appleton et al., 2008; Fredricks et al., 2004). Other studies provided definitions of engagement concerning human activity, where one can understand engagement as time spent actively participating, emotional effort and energy spent towards learning, and students' self-identifying with the purpose of study (Skinner et al., 2009). Engagement is a construct that includes more than being there and doing what is expected. It includes the investment of feelings and emotions toward learning where students do not just attend but take up academic and extracurricular activities (Newmann et al., 1992). Time and emotions set aside for engagement are important for learning, as they bring a feeling of being part of something and having a purpose in the community school. Engagement is also physically associated with positive affection or enjoyment and energy in terms of better educational experiences and outcomes (Kuh, 2003). That is, wider circles of students will be active and striving for positive achievements if only teachers make the environment engaging and encouraging. Inclusion is an interaction with deep or meaningful consequences for academic achievement and psychological development (Christenson et al., 2008).

2.2.2. The Role of engagement in enhancing English language learning

Engagement is crucial in improving language learning and achievement since it creates an atmosphere for active participation and social engagement (Christenson et al., 2008; Kuh, 2003). Active learners are more involved in language activities, and when they are involved, they have an improved capacity to learn and memorize new words, grammatical forms, and pronunciation. Baron and Corbin (2012) establish that such active learners tend to conduct language activities in and outside the class. As such, comprehension and achievement of a formal language will help enhance fluency. It is at such a level as language cannot be a subject to study and rehearse in a passive manner but one to employ and train.

Further, engagement improves academics hence improved effortful processing (Bakare & Jatto, 2023). The learners who attend classes and participate also engage in other metacognitive processes such as planning and evaluating learning and self, which are essential for learning of complicated academic material. Such self learning approaches assist them control their learning hence enhancing understanding and assimilation of the content. Moreover, emotional engagement, such as positive feelings and motivation, drives students to want to learn, accept challenges, and become committed to adversity (Skinner et al., 2009). This is critical in an educational environment where students face complicated issues requiring endurance and rigorous analysis. Thus, the development of student engagement is critical for students' language attainment and overall academic performance.

2.3. Theoretical framework

2.3.1. Fredricks et al.'s (2004) model of engagement

Engagement is discussed as a changeable and multifaceted process defined by Fredricks et al. (2004); it is important to recognize the specific characteristics of this process in educational contexts. The model identifies three interrelated dimensions: cognitive, affective, and psychomotor domains where these three aspects incorporate different value toward teaching and learning processes of students.
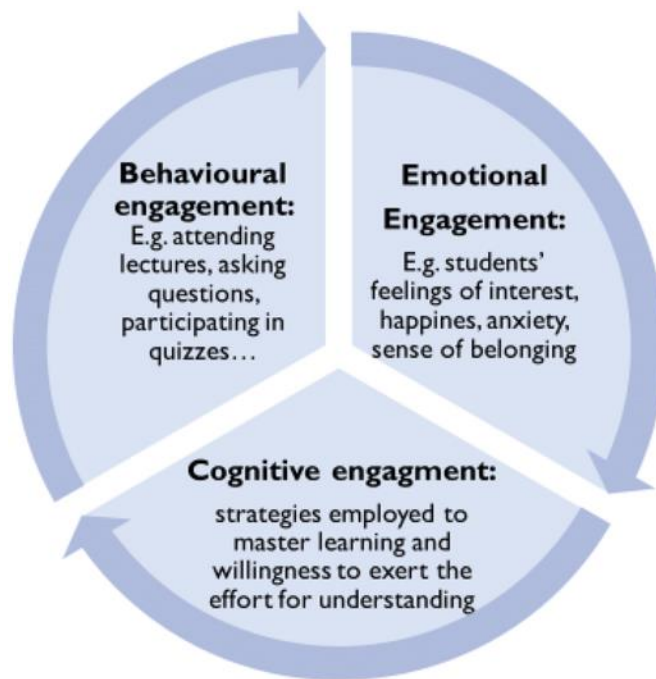
Figure 1. Engagement model by Fredricks et al. (2004)

Behavioral engagement includes the degree to which students participate in lesson and other out of lesson activities, obedience to classroom rules and regulations, and efforts in completing academic tasks (Fredricks et al., 2004; Finn & Rock, 1997). This dimension is critical as it positively correlates with academic achievement and minimizes student dropout chances (Rumberger, 2004). By actively participating, students follow the schools' regulations and have practical learning that contributes to achieving academic goals.

Cognitive engagement can be defined as the extent of mental involvement that students commit to learning processes. This includes planning learning strategies, self-control, and readiness to perform complex tasks (Fredricks et al., 2004). This dimension allows students to unpack the details of all the new things they learn and assimilate them into what they knew before to improve their understanding of concepts and retention (Finn & Zimmer, 2012).

Emotional involvement concerns with students' feelings either positive or negative towards the teaching-learning process and involves their feelings toward teachers, peers and the school in particular (Fredricks et al., 2004). Positive emotional affect means that learners are interested, happy and feel that they belong a feeling crucial when making students feel welcome when learning (Linnenbrink & Pintrich, 2003).

2.3.2. AI-enhanced learning in the context of student engagement

Education is being transformed by AI-enhanced learning by improving students' interaction with class work in a unique, personalized, hands-on manner. Li et al. (2024) note that a combination of cognitive factors and human-computer interaction in education with the aid of AI technology can positively affect the perceived usefulness as well as the perceived ease of use of the AI learning system, which is vital for the acceptance of the AI technology in learning. The focus of this research also has relevance to the importance of feeling intrinsic motivation to engage oneself in AI learning. Assessment of AI readiness, confidence to put AI courses into practice, and the availability of effective user interface designs deserve mention. Rizvi (2023) further examines the contribution of AI in a more specialized education setting. AI technologies such as virtual assistants and intelligent tutors may deliver feedback tailored to the learner's progress and assessments that are dynamically adjusted to the learner's pace. Such personalization addresses the requirements of various learners as it increases their independence and competence, thereby fostering their motivation. The research also warns of ethical issues, which include data safety and biases in the algorithms employed that need to be mitigated before AI can be rolled out in education. Salem (2023) corroborates how these tools aid education with AI-enhanced education by providing feedback in real-time and through different types of instruction. This. More importantly, AI-enabled regular classrooms were shown to facilitate student engagement with coursework and achievement of academic goals while increasing productivity by introducing new challenges, including technological disruption and privacy of data. There is a great need for teachers to develop

professionally in order to optimize the usage of such technologies. Sadegh-Zadeh et al. (2023) indicate that students' AI-enhanced online learning can be more attractive by adopting creative and interactive platforms such as Microsoft Teams. This is considered to be a major step in achieving the goal of targeting online learners' engagement since the participants in the study appreciated increased motivation levels and understanding skills as a demonstration of the potential of AI in enhancing learning.

In sum, the study highlighted the importance of participation through effective good AI integrated learning as it alters the learner's education journey through customization, flexibility and interactivity. These are impressive results; however, ethical and technological barriers must be tackled. Proper studies and cooperation between educationists, developers, and scientists are required to leverage AI's potential from a positive perspective.

2.4. Research gaps

The current study notices the need for adequate comprehension on the part of the researchers who have focused their studies on issues of student engagement in the context of the AI-enhanced learning space. While many studies investigated specific engagement features which influence learners' engagement, no engagement models comprise all three dimensions in AI enhancement. While Fredricks et al.'s (2004) framework focuses on addressing this problem and covers the direction for future practice in part, the actual practice that revolves around AI-based learning and its enablements remain an area of discussion as the enabling technology AI is multifaceted.

In an effort to support learning more fully, cognitive activity within AI systems is defined as the uses that students make of the various facilities and features of AI and/ or features of interactive AI that are at the student's intelligence level. Nevertheless, the scholars have to investigate how these tools can be developed to foster extended learning and cognitive skills development in the long run. On the other hand, behavioral engagement, meaning participation and effort to learn, can change tremendously with an AI's potential to alter and enhance the activity and game to be interactive. However, not much attention has been given to the effects of these features on behavior and patterns of action over an extended period. Positive attitude that students attach to learning is regarded as important, especially when students are provided with a lot of AI promotional interaction. But it could also lead to frustrating and demotivating frustration. However, what has not been given enough examination in the current literature is analysis of how AI can help in controlling emotions and facilitating a proper attitude towards learning for instance overcoming AI anxiety commonly faced by learners at the initial stage of using AI-based platforms.

3. METHODOLOGY

3.1. Participants

The study subjects included 138 non-English major students from a polytechnic university in Vietnam who learned Basic English based on the Market Leader Series (3rd edition) adopted by the Financial Times. The demographic breakdown shows that the composition of participants is not homogeneous: 49 males (35.51%) and 81 females (58.70%), the other gender: 8 (5.80%). In the willingness survey, in academic classification, 34 were freshmen (24.64%), 57 were second-year students (41.30%), 41 were third-year students (29.71%), and 6 were final-year students (4.35%). Moving from an array of majors, these students comprise one of the many sections in the university's academic scope that enriches the study's depiction of language learning among non-native speakers. Variations concerning gender and academic level ensure that various perspectives on English learning for specific non-major purposes are offered.

It has been these students' experience to have encountered AI technologies in their English classes as they were all participating in somewhat virtual classrooms due to COVID-19 restrictions. Changes have been observed in language teaching as much as AI languages are efficient as they have advanced technologies that help them teach independently with little supervision. Cognitive, behavioral, and emotional engagement in the courses has been affected by the incorporation of AI tools that have made the learning environment engaging and responsive. Students have faced various challenges, such as a lack of motivation and the digital divide due to the shift to an online environment. Nonetheless, there exists an avenue where language acquisition may be improved as the times have changed. Time feedback, tailored material, and engaging online activities may create a new environment where learners acquire English more efficiently and effectively.

3.2. Methodology and data collection instrument

The research employed a quantitative research approach, which was complemented by a structured questionnaire as the main data collection instrument. Using this method can be suitable for the perceptions and engagement of 138 non-English major students in the study. The adapted questionnaire from Li et al. (2024) and Sadegh-Zadeh et al. (2023) has been developed to contain 25 questions from the 5-point Likert scale whereby the study employs questions which are addressed with the aid of five different response options, these being Strongly disagree, Disagree, Neutral, Agree, and Strongly agree. Compared to this scale, this scale provides more perspective concerning the participants' attitudes and behaviors regarding AI-based language learning.

Self-rated behavioral, cognitive, emotional engagement and expectation based perception about AI tools, and the students' dreams and anticipations about the use of AI were reported. Behavioral items assess the extent of people's interaction with AI-driven tasks, peoples compliance with regard to task due dates and peoples propensity to undertake tasks that involve AI. Regarding cognitive AI, there are several parameters such aspects as feedback from AI concerning aspects of the English content being delivered and problem solving strategies. The emotional segment lays out the differences of students in emotional feelings about synthetic learning. It examines the hedonic tone, self-esteem, arousal, and threat concerning the use of AI applications and entity-related attachment. Last but not least, the expectation section, aims at finding out the expectation of the students regarding the closeness of the various facets of the course which entails features like AI tools sessions, constructive feedback, engaging sessions among other facets. In addition, it addresses the need for AI to meet specific learning requirements and alleviate certain difficulties.

3.3. Data analysis

Data were analyzed in SPSS 25, concentrating on the mean and standard deviation in analyzing students' AI extended language learning level. Concerns of interest were determined from the mean scores representing the overall trends of student responses and the standard deviations were used to show the variability of responses. The reliability of the questionnaires was optimized at 0.874 in Cronbach alpha. The obtained alpha value of 0.847 is greatly different from zero and represents substantial internal reliability, meaning that most items within the composite of the questionnaire are positively interrelated. This effectively and strongly statistical mathematic dimension illuminated the attitudes and working of non-English major students with AI tools in their EFL classes and thus contribute more to AI in the educational field.

4. FINDINGS AND DISCUSSION

4.1. The influences of AI-enhanced learning on students' behavioral engagement in English classes

The integration of AI-enhanced learning tools in English classes significantly impacts students' behavioral engagement, as reflected in the descriptive statistics in Table 1.

Table 1. Descriptive statistics for the influences of AI-enhanced learning on students' behavioral engagement in English classes.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Behavioral 1	138	3	5	3,49	0,557
Behavioral 8	138	4	5	4,39	0,490
Behavioral 9	138	2	4	2,99	0,391
Behavioral 13	138	3	5	3,51	0,583
Behavioral 17	138	3	5	4,24	0,477
Valid N (listwise)	138				

Engagement is most pronounced among the learners when it comes to completing assigned deadlines for the tasks designed with the help of AI (M=4.39). This means that such AI tools are helpful aids for the students in keeping track of their time and responsibility. Such features as reminders and progress reports may assist in high engagement by promoting organized learning. Naturally, AI tools that prompt the learners to practice more than the conventional

approach also witness high student engagement (M=4.24). Students could practice the language more regularly and over long periods, thus improving their skills and confidence in English thanks to AI's ease of use and availability. However, deficient levels of engagement are noted while using AI-embedded tools to provide feedback on English language acquisition; the engagement index is the lowest compared to other tools (M=2.99). The students might have learned about receiving immediate personalized feedback from an AI system, but they may require assistance in being aware of when and when not to use such a system. To avoid such an outcome, instructors should possibly do more to help students to better understand how to make use of the AI feedback given to them. Slightly above average levels of engagement are documented concerning the active cases of students learning a language through engaging with AI-driven activities, (M=3.49) and the willingness of the students to incorporate AI in learning, (M=3.51). Based on the findings, AI was effective in promoting students' attention and/ or motivation to engage them with activities though could be enhanced. These moderate level evaluations are attributed to to the type of interaction which is offered Students by the AI used in the program. However it has been realized that even more student engagement could be achieved out of the tool in case the design as well as its use were further improved.

4.2. The influences of AI-enhanced learning on students' cognitive engagement in English classes

Table 2 demonstrates the influence of AI-enhanced learning on various dimensions of students' cognitive engagement in English classes.

Table 2. Descriptive statistics for the influences of AI-enhanced learning on students' cognitive engagement in English classes.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Cognitive 2	138	2	4	3,54	0,542
Cognitive 3	138	2	4	3,15	0,578
Cognitive 11	138	3	4	3,43	0,498
Cognitive 18	138	2	4	3,27	0,561
Cognitive 21	138	2	5	3,75	0,495
Valid N (listwise)	138				

The student's cognitive involvement in English courses has changed dramatically due to the use of AI tools. Indicators are the highest when students engage in problem-solving by other means but with AI tools (M=3.75), evidencing increased critical thinking. Other responses that helped them better understand English (M=3.54) resulted from the content and context of the activity, which are animated. Only moderate engagement was reported for developing new learning strategies (M=3.43) and language problems involving critical thinking (M=3.27). Their scores suggested qualitatively that although these AI tools aided their strategic and analytical skills, they must still be fully deployed. The most damaging outcome is if we receive feedback from AI tools about the tasks performed (M=3.15), which means there are difficulties in understanding feedback. Maximizing the learning potential of the tasks set by educators first requires emphasizing students' feedback usage skills.

4.3. The influences of AI-enhanced learning on students' emotional engagement in English classes

Table 3 shows that AI-enhanced learning significantly boosts students' emotional engagement in English classes.

Table 3. Descriptive statistics for the influences of AI-enhanced learning on students' emotional engagement in English classes.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Emotional 4	138	3	5	4,35	0,522
Emotional 5	138	3	5	3,64	0,566
Emotional 10	138	4	5	4,44	0,498
Emotional 12	138	3	5	4,18	0,487
Emotional 15	138	3	5	3,77	0,654
Valid N (listwise)	138				

The highest score, which was equal to 4.44, was achieved so that AI tools make learning English enjoyable for students. This probably resulted from the interactivity and motion of AI tools in learning processes, which are more fun and interesting. In this case, students responded that they like the corresponding AI involving tools (M= 4.35), which shows students' perceptions of the use of technology in their learning processes. This enjoyment can the lead to higher motivation and willingness to contribute to activities that take place in class. Also, AI tools relieved the fear of making mistakes (M= 4.18). In this sense, AI tools created a safe and supportive environment, and students felt encouraged to take risks when using language without fear of negative repercussions. Using AI-driven tools, English confidence skills scored a mean of 3.64, which shows that they were average and can be enhanced as there is still room for improvement. Other features which aid the process of skill might be developed even further to increase this confidence. However, students are moderately interacted emotionally with their learning content where the average mean score was 3.77, a statement implying that though the students felt close to their content, the content could probably be made more engaging to support the learners.

4.4. Students' expectations for AI-enhanced further English courses

The data in Table 4 reveals significant insights into students' expectations for future English courses with AI-enhanced learning tools.

Table 4. Descriptive statistics for the influences of AI-enhanced learning on students' expectation for AI-enhanced further English courses

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Expectation 6	138	4	5	4,59	0,493
Expectation 7	138	2	5	3,72	0,589
Expectation 14	138	4	5	4,54	0,500
Expectation 16	138	4	5	4,42	0,495
Expectation 19	138	4	5	4,35	0,478
Expectation 20	138	3	5	3,26	0,571
Expectation 22	138	3	5	3,93	0,675
Expectation 23	138	4	5	4,49	0,502
Expectation 24	138	4	5	4,43	0,497
Expectation 25	138	3	5	3,31	0,538
Valid N (listwise)	138				

A notable finding is that most students expect AI tools to be necessary for the future of language learning (M=4.59). In his case, expectations for AI tools and learning activities with AI also scored high (M=4.54 and 4.42,

respectively), meaning the students seek a more personalized approach to learning and teaching. The lowest rank is the expectation that many students thought the topics of AI-incorporated learning would decrease the difficulties of mastering the English Language in ensuing courses (M=3.31). This comparatively low score suggests that students are enthusiastic about using AI in their education. However, they are prudent about how much it will meet their educational necessities. The expectation for AI to be in a position to offer customized learning experiences is also rated lower (M=3.26), indicating a more conservative view on the chances of AI providing learners with individualized pathways.

4.5. Discussion

The literature as it exists and the results of the present study point to AI-enhanced learning in English education as having a positive impact on student engagement: behavioral, cognitive, and emotional. One may start with behavioral engagement. Notably, timely completion of tasks and an ability to practice more often are positive outcomes. AI-based tools foster more frequent practice opportunities and the completion of tasks in a timely fashion. This notion was supported by Song and Wang (2020). The respondents of the current study need to demonstrate such competence in using AI-generated feedback. This starkly contrasts Bernacki et al. (2021) who conducted similar studies and elicited different results. There is an aspect of how AI works on personalized learning. In the current study, these were considered as care omissions, which is as expected from most of the current studies available. Regarding cognitive interactions, AI tools assist English learners in improving the problems solving and understanding skills. Chiu and Chai (2020) also support this, and they termed feedback during practice as real-time and its contribution towards improving fluency as critical. This may mean that improvement has to be made on the ability of the learners to develop strategies and use critical thinking. Such emphasis was also made by Fredricks et al. (2004). They argued that in the learning environment, one has to employ critical thinking rather than be passive. Bullying, frustration, boredom, and other unpleasant experiences were diminished vastly as students enjoyed using AI, and this has been consistent with the arguments of Hashim et al. (2022) that AI helps make learning fun. The encouraging atmosphere AI provides explains the anxiety reduction experienced.

However, the moderate level of confidence implies that more intervention is required in terms of skill enhancing of students, as Rizvi (2023) pointed out. It also tallies with the findings as the students had high expectations of the inclusion of AI in their future learning and so they should be given relevant comments and made to be active in interactive activities. This is by Paek & Kim (2021), who stated that AI can transform the learning spaces. However, doubts persist about the ability of AI to mitigate learning barriers, similar to the arguments raised by Nguyen et al. (2024) regarding the shortcomings of AI. Thus, the learning style that has embraced the AI-based learning to stimulate the students effectively according to the variety of factors was effective while at the same time, the principal problems of this study as an extension of the feedback loop and the range of the further replenishing courses still remained insufficient to an adequate extent.

5. CONCLUSION

The present study sought to determine how AI-based tools affect 138 non-English majors' interest in teaching English as a foreign language. In the research, questionnaire was delivered to yield the required data. Key findings were that AI increases behavioral engagement because positive behaviour was maintained by completing tasks on time and the number of practice times. Another improvement in the level of cognitive engagement was observed due to better problem-solving ability and understanding, and there was also high level of psychological engagement as the students found the method enjoyable.

However, it should be noted that the research work had some limitations. The sample was broad in terms of ethnicity but not oversized; therefore, the potential scope of the findings may be restrictive. The study took the form of a questionnaire, whereby the participants' responses were self-reported, which may be influenced by response biases such as exaggeration, social desirability, or underestimation of self-reports. In addition, because technology in this field develops rapidly, the study's interventions may quickly become irrelevant, and therefore, the study's findings may lose their weight in the future. Besides, the research concentrated on the immediate effects of students' commitment to their studies. It did not focus on the later effects of AI tools on the student's learning experience. This has implications for comprehending the potential outcome of linear AI tool usage on students' educational performance and learning processes.

Proposals for future study and practice have been made in light of the presented research and its limitations. Firstly, increasing the study sample size and selecting the participants of this study from different contexts of education would increase the external validity of the research. It is suggested to conduct LSM studies to learn the

impact of AI integration at improving learners' achievement over time. Further, increasing the share of more objective data on the degree and direction of engagement measuring the pattern of the software usage or performance achievements would enhance self-reports and provide a richer picture of the impact of AI. In conclusion the significance of refining the feedback approaches of AI instruments for the purpose of broadening knowledge and self-esteem of the students would be proposed. Finally, there is a need for concerted efforts among educators, technologists, and researchers to ensure that AI tools are and remain pertinent to the learning and teaching requirements of the modern era. Moving forward, the ones from the present study can be implemented so that the role of AI in education can be developed even further.

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IoT, IoToys, STE(A)M and Digital Pedagogy

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Abstract

The development of society is taking the form of a digitalized world placing demands on all educators exposed to the new and various requirements of the digital age. An educator can see the digital age and the constant development of digital technologies as a direction towards an unknown future requiring a reassessment of current and traditional concepts of pedagogy. Educators thus have to keep finding new pedagogical ways to involve children and learners in learning. Important competences of the 21st century emerge in this new educational climate, such as emphasis on creativity, development of thinking, cooperation, problem solving and particularly the development of digital literacy in pre-school children and then in primary school learners. The development of thinking and creativity of children and learners is an important aspect that is included in digital pedagogy. The review is focused on concepts such as IoT, IoToys, STE(A)M; i.e., the areas that are implemented in current and modern methods of education. It also deals with the concept and meaning of digital pedagogy.

Keywords: Education, Digital technologies, Digital pedagogy, IoT, IoToys

1. IOT, IOTOYS, STE(A)M

The Internet of Things (IoT) is quickly becoming one of the latest revolutionary technology enhancements. Originally created by technology pioneer Kevin Ashton, IoT involves the transformation of everyday objects into 'smart' objects that can transfer collected data to IoT platforms using the Internet. The benefits of IoT includes the ability to analyse various data in real time to better understand the world around us, thus allowing for more effective and autonomous problem solving and interactions. There are now countless smart objects (cars, watches, toys, appliances, etc.) that are connected via IoT. Although many people use IoT on a daily basis, it should be added that they often forget about the functioning of IoT and its security or privacy [1]. IoT is a crucial tool for making education more accessible, interactive, collaborative and facilitating online real-time interaction between children, pupils and students (hereinafter referred to as learners) and teachers. IoT has extended the classroom into cyberspace, i.e., physical distance has become less of an obstacle to learning, and this can make classroom learning more interesting, interactive and group projects much easier. IoT is important for education also because it allows learners to develop the skills, knowledge and tools they will need in the future. IoT is becoming an integrated part of our lives; learners should learn to handle and work with it as soon as possible. The benefits of IoT in education and at school can include [2]:

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1. Accessibility – Technologies in the form of computers (portable or desktop devices), electronic kits, audiovisual devices, mechanical devices and the Internet of Things makes education accessible to a wider range of learners. Instructional materials and courses can be easily accessed through online platforms.
2. Interactivity – Technologies are used to access an enormous online repository of information and as a means of communication and interaction between learners and teachers. Instructional materials can be more interactive.
3. Collaboration – Technologies enable collaboration at various levels, both online and face-to-face. For example, learners can collaborate on research work using shared documents that can be edited in real time by different group members and easily share information.
4. Easy access to resources – For example, using IoT technology makes it easier for learners and teachers to access different types of resources.
5. Cost-effectiveness – Various devices, systems and operations can be integrated using IoT technology. Some basic functions can be programmed, such as turning lights and air conditioners on and off at certain times of the day or under certain conditions. For example, sensors can be installed in classrooms to detect the presence and number of people. These sensors can automatically send information to the control system to set the optimal lighting and temperature. Many other building functions can be integrated into the IoT network; these will help to reduce electricity and other energy consumption.
6. Real-time usage and updates – The IoT system has built-in means to share information between different network devices and sensors, e.g., it is easy to record how many times and by whom an office printer has been used. (This system can become useful in a school for checking attendance or searching for an employee or learner.)

Nagar [3] adds personalized learning to the benefits of IoT in the educational environment, i.e., with IoT devices, educators and administrators can collect data on learners' learning style, progress and problematic areas. Such information can be used to create individual lesson plans and learning practices tailored to the individual needs of each learner. For example, a learner struggling with a particular concept may be given additional resources and support to help them better understand the topic. On the other hand, a student who excels in a subject may be asked to try advanced content to help them grow and develop further. The overall conclusion is that personalized learning can help ensure that each learner receives the support and guidance they need to succeed in their studies. Engaging and motivating learners by giving them learning opportunities that are meaningful to their needs and interests may also help. Aucott [4] believes that IoT in education includes accessibility and exclusivity, i.e., IoT devices can be adapted to meet the unique needs of each learner. In case of learners with disabilities or special needs, adapted devices can ensure that they are not left out of group exercises. He adds that a hearing-impaired learner can receive transcriptions of lectures in real time to ensure that they will be on the same level as their peers. Finally, Aucott states key findings about the future of learning with IoT, such as:

- broad IoT spectrum (in addition to phones and tablets, from home devices to wearable electronics),
- enhanced learning (a more personalized and seamless environment with digital integration),
- enhanced collaboration (IoT facilitates online/hybrid learning and turns learners into active collaborators),
- global classroom (bridges geographic gaps, supports real-time feedback and ensures inclusiveness),
- data-driven learning (gives insight into learners' behaviour and enables individualized learning plans),
- enhanced engagement (combines interactive tools, real-time participation and e-Learning),
- safety and security (features such as connected cameras, monitoring and smart access control),
- simplified management (automated tasks).

Education (especially pre-school and primary education) should be based on playfulness through a technological game platform that aims to develop learners' feeling of success by solving and overcoming challenges; for example, using toys such as IoToys in education can be an adequate interactive medium providing opportunities both for entertainment and for learning. IoToys (Internet of Toys) is a concept referring to a connectivity of a toy with the Internet, i.e.:

- IoToys are connected to online platforms via Wi-Fi and Bluetooth (or they can be connected to other smart toys).
- IoToys have sensors and are adapted to children's age. Such toys can be robots, dolls, teddy bears and clocks, etc.; all have common devices to connect to the Internet.

Toys connected to the Internet can record different types of data that children play with and communicate with (such as sounds, pictures, movements, location). IoToys differ from Smart Toys and do not necessarily have to be considered smart. IoToys are a subcategory of IoT (in short, Internet of Things is a system of interconnected devices that are completely unique and have the ability to transmit data over a network without requiring data transfer between a person with a computer).

Heljakka and Ihamäki [5] see IoToys as a learning environment that:

- enables, stimulates and promotes learners' creativity and their work skills for collaboration and knowledge acquisition,
- provides educational exercises in the form of educational entertainment,
- supports learning through various playful and physical activities.

According to the authors, the key benefits of IoToys include also:

- interconnected interaction that is governed by sound, light and movement,
- technological enhancement suitable for use in early learning of STE(A)M subjects, including encoding (mostly IoToys allowing movement and acting as a tool for teaching encoding, consisting of toys mobilized by players using commands simulating an encoding language). We see encoding as part of modern STE(A)M education, which develops problem-solving skills in a fun way. Playful skills are necessary for understanding how technologies work in a playful, interactive media environment.

With regard to STE(A)M – Science-Technology-Engineering-(Arts)-Mathematics, STEM integrates Science, Technology, Engineering and Mathematics and links them to everyday life. STEM is the intersection of Science, Technology, Engineering and Mathematics. STEM usually means an interdisciplinary approach to education that combines Science, Technology, Engineering and Mathematics to equip students with skills ready for the future. STEM education helps prepare learners for their future life and success in whatever career they choose. STEM education may be different, depending on how it is defined by an individual, school or educator; some educators consider social and political sciences to be STEM subjects, and some classify only traditional sciences, such as biology and chemistry, as STEM subjects. It is also important to note that there is not any standard for STEM education to implement it; individual subjects, such as science and mathematics, are governed by state standards that teachers must follow, but this is not the case with STEM [6].

STEM education is now extended by another discipline, namely Arts. For this purpose, Arts is not necessarily visual, musical or dramatic – we can include industrial and artistic design or the ability to know how to speak a language, formulate ideas and defend and present them convincingly. The European School Education Platform [7] characterizes STE(A)M as a dynamically developing field of the 21st century education. STE(A)M is a comprehensive methodology, suitable for the development of cooperation skills and interdisciplinary problem solving, allowing learners to explore unexpected connections between different aspects of disciplines represented by different subjects. STE(A)M is used in many countries at all levels, from pre-school to higher education to stimulating pre-school children's interest and awareness of STE(A)M disciplines and to teaching STE(A)M concepts. According to Yildirim [8], all children should take STE(A)M courses at an early age to increase their interest in these fields, which provide information about related job opportunities. Pre-school STE(A)M education helps children develop positive attitudes towards STE(A)M disciplines because pre-school children are curious and like to experiment, ask questions and want to discover relationships and causes of phenomena and situations. In other words, children in early childhood are to acquire 21st-century skills and it is STE(A)M education that allows the necessary skills to be acquired and developed. Pre-school STE(A)M education is of paramount importance also because it stimulates children's motivation and creativity, helps them develop their cognitive, affective and psychomotor skills [9].

Given the world is facing increasing changes and challenges, it is necessary for the future generation to have the ability to ask the right questions and find new solutions and it is the STE(A)M principles that motivate to look for answers to the questions 'how' and 'what', but also to 'who' and 'why' and encourage learners to approach the scientific problems of the real world with regard to the impact on humanity. STE(A)M aims to help learners improve their critical thinking skills and perceive the intersection of Arts, Science, Technology, Engineering and Mathematics. STE(A)M provides learners with tools and methods to explore new and creative ways of solving problems, displaying data, innovating and connecting multiple disciplines. The implementation of STE(A)M principles into education allows for more understanding, innovation and coherent classroom learning.

2. DIGITAL PEDAGOGY

Digital pedagogy focuses on the use of technology to break down learning barriers and improve the learning experience of learners. Its appeared only in the last decade when we started to be aware of the changing relationship between children, pupils and students and computers, portable devices, social media and others. Effective digital pedagogy includes basic educational objectives and strategies, adding appropriate technologies to strengthen the results and goals of children, pupils and students. Digital pedagogy is deeply affected by the development of technologies. Recent examples include the diversification of technologies, such as the increasing performance of smartphones, investments in classroom technologies and availability of new, marketed products in the educational environment. Digital pedagogy requires us to learn what is available and how we can seamlessly integrate it into

teaching and learning [10]. Digital pedagogy is the philosophy and practice of meaningful teaching and learning in the digital age. Like traditional (non-digital) pedagogy, digital pedagogy is evolving in response to pedagogical research, professional experience and innovation. In other words, digital pedagogy focuses on what matters most, namely teaching. Digital pedagogy is about knowing when to use technology to learn and how to incorporate digital tools to improve problem discovery and problem solving, engage children, pupils and students and improve their learning experience. Digital tools can include open educational resources such as e-books, learning management systems, open online courses, visual tools and video or digital storytelling. Digital pedagogy covers a wide range of concepts, educational processes, teaching techniques, methods and strategies, resources and contexts, tools and educational applications. It includes computer-supported training, computer-mediated education, technology-mediated pedagogy, virtual learning/training environments, digital curriculum, distance learning, e-learning, online education/online pedagogy, web-based education, cyber pedagogy, multimedia pedagogy, electronically supported pedagogy and hybrid pedagogy. In addition, digital pedagogy can include:

- direct use of digital technologies for educational purposes – for teaching, learning, evaluation or for managing education,
- provision of space for the use of digital technologies in education, e.g., through programmes for the purchase of equipment or through curriculum modification or through digital skills training programmes,
- consideration of the potential of digital pedagogy in the context of education, e.g., when creating education policy or in education design, when estimating the opportunity to use or not use a digital tool or digital resource [11].

Digital pedagogy and pedagogies with other focus (open pedagogy, critical pedagogy, interactive pedagogy) overlap to a certain extent. Digital pedagogy involves the use of technology to improve the learning process. The value of digital pedagogy lies in trying to take full advantage of modern technology in teaching, e.g. learning anytime, anywhere. Typical features of digital pedagogy include the aforementioned creativity and thinking, combining theory and practice, promoting playfulness and problem solving, promoting cooperation and involvement of other participants, promoting motivation to learn and increasing critical understanding of the digital environment. Digital pedagogy also seeks to promote virtual learning, and it should lead to increased social and education quality [12].

In general, digital pedagogy refers to the use of electronic means to improve or change education. Digital pedagogy can thus be considered as the pedagogical use of digital technologies. Digital technologies can be referred to here as digital devices and software. The review by Väätäjä and Ruokamo [13] presents a model of digital pedagogy that aims to explain the pedagogical use of digital technologies. Their digital pedagogy model includes three dimensions that can be used in education, i.e.:

1) Pedagogical orientation:
   Integration of digital technologies into teaching. Pedagogical orientation can be divided into two types: constructivist pedagogical orientation and traditional pedagogical orientation. A constructivist pedagogical orientation is based on collaboration, learner-oriented activities and learner's active participation in the discussion, rather than on the transmission of information led by the teacher. Here, technologies are seen as a cognitive tool that supports learners' learning. A traditional pedagogical orientation includes activities focused more on the teacher, where communication usually takes place from the teacher to the learners. Technologies in the traditional pedagogical orientation are used as educational tools by the teacher. Pedagogical orientation is then clearly reflected in digital pedagogical practice.

2) Pedagogical practices:
   Pedagogical practices in digital pedagogy can be seen in a learning environment that is rich in information and technology; it is the creation of a learning environment in which learners can engage in problematic assignments with technologies that are integrated into teaching, learning and evaluation processes. The pedagogical use of technologies should take into account some pedagogical activities and the roles of teachers and learners in technology integration. Learners should have initiative, learn independently or in cooperation with their peers. In many cases, it is recommended that teachers review and change their current teaching and learning practices when using digital technologies in teaching. Digital pedagogy should involve more than the mere use of technology in the classroom and the usage of technologies (e.g. IoToys in the educational process in pre-school education should be used to solve problems, develop critical thinking, creativity, collaboration and build social relationships).

3) Digital pedagogical competencies:
   It includes skills, knowledge, content and attitudes combining technical expertise with pedagogical intentions to improve and enhance learners' learning. The teacher should have knowledge of the integration of digital technologies and should understand them as personal support and motivation for continuous personal/professional development. Educators who are competent in digital pedagogy are able to integrate

digital technologies into education and can teach learners the basic digital skills that they will need in their everyday life and also for further education and subsequently for use in professional life. Digital competencies refer to the ways in which the educator is able to use digital technologies and the digital environment. The acquired knowledge from digital pedagogy will allow the teacher to better combine digital competencies with pedagogical competencies; understanding digital pedagogy is a prerequisite for the meaningful use of digital technologies in teaching. A digitally competent educator can select, create, edit, manage, protect and share a variety of digital resources, such as digital content or data used in teaching [14].

Digital pedagogy can be seen not only as the use of digital technologies for teaching and learning, but rather as an approach to digital tools from a critical pedagogical perspective. The teacher should think carefully about the use of digital tools in digital pedagogy; e.g., deciding when to use digital tools or pay attention to the impact of digital tools on learning and learners. The essence of digital pedagogy is exploring the impact of learning using digital tools.

3. DISCOURSE

It is now crucial for society to educate a generation that will be able to break through in the fast-moving world that requires creative individuals in a variety of fields. This requirement is reflected in the opportunities that children are to receive already in pre-school education. Modern education should emphasize the interactive cognitive process as it appears to be an ideal path in cognition and learning. Teachers must also have digital competence because they need to understand the constantly evolving digital environment. The educator should use appropriate digital tools for communication with parents and other stakeholders and should collaborate on improving communication strategies. When selecting digital resources, the educator should evaluate and select such digital resources that will be effective for teaching, considering all teaching objectives and a pedagogical approach appropriate to the given type of education. Implementing IoT, IoToys, STE(A)M and, subsequently, digital pedagogy into teaching can increase the effectiveness of (not only) teaching procedures; it can also serve as a tool for assessing learners' progress.

The benefit of digital pedagogy in teaching is its potential to actively involve learners in teaching activities because learners show curiosity and spontaneous interest, which can be used in the development of their digital literacy. Our time brings opportunities, especially in rapidly evolving technologies, and their educational potential is considerable, both in the field of motivation and in individualization and communication. The use of technologies in teaching and learning has a number of advantages, but it is necessary to consider certain disadvantages. Digital pedagogy, together with current digitalization, offers unrestricted access to various resources of information, such as websites, social media or chats, which can lead to some students, who use technology in an excessive or inappropriate way, risking that they will develop a compulsive relationship with it in the future. Excessive use of digital tools can damage learners' social and family life as well as their health. When implementing digital tools and digital pedagogy into the educational process, it must be borne in mind that learners grow up in a digital world in which their direct interpersonal communication can also be affected. That is why the implementation of digital pedagogy in teaching and learning should be approached in a prudent and sensitive, perhaps thoughtful and balanced manner, in combination with traditional educational strategies.

Acknowledgements

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The Health and Well-Being of a Nation: Establishing Social Prescribing through Evidence-Based Research in Wales, UK

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Abstract

This paper explores the Health and Well-being of a Nation relating to Social Prescribing (SP) through Evidence-Based Research in Wales, UK. The Welsh Government (Welsh: *Llywodraeth Cymru*), the executive arm of the devolved government of Wales recently launched *The National Framework for Social Prescribing in Wales* (NFfSP, December 2023). Numerous consultations with over 1,000 stakeholders resulted in the rationale, development and dissemination of this framework. The principles of SP across Wales are not new. They encompass (i) Taking an early preventive approach to enhancing people's health and wellbeing, (ii) Addressing health inequalities and (iii) Strengthening community cohesion, being consistent with the *Social Services and Well-being Act (Wales) 2014*, *the Well-being of Future Generations Act (Wales) 2015*, and the all-party long term plan for Health and Social Care '*A Healthier Wales*'(2021). The author, Dr Rogers, is passionate about the Health of the Nation being much involved herself in identifying "Critical success factors for Social Prescribing (SP) 'Art-on-Prescription' (AoP) in Wales, as a 4th year M.Phil. Candidate, at the University of South Wales, Faculty of Life Sciences and Education, Treforest, South Wales, UK. It is with increasing insights from her Director of Studies, Professor Carolyn Wallace (Director of the Wales School for Social Prescribing Research, WSSPR) and Academic Supervisors, namely Professor Steven Smith and Dr Sarah Wallace that the current research forges an exploratory pathway to gaining much needed evidence relating to the efficacy of SP not only in general, but also in particular regarding the how, what and the where SP in Wales is becoming more widespread. The mixed methods methodology, collecting qualitative data combined with quantitative analysis processes and tools uses 'Group Concept Mapping' (GCM) to seek stakeholder voices, by applying a rigorous analysis of their opinions, beliefs and values. GroupWisdom[TM] available at the University proved an invaluable research tool.

Keywords: Social Prescribing, Art-on-Prescription, The Welsh Government, Research-Based Evidence, Health and Well-being, Group Concept Mapping, GroupWisdom[TM]

1. INTRODUCTION

This paper explores the Health and Well-being of a Nation relating to Social Prescribing (SP) through Evidence-Based Research in Wales, UK. The Welsh Government (Welsh: *Llywodraeth Cymru*), the executive arm of the devolved government of Wales recently launched *The National Framework for Social Prescribing in Wales* (NFfSP, December 2023) [1]. Numerous consultations with over 1,000 stakeholders resulted in the rationale, development and dissemination of this framework. The principles of SP across Wales are not new. They encompass (i) Taking an early preventive approach to enhancing people's health and wellbeing, (ii) Addressing health inequalities and (iii) Strengthening community cohesion, being consistent with the *Social Services and Well-being Act (Wales) 2014*, [2] *The Well-being of Future Generations Act (Wales) 2015*,[3] and the all-party long term plan for Health and Social Care '*A Healthier Wales*'(2021) [4]. This approach is woven into the very fabric of what Welsh Government does in terms of

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empowering people and communities, with the development of a National Framework, a key programme for government commitment, directly supported by The Health and Social Care Regional Integration Fund (RIF). Deliberations relating to this historical moment began a decade ago, with the political will of creating The All-Party Parliamentary Group for Health and Wellbeing (APPGAHW, 2014) which endorses the Arts for Health and Wellbeing for the Nation, chaired by Lord Howarth of Newport. A 2-year research, evidence-gathering programme included discussions with patients, health and social care professionals, artists and arts administrators, academics, people in local government, ministers, other policymakers, and parliamentarians from both Houses of Parliament, resulting in the publication of The Inquiry Report (2015-2017), *Creative Health: The Arts for Health and Wellbeing* (2nd Edition) [5]. It endorses the professional practice for GPs to deliver SP referrals for patients who might have felt lost and powerless at challenging long-established problems to engage in community-based creative SP Services motivating people to make changes not through medicalisation but through engagement in creative community-based activities. The author of this Conference Research Paper, Dr Rogers, is passionate about the Health of the Nation being much involved herself in exploring "Critical success factors for Social Prescribing (SP) 'Art-on-Prescription' (AoP) in Wales", as a 4th year M.Phil. Candidate, at the University of South Wales, Faculty of Life Sciences and Education, Trefforest, South Wales, UK. It is with increasing insights from her Director of Studies, Professor Carolyn Wallace (Director of the Wales School for Social Prescribing Research, WSSPR) and Academic Supervisors, namely Professor Steven Smith and Dr Sarah Wallace that the current research forges an exploratory pathway to gaining much needed evidence relating to the efficacy of SP not only in general, but also in particular regarding the how, what and the where SP in Wales is becoming more widespread. The mixed methods methodology [6], collecting qualitative data combined with quantitative analysis processes and tools uses 'Group Concept Mapping' (GCM) to seek stakeholder voices, by applying a rigorous analysis of their opinions, beliefs and values (Kane and Trochim 2007) [7]. Whilst GCM is a structured, yet flexible method, it not only captures and organizes ideas of a group on any topic of interest, but also represents these ideas visually in a series of interrelated maps reflecting the stakeholders' perceptions and values. Initially it was necessary to familiarize with the software GroupWisdom™ [8] available at the University. Sample populations incorporated WSSPR members from medical professions, healthcare workers and Arts Practitioners amongst others. As a springboard for gathering data the initial activity implemented online "Brainstorming" using an 'open ended' focus prompt: "A critical success factor for the sustainability of social prescribing AoP in Wales is . . ." Several aspects emerged from 191 statements collected from a research sample (n=80). In addition to social benefits of group activities, some psychological mechanisms may relate directly to art making, e.g., when a person focuses on the role of the flow state [9] their attention is fully engaged in an activity, a person may lose awareness of self, space and time being engaged within the artistic process, i.e. where a coherent sense "being in the moment", may predict eudemonic happiness [10,11]. To date, results of the current research findings with a sample of namely, "Service Providers", indicate that the most 'important' and 'effective' means for the sustainability of SP AoP in Wales is shown to be the 'willingness' and 'understanding' for GPs (General Practitioners) in advocating the SP referral process [12]. The author, Dr. Rogers is much indebted to her Director of Studies, Professor Carolyn Wallace and Team who were instrumental in the development of the NFfSP (2023) in Wales.

2. DEVELOPING RESEARCH-BASED EVIDENCE FOR SOCIAL PRESCRIBING

The Inquiry Report (2015-2017), *Creative Health: The Arts for Health and Wellbeing* (2nd Edition) published by the APPGAHW [5], focuses on three benefits of bringing about wellbeing through creativity. These benefits include (i) The arts can help keep us well, aid our recovery and support longer lives better lived. (ii) The arts can help meet major challenges facing health and social care: ageing, long-term conditions, loneliness and mental health and (iii) The arts can help save money in the health service and social care. These three benefits emerged during many series of 16 round table discussions at which some 300 people – service-users, people working in the arts, health and social care, including the prison service and end-of-life care, commissioners, funders and academics – had come together to share their thoughts on challenges they face, observed they are already doing and what they aspire to do, debating how progress may best be achieved. It is important to understand that there existed substantial 'political will' to foster the arts for health and wellbeing at the very early stages of collaboration, between the Arts Council and the National Health Service (NHS), where the APPGAHW is part of a growing movement promoting their manifesto for a healthy and health-creating society. The Manifesto aims for 'the transformation of the health and care system from a hospital-centred and illness-based system to a person-centred and health-based system'.

Furthermore, the publication *Creative Health Review: How Policy Can Embrace Creative Health* [13] developed by the collaboration of The National Centre for Creative Health (NCCH) and the APPGHWB, recognizes the potential for creative health to help tackle pressing issues in health and social care and more widely. This Review

found evidence showing the benefits of creative health in relation to major current challenges, with examples of where this is already working in practice. Driven by the Prime Minister, coordinated by the Cabinet Office and supported through ministerial commitment, the Review recommends that all relevant policies ensure the integration of creative health measures. By supporting this development of a cross-departmental Creative Health Strategy, it is envisaged that such an approach will facilitate the establishment of sustainable cross-sectoral partnerships across regions and systems, modelled by national policy.

Stephen Clift, founding Chair of the Royal Society for Public Health, RSPH, Special Interest Group for Arts, Health and Wellbeing, and a founding trustee of Arts Enterprise with a Social Purpose (AESOP) [14, 15] continues to pioneer the arts for health and wellbeing. Being co-founder for the journal Arts & Health: An International Journal for Research, Policy, and Practice— he uses the publication as a platform where the healing power of artistic endeavours takes centre stage. An article, for example by Gorman, Farsides and Bonner [16] elucidates how using 'collage artforms' contributes to support parents coping with children suffering with rare diseases. Additionally, as joint editor of the Oxford Textbook of Creative Arts, Health, and Wellbeing [17], likewise, practitioners in the Arts and professionals in the Healthcare sector contribute their experiences and expertise to engage in the promotion of creativity for the health of a nation.

Researchers, Branding and House [18] investigated the feasibility of developing a social prescribing (SP) service to reach a significant proportion of primary care high resource users who may benefit from a social intervention, thereby alleviating the NHS from excessive demands. These researchers, Branding and House, contend that SP creates a formal means of enabling primary care services to refer patients with social, emotional or practical needs to a variety of holistic, local non-Clinical services. SP therefore aims to provide referred patients with holistic packages of support tailored to individual needs, where General Practitioners, GPs believe that a non-medical approach may achieve better outcomes.

3. SOCIAL PRESCRIBING IN WALES

The Welsh Government have now committed within the Programme for Government 2021-2026 to introduce an all-Wales Framework [19] (PHW, 2022) to further support the roll-out of SP, as a key mechanism to further the wellbeing agenda in Wales, identifying the long-term outcomes that SP aims to influence. By understanding these long-term outcomes, SP is seen to interface with the following three aspects:(i) mental (ii) physical and (iii) social health and wellbeing agendas. Subsequently there are operational interfaces between multiple agencies and professions, which support these agendas. For ensuring good health across the whole Nation, a vision and direction for individuals and communities to thrive and prosper, is ingrained in two legislative frameworks, namely:

(i)   *The Social Services and Wellbeing (Wales) Act* 2014.[2]
(ii)   *The Wellbeing of Future Generations (Wales) Act* 2015 [3]

Accompanied by a further Welsh Government publication, namely,

(iii)   *A Healthier Wales: Our Plan for Health and Social Care* (2019) [4] where the aim is to bring health and social care services together, so that they are designed and delivered around the needs and preferences of individuals, with a much greater emphasis on keeping people healthy and well.

The pioneering work carried out by The Wales School for Social prescribing Research, (WSSPR) and The Wales Institute for Health and Social Care, (WIHSC) in early December 2023, culminated in the recent epoch-making event, where Professor Carolyn Wallce, Director of WSSPR was instrumental in the Launch of "*The National Framework for Social Prescribing in Wales*" (NFfSP)[1] that has already made an impact in promoting Social Prescribing (SP) in Communities across Wales.

3.1   So, what is Social Prescribing?

SP in Wales is defined by Rees et al, (2019) [20] as "connecting citizens to community support to better manage their health and well-being" where *The Social Prescribing Model in Wales* (Wallace et al. 2021) [21] illustrates how individuals may access SP programmes, such as Art and Craft workshops i.e. AoP. The person-centred approach (Elliott et al., 2021) [22] means that individuals may (i) self-refer (ii) Access clinical advice from GP, Hospital or other Health Professionals (iii) Contact Social Services or (iv) find Community Link-worker, as shown in Figure 1 below:

Figure 1: Social Prescribing Model in Wales (Wallace et al. 2021)
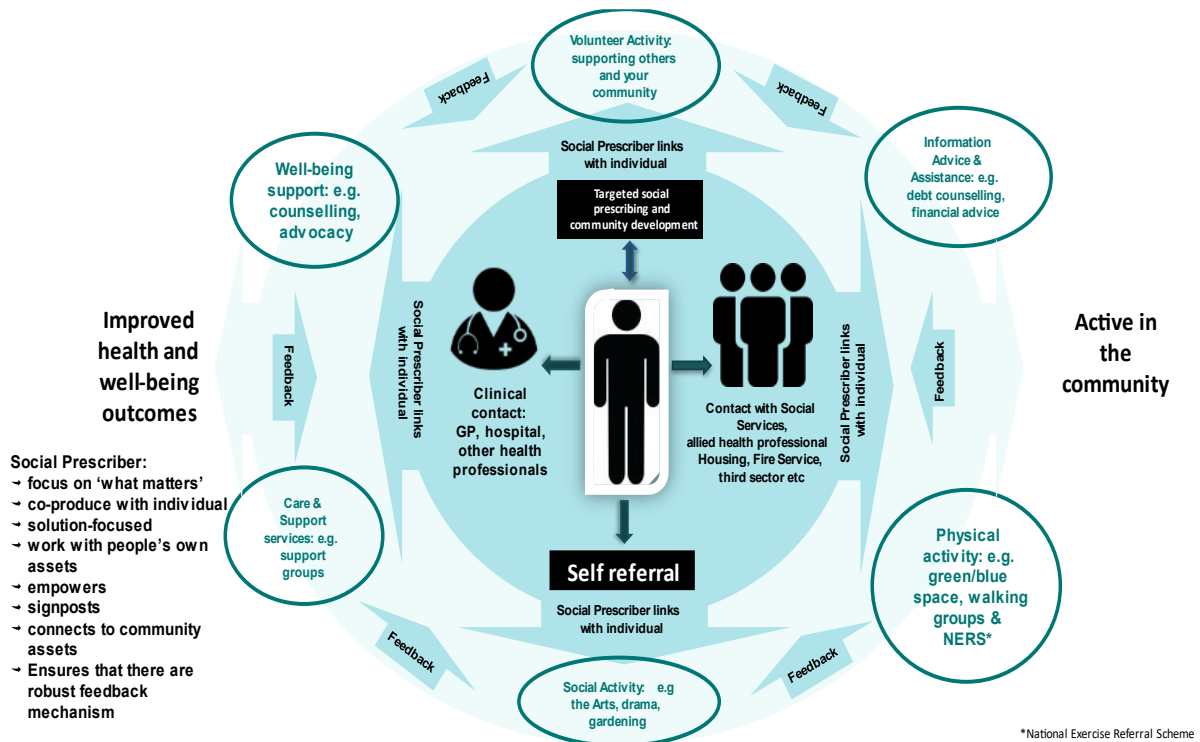
Moffat et al. [23] recognise SP as *a "multi-dimensional concept" addressing, potentially health inequalities, aiming to promote public health and well-being"*
It is seen as person-centred care, involving a link worker who has a 'what matters' conversation with the individual, co-produces goals and connects them with assets in their community, NFfSP Wales,2023 [1]

3.2   *Current landscape of social prescribing in Wales*

A baseline study[24] provides a snapshot of what is currently known about social prescribing in Wales.

Figure 2: Number of individuals referred to and using social prescribing services in Wales, by year.
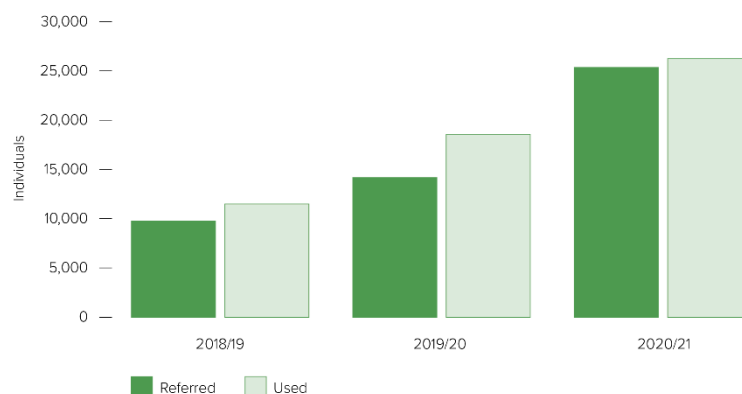
Source: Social Prescribing Activity in Wales, by Data Cymru.
   The study [24] showed there had been a clear year on year increase in referrals and use of social prescribing over the last three years from around 10,000 in 2018 to 2019 to just over 25,000 in 2020 to 2021. Interestingly, in this base

line study [24] (2021, p.23) there was only one reference to SP as a therapeutic interaction within one of the focus groups, in which a participant specifically talked about using therapy to influence behaviour change for service users.

4. CURRENT RESEARCH

The current research, carried out in the Faculty of Life Sciences and Education at The University of South Wales by Dr Susy Rogers, investigates the critical success factors for the sustainability of Social Prescribing 'Art-on-Prescription' in Wales. The Director of Studies, Professor Carolyn Wallace (Director WSSPR) leads the Academic Supervisory Team, namely Professor Steven Smith and Dr Sarah Wallace supporting the research methodology of mixed methods [24,25] implementing the method of Group Concept Mapping (GCM) [26] by adopting GroupWisdom[TM] s/ware [8] where Dr Rogers became the Project Administrator (Figure 3).

4.1   Methodology and Method

This Mixed Methods Research Methodology incorporates a 6-stage GCM online Method with several advantages. There is the opportunity of gathering data qualitatively eliciting from each person, in the sample population, their own unbiased viewpoints [22, 23] by:

(i)   Brainstorming ideas from a prepared Focus Prompt.
(ii)   Structuring ideas by sorting them into thematic groups, based on their perceived similarity and
(iii)   Analysing and Interpreting the Concept Maps generated.

In addition, the quantitative elements include the following:

(iv)   Rating qualitative statements generated on a bivariate scale and
(v)   Creating different visual maps to convey key concepts.

Figure 3 To illustrate the Steps in utilizing GCM [21]

Participants completed three sequential stages as shown in Figure 3, above, i.e. (i) Brainstorming, (ii) Sorting, and (iii) Rating.

During the Brainstorming stage, each participants was asked to generate statements in response to a focus prompt. Once statements were generated, participants sorted all the statements, individually, into 'piles' (that make sense to them), which they also labelled. Finally, during the last stage, research participants were asked to rate each statement on multiple rating scales.

5. OUTCOMES

This s/ware provided a springboard for gathering data, qualitatively, through online "Brainstorming"., asynchronously, allowing research participants to take their own time at their own pace and own location. Several interesting aspects are emerging from the 191 statements collected from a research sample (n=80) using the specific focus prompt "*A Critical Success Factor for the Sustainability of Social Prescribing Art on Prescription in Wales is . . . .(?)* . Figure 4 below indicates the number of research respondents that participated in the different online GCM activities.

Figure 4 To show the number of research respondents that participated in the different online GCM activities.
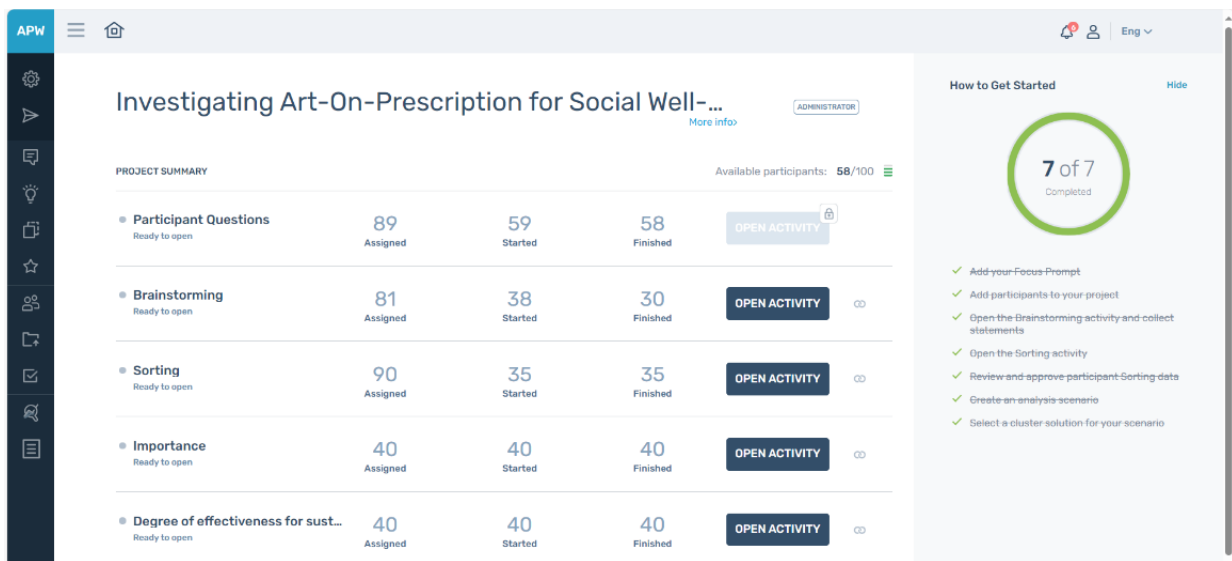
Following the Sorting Activity, it was possible to consider the clustering of statements provided by GroupWisdom^TM s/ware, enabling the identification of statements that were somehow similar thereby forming a cluster. It was found that the clustering of five clusters brought together statements with their numbering as can be noted in the Statement List (n=125). At the same time, it was instrumentally a rapid process to be able to show comparative gender outcomes (i.e. .female : male) as shown in Figures 5 and 6 below.

Figure 5 To show the 5-Cluster Map of statement from the Female Research Participants

Figure 6 To show the 5-Cluster Map of statements from the Male Research Participants
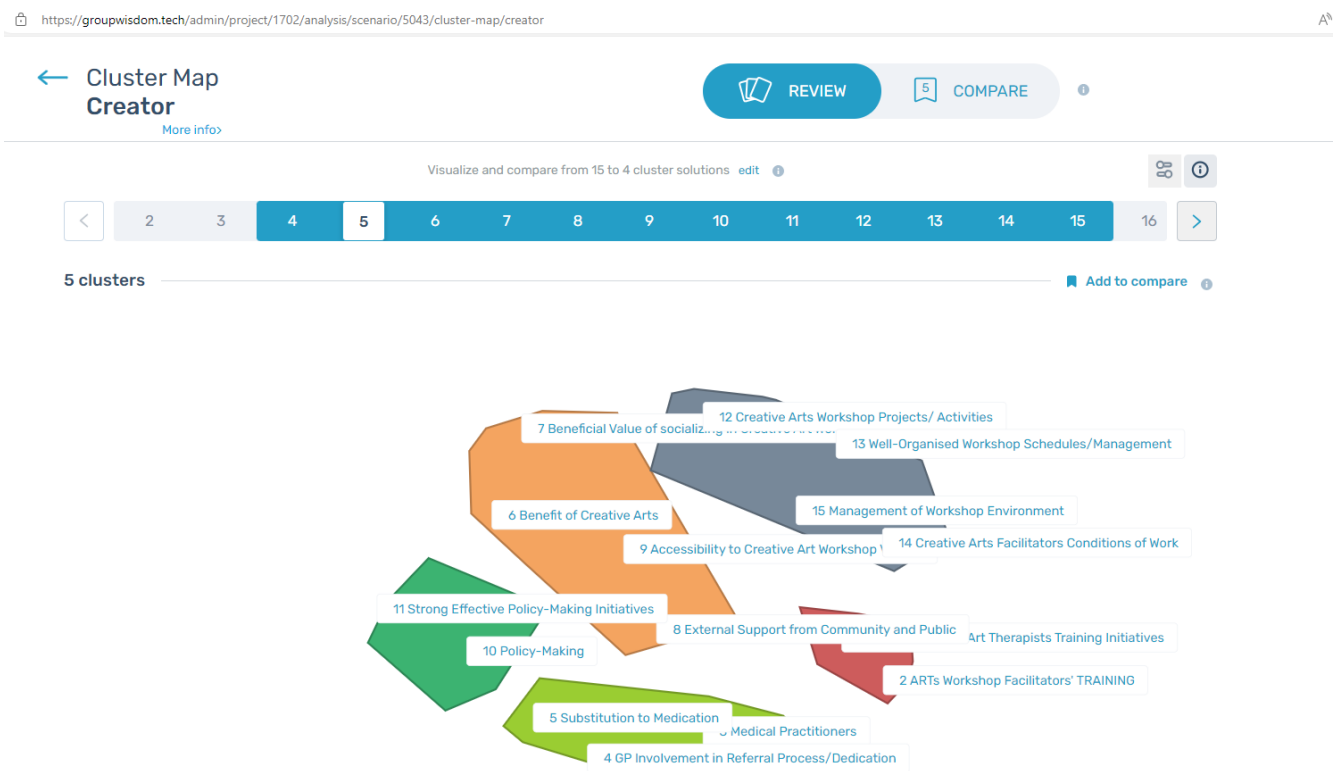
The GCM Rating Activity, following the Sorting Activity was based on a bivariate scale, namely (i) the importance of each statement (ii) the effectiveness of sustainability. Each of these were measured on a 1-5 Likert scale (1= low + 5= high) for each statement in a Statement List (n=125) where the original Brainstormed List (n=191) was synthesised,

carefully by editing, i.e. combining / jettisoning duplicate 'meanings', whereby *A Critical Success Factor* was interpreted as "an *element of an activity that is vital for the success of social prescribing arts on prescription"* relating both to its 'importance' and 'effectiveness of sustainability' . From this quantitative rating activity, a 'Go-Zone' graphical interpretation was produced where in the top right (green) quadrant the average of both these variables was the highest score (i.e. highest average score=5), as shown in Figure 7.

Figure 7 To show the 'Green' Go-Zone area on the graph where the 2 ratings average=5
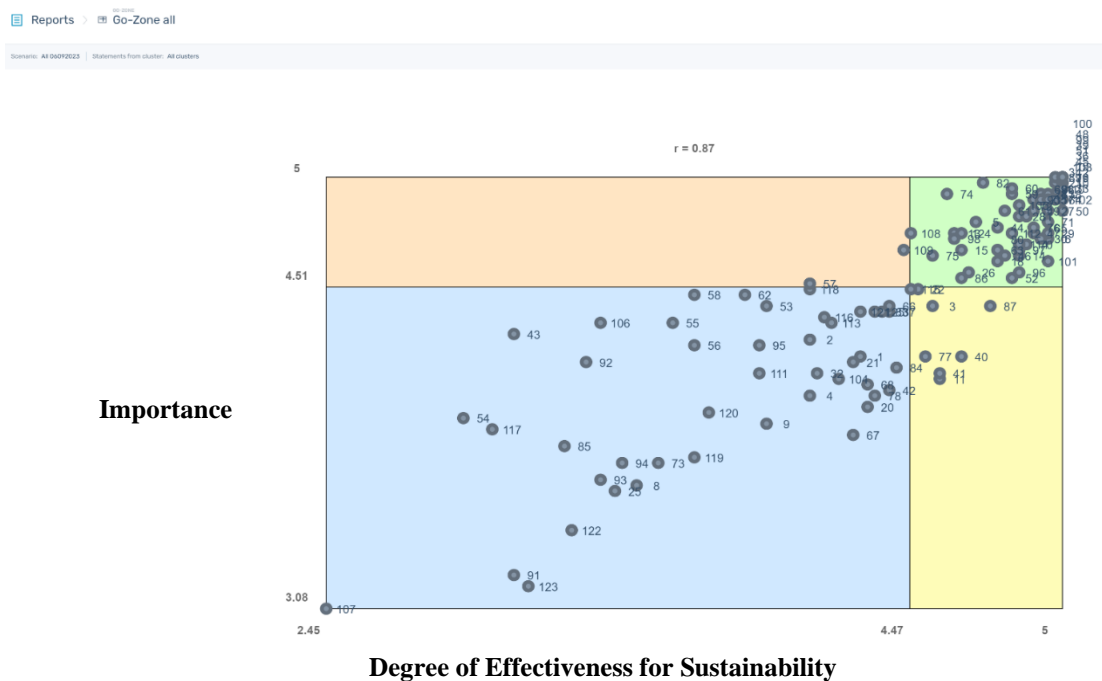
Work-in-Progress continues to decipher the ranking order of the statements in the so-called Go-Zone area, that will evolve. This proves to give an invaluable insight to the application of GCM [26] (Kane and Rosas, 2017) from the sample of arts practitioners and healthcare professionals who participated in the research at various points of action.

6. CONCLUSIONS

Thus far the research, has collected insightful perspectives from the research participants (mainly 'Service Providers') regarding a beneficial impact not only for promoting social prescribing art-on-prescription for social well-being but also for the sustainability of such services in community settings. In addition to social benefits of group activities, some psychological mechanisms may relate directly to art making. For example, the role of the *flow state* [9] (Csikszentmihalyi, 1996) when attention is fully engaged in an activity and a person loses awareness of self, space and time being engaged within the artistic process, i.e., as a coherent sense *being in the moment*, predicting eudemonic happiness [10,11] (Ryff & Singer, 2008; Vittersø, 2016). Furthermore, several statements highlighted the importance of continuing professional development of Arts Practice Facilitators conducting AoP workshops in the community for health and wellbeing [12,29] (Pringle & Jeurasa, 2022; Schank & Childers 1988). Limitation of the research include the lack of triangulation for validity that would be made possible with the implementation of another sample population comprising of "service" users / i.e. beneficiaries of the social prescribing opportunities offered by Art-on-Prescription" in community settings [30, 31]. That would entail the further development of a much-needed evidence-base. We are most indebted to Professor Carolyn Wallace as being instrumental in the launch of NFfSP[1] (December 2023) in Wales which is significant for several reasons:

1. **Consistency and Quality**: The framework aims to ensure that social prescribing services are delivered consistently and to a high standard across Wales. This helps reduce confusion and ensures that everyone receives the same level of care and support.
2. **Improving Health and Wellbeing**: Social prescribing connects individuals to community resources that can help improve their physical, mental, and social wellbeing. This approach can reduce the burden on traditional healthcare services by addressing social determinants of health.

3. **Community Empowerment**: By linking people to local community assets, social prescribing empowers individuals to take control of their health and wellbeing. This can lead to stronger community ties and a more supportive environment for everyone.
4. **Standardization**: The framework provides a standardized model and terminology for social prescribing, which helps in raising awareness and understanding among both professionals and the public.

Overall, the NFfSP [1] is a crucial step towards a more integrated and holistic approach to healthcare in Wales, promoting both individual and community health in the Nation.

Acknowledgements

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Teaching English Using Videos: How to Plan a Lesson

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Abstract

This article explores the implementation of video-based instruction in English language teaching, particularly in a classroom in Tbilisi with Georgian-speaking students. By emphasizing cultural diversity through video content, this lesson plan aims to enhance students' linguistic competencies and intercultural communication skills. The framework integrates communicative language teaching (CLT) methodologies, metacognitive strategies, and Bloom's Taxonomy, fostering an interactive learning environment. Data were collected through student reflections and assessments to evaluate the effectiveness of the lesson plan, preparing students for effective communication in a globalized world.

Keywords: Video-based instruction, cultural diversity, communicative language teaching, intercultural communication

1. INTRODUCTION

In a vibrant classroom in Tbilisi, 15 students gather each week for a comprehensive 90-minute session, embarking on a journey of English language acquisition. With Georgian as their first language, these learners possess English proficiency levels ranging from B1 to B2 on the Common European Framework of Reference for Languages (CEFR), indicative of their capacity to communicate in everyday situations and handle more complex topics. The primary goal of this classroom is not solely to prepare for standardized tests but to develop foundational English language skills that facilitate effective communication in various contexts. This diverse group showcases a range of learning strategies influenced by their native language and cultural background, illustrating the principles of interlanguage development, where students construct their evolving language systems.

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2. THEORETICAL FRAMEWORK

Utilizing communicative language teaching (CLT) methodologies (Brown, 2007), each 90-minute session emphasizes interaction as a crucial component of language learning. Students engage in task-based learning activities that promote collaboration and the practical application of language skills. This approach aligns with social constructivist theories (Vygotsky, 1978), asserting that knowledge is constructed through social interactions and shared experiences, enhancing both linguistic and sociolinguistic competencies.

Furthermore, the integration of video materials supports the Noticing Hypothesis (Schmidt, 1990), which posits that learners must consciously notice language features to acquire them effectively. By providing rich contextual cues, videos facilitate this noticing process, making language learning more accessible. The Input Hypothesis (Krashen, 1982) underlines the importance of comprehensible input; thus, carefully selected videos can serve as engaging sources of i+1 input, lowering the affective filter and enhancing student motivation.

Incorporating Task-Based Language Teaching (TBLT) principles (Nunan, 2004), students engage in meaningful tasks that require authentic communication, reinforcing their language skills in practical contexts. This aligns with Swain's Output Hypothesis (Swain, 1985), which emphasizes that language production is critical for acquisition; video prompts can inspire discussions and reflections, allowing learners to practice their output effectively.

Moreover, Harmer (2007) highlights the significance of student engagement in the learning process. Engaging video content not only captivates students' interests but also fosters active participation. Additionally, drawing on Frederickson's (2001) work in positive psychology, the use of culturally rich video materials can cultivate a positive learning environment, promoting positive emotions that enhance learning outcomes.

Table 1.

Author	Year	Theory/Contribution	Key Points
Brown	2007	Principles of Language Learning and Teaching	Emphasizes interaction and learner-centered approaches.
Vygotsky	1978	Social Constructivism	Knowledge is constructed through social interactions.
Krashen	1982	Input Hypothesis	Importance of comprehensible input in language acquisition.
Nunan	2004	Task-Based Language Teaching	Focus on real-world tasks to promote language use.
Swain	1985	Output Hypothesis	The role of language production in learning.

In a vibrant classroom in Tbilisi, 15 students gather each week for a comprehensive 90-minute session, embarking on a journey of English language acquisition. With Georgian as their first language, these learners possess English proficiency levels ranging from B1 to B2 on the Common European Framework of Reference for Languages (CEFR), indicative of their capacity to communicate in everyday situations and handle more complex topics.

The primary goal of this classroom is not solely to prepare for standardized tests but to develop foundational English language skills that will facilitate effective communication in various contexts. This diverse group showcases a range of learning strategies influenced by their native language and cultural background, illustrating the principles of interlanguage development, where students construct their own evolving language systems.

As students participate in discussions, group projects, and role-playing scenarios, they develop metacognitive strategies that empower them to take ownership of their learning. Self-monitoring, reflective practices, and adaptive learning techniques tailored to individual needs become essential components of their language acquisition process. The teacher plays a vital role in scaffolding this journey, offering guidance and support that enable students to navigate challenges and achieve greater linguistic proficiency.

Through this comprehensive approach to language learning, students not only enhance their English skills but also cultivate intercultural communication abilities vital for engaging in a globalized world. Over the course of their studies, they are not merely acquiring a new language; they are participating in a transformative educational experience that prepares them for effective communication and cultural exchange beyond the classroom.

3. LEARNING OUTCOMES

By the end of the lesson, students will be able to:
1) Identify (Remember) key vocabulary related to cultural practices presented in the video, assessed through a vocabulary quiz; 2) Describe (Understand) specific cultural traditions using the simple past tense in a reflective writing assignment; 3) Compare (Analyze) cultural practices from the video with their own experiences during group discussions; 4) Discuss (Evaluate) the significance of cultural diversity in small groups, evaluated through peer feedback; and 5) Create (Apply) a short reflection paragraph summarizing their insights from the lesson, assessed using a rubric focusing on clarity and coherence.

These outcomes are designed to enhance the students' linguistic competencies while fostering a deeper appreciation for cultural diversity. Each activity is carefully structured to promote engagement and reflection, allowing students to practice their language skills in meaningful contexts.

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Through this comprehensive approach to language learning, students not only enhance their English skills but also cultivate intercultural communication abilities vital for engaging in a globalized world. Over the course of their studies, they are not merely acquiring a new language; they are participating in a transformative educational experience that prepares them for effective communication and cultural exchange beyond the classroom.

4. METHODS AND TOPIC

4.1. To Create Interest and Prepare Students for the Coming Topic (10 minutes)

To kick off the lesson on cultural practices, the teacher initiates a brief discussion designed to engage students and pique their curiosity. Students are invited to share one unique tradition from their families or regions. This warm-up activity not only fosters personal connections to the topic but also encourages students to think critically about their own cultural experiences. By linking these personal anecdotes to the broader themes they will explore in the lesson, students become more invested in the upcoming content and are better prepared for the video and subsequent discussions.

In this section, I outline methods designed to engage students actively with the topic of cultural practices. To assess understanding, students will complete a reflection handout, which will be evaluated using a rubric that measures both linguistic competency and depth of cultural analysis.

Activity Outline: Engaging Students with Cultural Diversity (10 Minutes)
> **Introduce the Topic of Cultural Diversity**
>> Duration: 5 minutes
>> Procedure:
>> 1. Begin by introducing the topic of cultural diversity, explaining its importance in understanding global perspectives and promoting mutual respect.
>> 2. Show a selection of images representing various cultures (e.g., traditional clothing, festivals, food, rituals).
>> 3. Ask open-ended questions to prompt discussion:
>>> "What do you see in these images?"
>>> "What do you know about these cultures?"
>>> "Have you experienced any traditions similar to those shown?"
>> 4. Encourage students to express their thoughts, fostering a sense of curiosity and connection to the topic.

> **Distribute the "Cultural Practices Brainstorm" Handout**
>> Duration: 5 minutes
>> Procedure:
>> 1. Hand out the "Cultural Practices Brainstorm" worksheet to each student.

2. Instruct students to pair up and list traditions from their own backgrounds, encouraging them to think of specific examples (e.g., holidays, family rituals, traditional foods).
3. Allow students to share their lists with their partners, promoting interaction and exchange of ideas.
4. After a few minutes, invite a few pairs to share their traditions with the whole class, creating a richer understanding of the cultural diversity within the classroom.

Cultural Practices Brainstorm
Reflection handout 1.
Instructions:
1. Pair up with a partner and discuss the cultural traditions from your backgrounds.
2. Together, list as many specific examples as you can think of, such as holidays, family rituals, traditional foods, or any other cultural practices.
3. Be ready to share your findings with the class after your discussion.

Partner A:
Traditions from My Background:
1. _____
2. _____
3. _____
4. _____
5. _____

Partner B:
Traditions from My Background:
1. _____
2. _____
3. _____
4. _____
5. _____

Class Sharing
After your discussion, be prepared to share one or two traditions with the class. Consider the following questions:
- What makes this tradition special to you?
- How is it celebrated or practiced in your culture?
- Have you noticed any similarities or differences between your traditions and those of your partner?

Sample Dialogue 1
Teacher (T): "Good morning, everyone! Today, we're going to explore the fascinating topic of cultural diversity. I have some images to share with you. Let's take a look!"
(Teacher displays images of various cultural practices, such as a traditional festival, a family gathering, and a unique dish.)
T: "What do you see in this first image? Can anyone describe it?"
Student 1 (S1): "It looks like a festival. Maybe a parade?" T: "Great observation! This is actually a parade during a cultural festival. What do you think the people are celebrating?" Student 2 (S2): "It could be a holiday or a special event in their culture.
T: "Exactly! Different cultures celebrate various events in unique ways. Now, let's look at the second image."
(Teacher continues with the discussion for each image, encouraging students to share their thoughts.)
T: "Now that we've shared some ideas about these cultures, I want you to think about your own backgrounds. I'm going to give you a handout called 'Cultural Practices Brainstorm.' Please take a moment to fill it out."
(Teacher distributes the handout.)
T: "On this handout, list three cultural traditions from your background. After that, find a partner to discuss what you've written. Remember to ask each other questions about your traditions!"
Student 3 (S3): "Can we also share why those traditions are important to us?"

T: "Absolutely! Sharing the significance of your traditions will make the conversation even more meaningful. Let's take about 10 minutes for this activity. Ready? Go!" This format can help model the interaction and encourage engagement among students as they discuss their cultural backgrounds!

Teacher (T): "Now that we've discussed cultural diversity, let's focus on some important vocabulary words that we'll encounter in the video. I'll introduce a few words first."

(Teacher writes the vocabulary words on the board: tradition, compare, unique, celebrate, customs.)

T: "The first word is 'tradition.' Can anyone tell me what a tradition is?"

Student 1 (S1): "Isn't it something that is passed down through generations?"

T: "Exactly! A tradition is a practice or belief that is passed down over time. Now, the next word is 'compare.' What do you think it means?"

Student 2 (S2): "It means to look at two things and see how they are the same or different."

T: "Perfect! 'Compare' is about examining similarities and differences. Next, we have 'unique.' What does that mean?"

Student 3 (S3): "It means something special or one of a kind." T: "Yes, 'unique' refers to something that is unlike anything else. Great job! Now, I'll give you a handout with a matching exercise. You will match each vocabulary word with its correct definition." (Teacher distributes the handout.)

T: "Take a few minutes to work on this in pairs. After you finish, we'll review the answers together." (Students work on the matching exercise.)

T: "Okay, time's up! Let's go over the answers. Who can tell me the definition of 'tradition'?"

Student 4 (S4): "It matches with the practice or belief that is passed down." T: "Correct! Now, can anyone use 'tradition' in a sentence?"

T: "Correct! Now, can anyone use 'tradition' in a sentence?"

Student 5 (S5): "In my culture, we have a tradition of celebrating New Year's with family gatherings."

T: "Great example! How about 'compare'?"

Student 6 (S6): "We can compare how different cultures celebrate weddings."

T: "Exactly! Keep thinking of sentences as we go through the rest. Who can explain 'unique'?" (The class continues to review and share sentences for each vocabulary word.)

T: "Wonderful job, everyone! These words will be very useful as we watch the video."

This dialogue helps engage students in learning vocabulary while encouraging them to actively participate and use the words in context!

4.2 To Improve Listening Comprehension (20 Minutes)

The teacher begins by showing the video once, instructing students to focus on key details related to cultural practices. This initial viewing allows students to familiarize themselves with the content without the pressure of taking notes.

After the first viewing, the video is played again, and students are encouraged to take notes on specific cultural aspects presented. This second viewing helps them hone in on important information and enhances their listening skills.

During the video, the teacher pauses at key moments to facilitate discussion. Students are invited to share their observations and insights about what they have seen, allowing for deeper understanding and clarification of cultural elements. This interactive approach not only reinforces listening comprehension but also encourages critical thinking and engagement with the material.

Teacher (T): "Now it's time to watch the video! I want you to focus on the key details about the cultural practices presented. Pay attention to the different traditions and any specific cultural elements you notice."

(Teacher plays the video for the first time.)

T: "Great! Now we're going to watch the video again. This time, I'd like you to take notes on any cultural aspects that stand out to you. Think about what you find interesting or surprising.
(Teacher plays the video a second time, allowing students to take notes.)
T: "Alright, let's pause for a moment. What did you observe? What cultural practices stood out to you?" Student 1 (S1): "I noticed that they celebrate with a big feast. Food seems really important in their culture."
T: "Excellent observation! Food often plays a central role in many cultures. What else did you see?" Student 2 (S2): "There was a ritual where families gathered together to honor their ancestors. It looked very meaningful."
T: "Yes, honoring ancestors is a significant tradition in many cultures. Let's take a moment to discuss how these practices might compare to our own traditions. What do you think?"
Student 3 (S3): "In my culture, we also gather for family events, but we celebrate different holidays."
T: "Great point! Gathering as a family is a common theme across cultures. Let's keep this discussion going. I'll play the video again for a few key moments so we can analyze them together."
(Teacher replays specific segments of the video, pausing at key moments for further discussion.)
T: "In this part, we see a traditional dance. Why do you think this is significant?"
Student 4 (S4): "It shows their history and identity. Dancing is a way to express culture."
T: "Absolutely! Dance can convey deep cultural meanings. You all are doing a fantastic job connecting these observations to our earlier discussions. Let's keep that momentum going!"
   This format encourages active engagement with the video content while promoting thoughtful discussion among students.

4.3. To Encourage Meaningful Communication and Analysis (25 Minutes)

   The teacher organizes students into small groups to foster collaborative discussion. Each group is provided with guiding questions to facilitate meaningful conversations about the cultural practices presented in the video. Questions include: "What cultural practices stood out to you?" and "How do these practices compare to your own traditions?"
   As students engage in discussion, they analyze and reflect on their observations, drawing connections between the cultures depicted in the video and their personal experiences. This collaborative approach encourages students to articulate their thoughts and listen to different perspectives, promoting a deeper understanding of cultural diversity.
   After the discussions, each group summarizes their key points and shares them with the class. This sharing process not only reinforces their learning but also enhances their public speaking skills and encourages a collective exploration of cultural practices, enriching the overall classroom experience.
Sample dialogue 2.
Teacher (T): "Now that we've watched the video and discussed some key cultural practices, it's time for you to dive deeper in small groups. I'm going to organize you into groups of three or four."
(Teacher organizes students into small groups.)
T: "Each group will discuss the cultural practices that stood out to you from the video. To help guide your conversation, here are a couple of questions:"
(Teacher writes the guiding questions on the board.)
1. What cultural practices stood out to you from the video? 2. How do these practices compare to your own cultural traditions?
T: "Take about 15 minutes to discuss these questions. Make sure everyone gets a chance to share their thoughts!"
(Students engage in discussion within their groups.)
T: "Alright, time's up! Now, I'd like each group to summarize your discussion points. Who would like to start?"
Student 1 (S1): "In our group, we talked about the importance of family gatherings in both the video and our cultures. It seems that family is central to celebrations."
T: "That's a great point! Family connections are indeed a common thread. What else did your group discuss?
Student 2 (S2): "We also noticed that the video highlighted unique festivals. For example, the dance we saw is similar to the folk dances we have during our local festivals."
T: "Interesting comparison! Folk dances often represent cultural identity. How about another group? What insights do you have?"
Student 3 (S3): "Our group focused on food traditions. The video showed a big feast, and we compared it to how we also have special dishes for holidays."

T: "Food really is a universal aspect of cultural celebrations! Thank you for sharing your insights. It's clear that while cultures may differ, many of our practices share common values.

This dialogue structure promotes collaboration, critical thinking, and sharing of ideas among students!

4.4 To Assess Understanding and Promote Reflection (20 Minutes)

The teacher distributes a reflection handout to the students, providing clear instructions for the activity. Students are tasked with writing a 200-250 word reflection on what they learned about cultural practices during the lesson and how these insights relate to their own experiences.

This reflective writing exercise encourages students to synthesize their learning, articulate their thoughts, and make personal connections to the cultural practices discussed. By reflecting on the material, they deepen their understanding of cultural diversity and its significance in their lives.

Reflection Handout 2: Cultural Practices Through Video
Name: _____
Date: _____

Reflection on Cultural Practices
Instructions:
Reflect on what you learned about cultural practices during the lesson. Consider the insights gained from your classmates' traditions and how these relate to your own experiences. Write your reflection in the space provided below. Aim for 200-250 words.

Reflection:

(Please write your reflection here. Use the following guiding questions to help you articulate your thoughts:
- What new insights did you gain about cultural practices?
- How did your classmates' traditions influence your understanding of cultural diversity?
- What personal connections can you make to the cultural practices discussed?
- Why is cultural diversity significant in your life?)

Additional Notes:

(Feel free to jot down any additional thoughts or questions you may have about cultural practices or diversity.)

Signature: _____

Instructions for Submission
- Please complete this handout after watching the video and discuss your answers with a partner before submitting it. Your responses will be evaluated based on completeness and depth of insight.

5. DISCUSSION

Table 2.

Student Engagement Scores Before and After Implementing Video-Based Lessons

The **Traditional Lessons** category has a score of **65%**, indicating moderate engagement among students. This level of engagement suggests that while students participate in traditional instruction, the methods employed may not fully capture their interest or stimulate active involvement. Traditional lessons often rely heavily on lectures and direct instruction, which can lead to passive learning experiences. Students may find it challenging to connect with the material, especially if it lacks interactive elements or practical applications. This moderate engagement score may reflect the limitations of a one-size-fits-all approach to teaching, where diverse learning styles and preferences are not adequately addressed.

In contrast, the **Video-Based Lessons** category shows a significantly higher score of **85%**, suggesting that students are much more engaged when video-based instruction is utilized. This increased engagement can be attributed to several factors inherent in video-based learning. Firstly, the dynamic and visually stimulating nature of video content can capture students' attention more effectively than traditional teaching methods. Videos often incorporate storytelling, visuals, and sound, making the learning experience more immersive and relatable. This multimedia approach not only caters to various learning styles—such as visual and auditory learners—but also encourages active participation as students engage with the content through discussions, reflections, or collaborative activities.

6. CONCLUSION

This lesson plan is designed to engage students in a meaningful exploration of cultural diversity through video content. The selected video provides rich visual and auditory stimuli that cater to diverse learning styles, making the lesson accessible to all students, regardless of their English proficiency level. By integrating listening activities with vocabulary development, students are encouraged to actively engage with the material, enhancing their comprehension and retention. This approach not only fosters language acquisition but also cultivates critical thinking and cultural awareness.

Future research could explore the longitudinal effects of video-based instruction on language retention and intercultural competence, providing insights into its efficacy in diverse educational settings, particularly by examining how the process of students creating their own videos influences their learning outcomes and engagement.

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Language Education Entrepreneurship Based on Non-formal Out-of-School Education

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Abstract

Development is carried out with the aim of increasing the welfare of the people, including economic, social, political and cultural needs. In this effort, education is always next to the struggle for independence and development, and is an important part of it. Psychologically, education creates changes in the attitudes, behaviors and values of individuals, groups and society, allowing them to be open and see ways to meet their needs. The young generation is the successor to the ideals of the nation's struggle and a human resource for national development. Therefore, efforts to improve its development must continue to be encouraged within the framework of national education. In order to improve national policies in the field of education, empowerment in all educational pathways—both formal, informal, and non-formal—is absolutely necessary. Non-formal education as one of the educational pathways seeks to empower productive youth through life skills education programs. Non-formal education includes life skills education, early childhood education, youth education, women's empowerment education, literacy education, skills education and job training, equivalency education, and other education aimed at developing students' abilities. In the study we aimed to determine the entrepreneurship in the field of language education based on out-of-school education.

Keywords: Entrepreneurship, Non-formal education, Out-of-school education, Educational Management, Language education

1. INTRODUCTION

From the past until now, the problem of poverty has been a major topic in various developing countries. Not only referring to individuals who are in a state of lack of money or goods to guarantee their living needs, poverty is also closely related to limitations in the world of employment. Limited employment opportunities make many people unable to work or unemployed. The unemployment experienced by the community is what ultimately makes it difficult for them to meet their living needs, resulting in an increase in poverty rates. Various previous studies from various perspectives have been conducted by researchers and the results show that unemployment, whether open unemployment, disguised unemployment, or under unemployment—does have a significant impact on poverty rates. Therefore, the availability of jobs or business opportunities that are open to all citizens is one of the important things for a nation. In fact, not a few figures argue that—in addition to economic growth—the number of available jobs is one of the benchmarks for the progress or otherwise of a country. The problem of unemployment is still a spectre that needs serious attention. The government, educational institutions, and the private sector need to work together to increase employment opportunities and at the same time produce superior entrepreneurial seeds so that the unemployment rate can be minimized. As is known, with the still large number of unemployed or job seekers amidst the minimal availability of jobs, efforts to produce more entrepreneurs from an early age must be recognized as one of the solutions that are still and must continue to be encouraged at various levels of society. This is because entrepreneurship can be one way for every individual to work and build a career for their life in the future without having to "raise their hands" while waiting for job vacancies to come.

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Even by becoming an entrepreneur, every individual can even open up new jobs for people who need or are looking for work, so that the government's task of reducing unemployment growth can be realized more quickly. In short, an entrepreneur no longer needs to depend on others.

2. ENTREPRENEURSHIP

Entrepreneurship is being able to take action with the right strategy and at the right time, being patient and being successful, or being unsuccessful and learning from it. Entrepreneurship is a process that requires taking certain risks in the process by evaluating existing market opportunities in order to develop a new product, service or business model. The question of what entrepreneurship is usually an important concept for individuals and organizations that try to make a difference in the business world with innovative ideas. Entrepreneurs produce creative solutions when faced with any problem or opportunity and are determined to overcome the difficulties they encounter while implementing these solutions.

In the context of entrepreneurship, there are two terminologies that are different in concept but have similarities in practice, namely entrepreneurship and intrapreneurship. Entrepreneurship is defined as the ability to manage one's own business, while intrapreneurship is defined as the ability to apply entrepreneurial concepts in managing other people's businesses.

Entrepreneurship is not only an activity aimed at gaining commercial profit, but also includes producing innovative solutions to social problems. For example, an entrepreneur who solves environmental problems can both achieve commercial success and benefit society. From this perspective, the question of what entrepreneurship is refers to a process in which individuals and institutions try to make a difference in the market by producing innovative solutions. For institutions, entrepreneurship means more innovation and growth opportunities.

The term entrepreneurship itself only began to be famous in the vocabulary of the business world in the 1980s, although the term entrepreneurship had emerged in the 18th century (1755) when French economist Richard Cantillon associated entrepreneurs with risk-taking activities in the economy. Entrepreneurship has been a concept for centuries, but economists did not include entrepreneurs and entrepreneurship in their economic models until the mid-1900s. The main reason for this was that all actors in the economy were assumed to be completely rational and have access to perfect information. However, in the real world, economic actors are not completely rational and do not have access to perfect information. For this reason, models prepared with this logic could not reach the desired results. The uncertainty within the economy and social structure had to be taken into account, and therefore the people who would eliminate this uncertainty and take on the risk had to be included in the models. At this point, the concept of entrepreneurship began to take its place in modern economic models.

Entrepreneurship is the spirit, attitude, behavior, and ability of a person in handling an activity that leads to efforts to find, create, and apply new ways of working, technology and products by increasing efficiency in order to provide better service and obtain greater profits.

Entrepreneurship is;
- a value that is manifested in behavior that is used as the basis for resources, driving force, goals, strategies, tips, processes, and business results.
- an ability to create something new and different
- a process of applying creativity and innovation in solving problems and finding opportunities to improve life.
- a value that is needed to start a business (start-up phase) and business development (venture growth).
- a process of doing something new (creative) and something different (innovative) that is useful in providing added value.
- an effort to create added value by combining resources through new and different ways to win the competition.

Entrepreneurs must be recognized as having an important role, because they are the ones who are able to see opportunities, develop, and create new businesses. Especially in the digital era like today, there are almost no obstacles to starting a business. With capital in the form of creativity and courage, anyone can start a business.

Many governments' vision and mission to grow and improve the national economy by increasing the number of entrepreneurs through various entrepreneurship programs such as the Student Creativity Program, Integrated Work Learning Program, Student Business Competition, Student Entrepreneurship Expo, and others have shown that entrepreneurship development activities are still being handled by many governments. Although the results are not yet completely satisfactory, various existing social indicators have shown improvements in reducing unemployment and poverty rates.

There are at least four main competencies that entrepreneurs must have, namely:

1) Technical competency or product or operational design,

2) Marketing competency or finding markets, identifying customers, and maintaining the company's survival,

3) Financial competency or financial competency in obtaining and managing the use of funds, and
4) Human relations competency or developing personal relationships that include relations and partnerships.

No less important to encourage is that an entrepreneur not only masters science but also new ways of thinking, various new skills, and new forms of behavior. Therefore, in order to increase students' interest in entrepreneurship, universities need to increase the frequency of entrepreneurial practices and apply contextual learning periodically in the form of field studies.

The components of the curriculum and teaching methods are one way to encourage the effectiveness of entrepreneurship education in universities. The description of the components of the curriculum and teaching methods can be seen in the following table:

Curriculum	Teaching Methods
* Contains theoretical knowledge of entrepreneurship and social network development. * Involves entrepreneurial practitioners in the curriculum development team. * The curriculum is flexible in accordance with changes in the business environment. * The curriculum is able to develop creativity and entrepreneurial skills * The curriculum is thematic in accordance with local potential. * The curriculum is in line with industry needs. * The curriculum is able to accommodate student interests and talents. *Internalization of Entrepreneurship values in the curriculum/syllabus of all existing courses.	* Prioritizes practice over theory in class. * Learning is contextual learning. * Learning methods are fun and create entrepreneurial enthusiasm. * Using a problem-based learning approach.

Table of Curriculum Components and Effectiveness of Entrepreneurship

One thing to note is that as a knowledge, entrepreneurship can be learned as we learn other knowledge. The most important thing is to capture the entrepreneurial spirit. This spirit is what will later motivate someone to develop their entrepreneurial abilities. The strategy of entrepreneurship education in higher education will ultimately shape students' soft skills to behave according to entrepreneurial character with characteristics including:

- Cultivating entrepreneurial motivation among students,
- Building an entrepreneurial mental attitude, namely self-confidence, awareness of one's identity, motivated to achieve an ideal, never giving up, being able to work hard, being creative, innovative, daring to take calculated risks, behaving as a leader and having a vision for the future, responsive to suggestions and criticism, having empathy and social skills,
- Improving the skills and abilities of students, especially their sense of business,
- Cultivating new entrepreneurs who are highly educated,
- Creating new business units based on science, technology and art, and
- Building business networks between business actors, especially between novice entrepreneurs and established entrepreneurs.

3. ENTREPRENEURSHIP AND NON-FORMAL EDUCATION

Education is the backbone of a nation's welfare. This statement is based on the idea that education has the ability to create and use new knowledge continuously where this can be obtained through entrepreneurship education which can ultimately affect a person's degree of entrepreneurship. Furthermore, entrepreneurship is truly a dynamic process for creating a prosperous order for all. So far, many people have complained because educational degrees, even to college, seem not enough to achieve the prosperity that everyone hopes for. The investment to finance the education process, which is not small, is often paid for by unemployed school graduates and undergraduates. Therefore, the existence of entrepreneurship education is expected to be able to hone students' reasoning skills and entrepreneurial talents so that they can be independent and able to open up employment opportunities.

Unfortunately, formal education, which is the hope of many parties with its role and contribution to produce output that is agile in breaking the chain of poverty and unemployment, actually leaves quite a few educational problems in school education. In this context, Non-Formal Education (NFE) takes on—or rather patches up the shortcomings— the role of helping schools and communities in reducing these problems. In other words, here NFE plays a role as a

"complement, addition, replacement, and perfection" (Kindervatter, 1979; Anderson, Lucas and Ginns, 2003; Jeffs and Smith 2005; Bramono, 2012; Saraka, 2020)

As we all know, Non-Formal Education is all forms of learning activities outside the school system, which are organized, deliberate and planned to help community members gain the knowledge, attitudes, and skills needed to improve their standard of living. Therefore, activities such as courses, coaching, training, counseling, and group learning are part of the variety of out-of-school education programs.

Out-of-school education (OoSE) functions to complement students' abilities by providing learning experiences that are not obtained in school education. The program material provided in OoSE is based on the needs of students and is carried out by education providers and in collaboration with the community. The programs planned in OoSE can vary, such as productive skills education, sports, arts, study groups, nature lovers' groups, and others. Gradually, the existence of OoSE is increasingly felt by the community because it is able to meet the learning needs of the community and bring the function of school education closer to the reality in society.

In the context of Out-of-School Education, there are at least four education models used in many developing countries, namely:

1. *Basic education which is directed at achieving basic education (elementary school or junior high school).* The concrete form of this type of education model is the Package A program which was formerly known as the Illiteracy Eradication Program. Through this Package A program, it is hoped that the community can obtain an Elementary School equivalency certificate as a prerequisite to be able to pursue a higher level of education.

2. *Education to improve the standard or quality of family life.* This type of education is manifested in family planning programs, health and nutrition, family welfare, healthy environment, toddler development, and so on.

3. *Education to improve the institutional life of the community.* This kind of education emerged as an impact of the increasingly advanced and complex life on the one hand and the increasing demands for an institution in society with professional management.

4. *Education to get a job or create new jobs for themselves or others.* This education model may be more familiar to us with the term courses or skills training organized by the government, private institutions, and educational institutions. This type of education curriculum focuses more on efforts to prepare prospective entrepreneurs by referring to real needs in the field, academic abilities, and financial conditions of the education participants. Meanwhile, the types of community education programs are divided into three types, namely:

Developmental program. Developmental programs involve the target audience in determining problems or needs and the scope and nature of the program. The role of the developer of entrepreneurship education programs is to facilitate the entire process of education and training, from recognizing needs to evaluating results and programs.

Institutional program. Institutional programs involve the target audience in implementing training. While the role of the developer of entrepreneurship education programs is to disseminate knowledge and technology through the instructional process.

Informational programs. Informational programs involve the target audience primarily as recipients of information. The role of the programmer is to provide answers to requests for information.

4. ENGLISH EDUCATION ENTREPRENEURSHIP BASED ON NON-SCHOOL EDUCATION

Learning an international language is one of the needs of today's society. Because in the midst of today's developments, the students' mastery of any international language such as English is an important provision or investment for the future both to improve communication skills, for work purposes, to support the education they are taking, and for the business needs they run (Saraka, 2005; Maden, 2012).

In fact, learning English is easy and you can do it yourself by purchasing guidebooks that are widely available in the market. However, most people are still looking for English language training institutions that can help them become proficient in both spoken and written English (Hutchinsons, Waters, 1991). This increasing public interest means that entrepreneurship in the field of English has bright prospects and still has the potential to be a business opportunity worth trying. This is also what encourages this business to move around in various regions to meet the market demand. Because the target market is not only students and college students, the general public is also a potential target market.

Among the many English language education businesses that are developing today, there are several institutions that have succeeded in developing their businesses to have branches and partnerships in several countries. For example, English First (EF), IELTS,TOEFL have been successful with a marketing strategies that determine their target markets widely, starting from children, teenagers, adults, and language courses for corporate level. In addition, there is also Kidea Learning Center which determines its target market specifically for children aged 3 to 12 years. Business actors deliberately choose the target market of children, because many parents start introducing English since their children were young. It turns out that the marketing of this business is quite interesting, and encourages parents

to enroll their children in the English language course institution. The public's need to learn English is likely to continue to increase. If you have expertise or skills in this field, then there's nothing wrong with starting an English language business. You can start with a small business that does not require large capital, for example offering private services for English courses. However, if you have sufficient capital, you can try to collaborate to establish a partnership with a well-known course institution.

4.1. Development of Entrepreneurship in the Field of Global Language Education Based on Out-of-School

Crystal (2000) stated that English is a global language. This statement represents the meaning that English is used by various nations to communicate with nations around the world. So, English is one of the international languages as well as a global language. Learning and understanding English becomes an unavoidable need. By learning English, a person will be open to international insights and knowledge. As a global language, English holds a very large function and role. One of the visible implications is that more and more people are trying to learn or master English well. In fact, English is absolutely needed to compete in the era of globalization. Knowledge of English for the development of an individual in many countries is something that is inevitable. Like it or not, this subject is something that every individual in developing countries needs to learn. Even if you are not sure you will get the opportunity to go abroad, this knowledge is still needed. At least, you don't need to be dumbfounded when watching CNN news broadcasts because there are no translations at the bottom of the television screen or confused when reading the manual for using electronic devices that are only printed in English (Irta Fitria, 2012).

Of course, we learn English for a specific purpose. Many people learn English because they know exactly what benefits they will get from learning the language. There are many benefits of English that we know and many that we don't know. Our concept of thinking so far has been too narrow in responding to the meaning of learning English as a compulsory subject in school to achieve the specified standard grades. In fact, there are several general benefits of English that can motivate and stimulate our interest in learning. Some of these benefits include:

* For academic purposes. English lessons are indeed compulsory for all students, even those who are not majoring in English.

* For career development. The world of work is tempted by people who are proficient in English. This skill will be an added value for prospective job applicants because they are considered more competitive than those who are not/less proficient in English.

* To go abroad. For students, continuing their studies abroad is very prestigious. However, they must pass the IELTS or TOEFL. This test measures our ability to speak English.

* To expand the circle of friends. English is very important for establishing international communication.

* To conquer the internet. You might think that many sites are translated into domestic language. In fact, 80% of electronic information is only available in English, while the remaining 20% is not all dominated by domestic language.

The English language education entrepreneurship development program based on Non-Formal Education in some countries is intended to form small and medium entrepreneurs who are able to apply their capacity and capabilities in the field of English in the business world. Therefore, students who already have competencies in accordance with graduate competency standards need to be directed and guided to start small businesses. The steps in starting a small business are:

Analyze the right location to start a business: right between the type of goods or services sold and the needs of the community, right and strategic with raw materials.

Plan a small business, which includes: how much capital is needed, the facilities and infrastructure needed, the specifications of goods that are in accordance with needs, promotional plans, the number of workers needed, and others.

Starting an independent business, what is needed in starting an independent business is: production of goods or services, pricing, location accuracy, promotion patterns, administration, and services.

Developing business, by: maintaining the quality of production of goods or services, diversifying production of goods or services, improving the quality of services, innovating various forms of products or services, corporations, strengthening capital, and using technology.

5. CONCLUSION

Education takes place in two ways: planned in schools as formal education and outside of school, in a natural environment, outside of the program as informal or non-formal education. Today, schools constitute the most important part of the education process. Education is not only provided in schools. However, there are also institutions that provide short-term training outside of schools to prepare young people and adults for a profession and to facilitate their adaptation to life. Education also takes place in the family, workplace, military base, church, mosque and various groups formed by people. A person does not learn only by listening to what the teacher says at school, but from birth, he continues to learn throughout his life from his parents, elders, relatives, friends, neighbors, television, cinema, theater, museum visits, books, newspapers and magazines. Non-formal learning is a process that includes establishing dialogue in real life situations, gaining experience and discovery skills, recognizing and benefiting from private and social environments, learning randomly, and acquiring desired and undesired behaviors required by daily life. Non-formal learning achieves its goal by using various educational activities and case studies, and sometimes real events, in living areas determined according to need outside of school.

Language should be taught in accordance with real life and considering its use in a natural environment. For this reason, in teaching any language as both a mother tongue and a foreign language, it is important for the individual to practice and do exercises that are appropriate for the use of the language in real life. In this context, contemporary educational research emphasizes that teaching methods that emphasize active learning, individual differences and practice should be used in language teaching, and that all living spaces in and outside of school should be used in accordance with the goals for the success of learning within the scope of lifelong learning. In addition to in-class practices, language learning and teaching studies in non-formal education environments implemented outside of school that aim/ensure the lifelong development of language skills can serve the mental, social and language development of the individual to a high extent. Learning a language in non-formal environments and developing basic language skills is an area of application that varies from person to person and affects language skills in preschool, school and later professional life, but has gained importance based on the results of scientific findings on language acquisition-teaching and social development of the individual. Non-formal language education can be an alternative to programmed in-school language teaching in some cases, but in general, it is a form of learning in which language skills can be continuously supported according to the needs of daily life.

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The Importance of Suggestopedia Method in Teaching Foreign Language

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Abstract

In language teaching, methods increase efficiency for both the teacher and the student. Teachers also use various methods according to the skills to be developed in the target language and the needs of the target audience. The Grammar Translation Method, the Direct Method, and the Communicative Method are among the common methods used in teaching foreign languages. Of all the methods used in teaching foreign languages, Suggestion Method or Suggestopedia is known less than others. Suggestopedia Method softens the aggressive tendencies in students and ensures their adaptation to society. Although the Suggestopedia Method was not regularly used as a foreign language teaching method in the literature, the success of the method in language teaching has recently been proven and its application in teaching a foreign language has been suggested. In the study we aimed to determine its usability and applicability in teaching foreign language under the light of literature.

Keywords: Suggestopedia Method, Suggestion Method, Language Teaching, Educational Management

1. INTRODUCTION

Throughout the history of foreign language teaching, how to teach a language has always been a subject of debate. Foreign language teaching methods are systems that strive to show the way to make the student a more competent learner in teaching studies, beyond being a tool for learning a foreign language and gaining knowledge. In language teaching, a method is a teaching element that will help the student reach the goals of education in the fastest and most reliable way. Although many teaching and learning methods have been developed to date, it is not possible to speak of a truly adequate and ideal method.

The variety of methods in foreign language teaching also brings with it the question of which methods are more effective in language teaching. A method that may be useful for one person may not be as successful or may be completely unsuccessful for another person (Tarcan, 2004). Knowing foreign language teaching approaches and methods well is very important for the development of new approaches and methods and for following this process (Demircan, 2013). The method used in foreign language teaching determines the theoretical foundations of teaching. For this reason, it is necessary to know the basic principles, boundaries, limitations, usage and features of the methods used well. Although there are various sources published about foreign language teaching methods, these sources contain 'different, incomplete or incompatible information' about the methods. It is thought that the errors that occur during translation due to the fact that the primary sources about the methods are in foreign languages, the mistakes that occur due to transfer from secondary sources and especially the inability to access sufficient information about the usage features of the method that can be obtained by applying the methods cause these problems.

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The methods used in foreign language teaching have generally emerged to cover the deficiencies or inadequacies of a method in use, and these efforts have contributed to better teaching of foreign languages and have brought alternative methods to this field (Memiş and Erdem, 2013).

Of all the methods commonly used in language education, the Suggestion Method is a foreign language teaching method developed by the Bulgarian psychotherapist and educator Georgi Lozanov after 1960, using data from psychology. The suggestion method aims to control the effects that are not based on reason and/or consciousness and redirect them in a way that will ensure learning (Hengirmen, 2006).

2. SUGGESTOPEDIA (SUGGESTION METHOD)

Suggestion-based learning in language learning is called 'suggestiopedia' or what is now better known as 'desugestopedia'. This learning concept is included in the Humanistic approach. Suggestopedia is an application of suggestion in pedagogy where the learner's feelings of failure can be eliminated. In the suggestopedia learning model, the psychological obstacles of learners can be overcome (Brown, 2001). This method was pioneered in 1975 in Bulgaria when a group of enthusiasts at the Pedagogical Research Institute under Georgi Lozanow conducted research on foreign language teaching. In its early development, suggestopedia was only tried in Eastern European countries such as the Soviet Union, East Germany, and Hungary (Dardjowidjojo, 2003). As a doctor, psychotherapist, and physicist, Lozanov believed that relaxation and concentration techniques would help learners open their subconscious sources and acquire and master a greater vocabulary and more solid structures than they might have ever thought possible (Richards & Rodger, 1993).

According to (Lozanov, 1978) the most basic foundation of Suggestopedia is suggestology, a concept that presents a view that humans can be directed to do something by giving them suggestions. The mind must be made as calm, relaxed, and open as possible so that materials that stimulate the receptive nerves can be easily accepted and maintained for a long period of time (Dardjowidjojo, 2003).

The characteristics of this method include a suggestive atmosphere in the place of application, with soft lighting, soft music, cheerful room decoration, pleasant seating, and dramatic techniques used by the teacher in presenting learning materials. All of this is totally aimed at making learners relaxed, allowing them to open their hearts to learn language in a model that does not pressure or burden students. (Richards & Rodgers, 1993) Each teaching method has advantages and disadvantages, as does the Suggestopedia method. In its application itself, this method also has several techniques that can be used such as role-play, positive suggestion, first concert, second concert and so on.

2.1. Principles of Suggestopedia

There are ten principles of Suggestopedia Method (Giyoto and Hum, 2021)

- **Teacher's Objectives Using Suggestion-Based Methods:** Teachers hope to accelerate the process by which students learn to use another language for everyday communication. To do this, the mental powers of the students must be harnessed to a greater extent. This is done by removing the psychological barriers that learners bring to the learning situation.
- **The Role of Teachers and Students:** The teacher is the authority in the classroom. For this method to work, students must trust and respect them. Students will retain information better from someone they trust because they will be more responsive to 'putting aside' their limitations and suggesting how easy it is for them to succeed. Once students trust their teacher, they will feel more secure. If they feel secure, they can be more spontaneous and less inhibited.
- **Characteristics of the Teaching and Learning Process:** The lessons are conducted in a bright, cheerful classroom. Posters displaying grammar information about the target language are hung around the room to take advantage of the students' peripheral learning. The posters are changed every few weeks. Students choose a name for their target language and choose a new job. During the course, they create a full biography to match their new identity. The text of the students' work is a handout containing a long dialogue (up to 800 words) in the target language. Next to the dialogue is a translation into the students' native language. There are also some notes on vocabulary and grammar that correspond to the bold items in the dialogue. The teacher presents the dialogue during two 'concerts.' This represents the first main phase (receptive phase). In the first concert, the teacher reads the dialogue, adjusting her voice to the rhythm and pitch of the music. In this way, the students' entire brain (left and right hemispheres) is activated. The students follow the target language dialogue as the teacher reads it aloud. They also check the translation. In the second concert, the students listen quietly while the teacher reads the dialogue at a normal pace. For homework, the students read the dialogue before they go to bed, and read it again when they wake up the next morning. This is the second main phase (active phase), in which students engage in a variety of activities designed to help them gain facility with the new material. These activities include dramatizations, games, songs, and question-and-answer exercises.

- **The Nature of Student-Teacher Interaction:** The teacher initiates interactions with the whole group of students and with individuals from the beginning of the language course. Initially, students can only respond nonverbally or with a few words of the target language that they have practiced. Later, students have more control over the target language and can respond more appropriately and even initiate interactions themselves.
- **Treatment of Students' Feelings and Emotions:** Much attention is paid to the feelings of the students in this method. One of the basic principles of this method is that if students are relaxed and confident, they do not have to make a great effort to learn the language. It will come naturally and easily. It is considered important in this method that psychological barriers brought by students are avoided. Indirect positive suggestions are made to increase students' self-confidence and to convince them that success is possible. Students also choose the name of the target language on the assumption that the new identity makes students feel safer and more open to learning.
- **Views on Language and Culture:** Language is the first of two domains in the two-domain communication process. In the second domain are factors that influence the linguistic message. For example, the way of dressing or nonverbal behavior used affects how a person's linguistic message is interpreted. The culture that students learn concerns the everyday life of the people who speak the language. The use of fine arts is also important in Desuggestopedia classes.
- **Emphasis on Language Fields and Skills:** Vocabulary is emphasized. Claims about the success of this method often focus on the large number of words that can be acquired. Grammar is addressed explicitly but minimally. In fact, it is believed that students learn best if their conscious attention is focused, not on the form of language, but on the use of language. Communicative speaking is emphasized. Students also read in the target language as dialogues and write in it as imaginative compositions.
- **The Role of Students' Mother Tongue:** Native language translations are used to clarify the meaning of dialogues. The teacher also uses the native language in class when necessary. As the course progresses, the teacher uses the native language less and less.
- **Strategies for Evaluating Learning Outcomes:** Evaluation is usually based on the student's normal performance in class and not through formal tests, which would threaten the relaxed atmosphere considered essential to accelerated learning
- **Teacher's Treatment of Student Mistakes:** Errors are corrected gently, with the teacher using a soft voice.

3. ADVANTAGES AND DISADVANTAGES OF SUGGESTOPEDIA METHOD

Some of the advantages or benefits that can be obtained from the suggestopedia teaching method compared to other methods are:

- It can be understood based on the principles of desuggestion and suggestion. By using this teaching method, students in learning a language can reduce their affective filter. With class conditions that are positively suggested to students, students can enjoy the class with optimal psychological conditions. Suggestopedia classes are also held in regular classes with comfortable chairs which can also help students relax. Teachers can also do several other things to reduce the affective filter. According to Krashen (1989), activities that allow students to get to know each other better and can help reduce difficulties and make students use new names during language learning can have different psychological effects.
- *The concept of authority;* In the Suggestopedia class, the teacher has full authority in the teaching and learning process. Students remember and are most influenced by information that comes from an authoritative source, the teacher.
- *Dual planning theory;* This theory refers to two aspects of learning, namely the conscious aspect and the subconscious aspect. This method allows giving suggestions to students consciously or subconsciously. Students can get suggestions for teaching instructions from both direct instruction and the teaching environment.
- *Surrounding learning;* Suggestopedia supports students to apply language freely, take personal responsibility for their own learning and to gain more confidence. Surrounding information can also help support students to try more, and find sources other than teachers. For example, students can make several sentences using grammatical structures on the classroom wall, describe certain places in foreign countries by looking at posters on the wall, etc. When students succeed in doing self-activities, they will be more confident.

As with methods in general, besides having advantages or benefits, Suggestopedia has several disadvantages and pitfalls. The main disadvantages of Suggestopedia as quoted by Arulselvi (2017) are:

- *Environmental limitations;* The number of students in a class that is effective for implementing this method is ideally 12 students. While most schools in developing countries have classes consisting of 30 to 40 students.
- *Use of hypnosis;* Some people say that Suggestopedia uses hypnosis, so it has a bad effect on human life. Lozanov strongly denies it.

- *Childish learning;* Suggestopedia classes are conditioned into childish situations. In fact, some students do not like to be treated like this as they think they are adults.
- *Use of classical music;* This is one of the problems because there are some people who do not like classical music, some people find classical music more annoying than stimulating and in some cultures it may sound foreign.
- *Long text:* Some students may have a negative treatment of long texts that tend to be boring.
- *How is the language learning part of the role:* The main components of language learning, namely vocabulary, structure, function and language topics in this method can be more confusing for students than motivating. This is because the components are not integrated/do not match the sound base.

4. TECHNIQUES OF SUGGESTOPEDIA

There are some examples of Suggestopedia method application techniques in the foreign language learning process. These examples can be seen on the application of the Suggestopedia method. According to Laser-Freeman & Anderson (2011), there are many techniques that can be used in teaching foreign languages with the Suggestopedia method, including: classroom setup, peripheral learning, positive suggestion, choose a new identity, role play, first concert, second concert, primary activation and creative adaptation. Some of the important techniques are:

Role play: Students are encouraged to become small children, then play the role of a teacher and assume new names and roles in the target language so that they are easy to understand.

In this teaching method using Suggestopedia, it was developed to help students reduce the feeling that they will not succeed in learning, thus solving problems of learning limitations. In this role play, all students will feel like they are playing the role of a teacher and student. However, there is a difference between role play and simulation. Role play here all roles have been planned scenarios in advance, while student simulations play roles as if they were in the real world in a way that they are free to express themselves.

This technique is a way to play a role but with a fun technique, so it is not only limited to playing a role, but how to play the role can be effective and fun. Here students are trained to be the role of others, for example as a teacher, so that they can feel and get experience being a teacher and the goal is that they can explore their skills or potential. In addition to being able to train skills, with this role play method, they can grow their empathy so that there can be cooperation between the roles played as a teacher and students, can train the development of good communication or how to explain to others, so as to spur oral fluency.

When students are comfortable with role play, they are expected to be able to convey the target language in their own style so that it is easier to understand. Through this role play media, it also helps students who are insecure. Because they can learn with their own friends without being embarrassed to ask because the nature of this role play is fun and exciting. This role play teaching technique is very suitable for elementary school children because of their very high enthusiasm for the world of play where the nature of this method is fun play. So that students who have difficulty in absorbing language material will not feel burdened by this technique.

In the role play implementation technique, the teacher first introduces the topic that will be discussed that day. Then stimulate students' interest in the material by giving real examples in everyday life, by giving new vocabulary to language learning on the same material but the context is deeper because at the beginning the teacher has given a little picture of the content of the material, stop the story at the climax, discuss the existing dilemma, then do a role play. Students are asked to temporarily pretend to be someone else who is played according to the material that has been studied and appear in the target language. Students can also be asked to create their own roles or improvise according to the story situation or material. After the role play is carried out, the teacher and students prepare learning to listen and respond, act out the remaining story, discuss the way out that must be taken in the story, and re-enact the contents of the story with new strategies if needed.

Positive suggestion: Students learn at different speeds and levels. One of the reasons for their inefficiency in learning is that they create psychological barriers to learning. They are afraid that they will not be able to do it, that they will be limited in their ability to learn, and therefore they fail. Students do not use the full mental power that they have. According to psychologists, we may use five to ten percent of our mental capacity. In order to use our reserve capacity better, its limitations, obstacles and fear of failure need to be 'suggested' (Arulselvi, 2017).

In the Positive Suggestion technique, the teacher's responsibility is to arrange suggestive factors in the learning situation, thus helping students overcome the learning barriers they bring. A teacher tells students that they will succeed. This type of suggestion is called Direct Suggestion and directly appeals to students with consciousness. Indirect Suggestion appeals to the subconscious of students which is stronger than the two. In each technique, mistakes are corrected gently and indirectly. The teacher gives the impression to students that learning is easy and fun. The teacher helps students activate the material they have opened or delivered and integrates indirect positive

suggestions into the learning situation. Steps or activities of teachers and students that can be done in the Positive Suggestion technique:

- The teacher opens/starts the lesson by saying hello in a class condition that has been arranged in such a way, for example, the lighting has been adjusted, the seating position is in a circle and new teaching materials have been installed on the wall.
- The teacher greets and asks how the students are overall using their mother tongue.
- The teacher motivates and encourages students by convincing them that they will succeed in everything, especially in the process of learning a foreign language.
- The teacher asks students about any obstacles they faced in the foreign language learning process before, then the teacher provides solutions.
- The teacher repeats the previous day's lesson material in the form of conversations, games, sketches and acting. If students make mistakes, the teacher corrects them by using a sentence tone that encourages positive.
- The teacher presents classical music as a beginner in delivering new teaching materials.
- The teacher delivers new materials presented in context through long dialogues and the method is not much different from the traditional method: the material is presented and demonstrated, followed by explanations of new words and grammar. The dialogue used as teaching material must be relevant, real, interesting, and used according to its content.
- The teacher does not give homework to students.

Peripheral learning: In terms of language, peripheral learning is defined as learning from the students' surrounding environment in which they can learn many things that they see around them. With learning as part of the environment, students can absorb information easily. Students can even receive or learn more things in the surrounding environment than learning in class that is followed consciously. With this in mind, a Suggestopedia initiator, Lozanov (1978) came up with the idea of peripheral learning as one of the language learning teaching techniques.

As one example of the steps for implementing peripheral learning techniques in class, teachers can put up posters with grammatical content. By putting up posters containing grammatical information of the target language on the classroom walls, students will absorb important information easily. The teacher does not need to ask students' attention to be directed to the posters. Then the posters can be changed from time to time to provide information that is in accordance with what students are learning. So, in the learning environment applied in the classroom, it does not require many steps. The teacher does not need to give instructions, just by putting up posters or other media that can be seen and read by students, who will consciously or unconsciously be suggested and receive the information in optimal conditions. However, at certain times in a context that adjusts to the complexity of the material being studied by students, the teacher also needs to ask for students' attention and explain it.

5. CONCLUSION

In recent years, significant developments have occurred in the field of foreign language education, foreign language teaching techniques have changed, and thanks to the development of technology, traditional methods have been replaced by methods that focus on the student. This study examines the suggestion method, also known as the Lozanov method, which emerged to teach a foreign language quickly and effectively and is used in many countries around the world. According to the suggestion method, students who want to learn a foreign language come to class with some negative feelings, thoughts, and prejudices. The suggestion method aims to purify students from these negative feelings and thoughts with the teacher and the techniques of the method and to teach and make them speak the foreign language. Today, language centers that provide foreign language education with this method are quite common in European countries. In Turkey, the suggestion method is not very well known. It is known that foreign language education in Turkey is not at the desired level and that the desired success is not achieved from the methods used. In this context, it is thought that the suggestion method, which is thought to be beneficial for foreign language education, should be researched by the Ministry of Education and used in foreign language education in schools.

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Students' Perspectives of Formative Feedback in English Classes: A Case Study at a Military University

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Abstract

An investigation of 57 military university students' perceptions of formative feedback in English language learning is carried out, particularly with the scaffolding function, motivational impacts, and performance enhancement. The research used a mixed-method approach, including questionnaires from Nguyen (2023) and adapted and semi-structured interviews. Findings show that students find formative feedback a scaffold highly valuable to their language progress, with strong positive responses to the forms' role in developing students' self–assessments and strategic learning skills. Instead, feedback appears to be more effective in the structured military environment, resulting in improved consistent performance and learner autonomy. The study recommends that structured feedback approaches be maintained and more opportunities for student-teacher dialogue be incorporated into the feedback process or that technology-enhanced feedback methods be implemented to optimize feedback practices.

Keywords: Formative feedback, students' perspectives, military university.

1. INTRODUCTION

Formative assessment and feedback in language learning are essential, especially where feedback is concerned (Hyland, 2000; James & Folorunso, 2012). From this perspective, feedback is a potent vehicle in indicating a way ahead for a student concerning what is going right and what is not at an opportune time (Shute, 2007). Afitska (2014) claims that development feedback, in particular, focuses on continual evaluation rather than a last supposition and endeavors to support student learning through the conveyance of functional arrangements in the learning setting. In addition to helping students identify their errors (or misconceptions) in learning a topic, it also encourages self-reflection and active engagement in the learning process (Moss & Brookhart, 2009).

The focus of formative feedback is a topic of unique concern and possibility in a military university in Hanoi. Traditional academic universities do not operate under this level of discipline, structure, and deadline set in place for students to remain stuck, as military universities do. Different factors play a role in changing attitudes about learning and students' reactions to feedback. While formative feedback offers the potential to aid language development, the way in which students in a military environment perceive and use this type of feedback has not been investigated extensively. Again, in such a setting, feedback from a teacher could be perceived by students as an installment of an authoritarian model of instruction, as opposed to a means of self-improvement, which is needed for a student to move closer to effective learning. The challenge is that studies have not examined formative teacher feedback from students'

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perspectives at this military university, nor is there a comprehensive understanding of the students' perspectives on formative teacher feedback. Educators cannot efficiently design effective feedback practices without incorporating students' perspectives; without doing so, there is a potential disconnect between teacher intentions and student reception. Additionally, the characteristics of military education, which dictate discipline and structured learning, could impact feedback dynamics distinctively than those encountered in civilian universities. Consequently, there is a compelling need to examine to what extent the ongoing formative feedback practices match students' learning needs and preferences.

The main goal of this investigation is to understand how students view teacher feedback in the formative context of a military school. Research of students' perception of feedback would help determine which factors influence how students receive and use feedback and provide some practical hints for improving teaching practice. Results may have practical implications for applications of feedback in this particular educational environment. The above research problem and objectives give rise to the following research question: "What are students' perspectives on the effectiveness of formative feedback at a military university in Hanoi?"

2. LITERATURE REVIEW

2.1. The concept of formative feedback

Moss and Brookhart (2009) list formative feedback as feedback given to students primarily to help improve their learning compared to judging their performance only. While summative feedback concentrates on judging the final product, formative feedback continuously happens while learning and gives constructive feedback (Peterson & Siadat, 2009). Mostly, this feedback is specific and actionable; it helps students learn about their strengths, weaknesses, and steps to improve their skills (Afitska, 2014). Formative feedback is timely, transparent, and aimed at the appropriate learning objectives so students know how to use it to improve their practice (Shute, 2007).

Formative feedback is an invaluable tool to use in language learning, especially in developing writing and speaking. Yeh (2009) believes that formative feedback guides students to correct grammatical errors and provide coherence but also aids students to refine their ideas when writing during the drafting and revising stage. Teachers can help guide students toward a more transparent, more polished piece of writing by only offering targeted comments on structure, vocabulary, and argumentation. Formative feedback can be provided for speaking to help learners improve pronunciation, fluency, and suitable use of language structures and feel more confident about their speaking (Yin et al., 2008). It also creates opportunities for students to think reflectively on their learning journey and participate actively in this learning journey.

2.2. Formative feedback – a form of scaffolding

It is possible to view formative (assessment) feedback as scaffolding to support students throughout the learning process (Yin et al., 2008; Moss & Brookhart, 2009). Scaffolding, as a concept, is based on Vygotsky's Sociocultural Theory (1978) and refers to providing learners with temporary support while they develop new skills or knowledge and retaining less support as the learner becomes independent. Formative feedback of this type has 'scaffolding' functionality, in Shute's (2007) terms, in that it provides students with guidance and constructive criticism to move from their current level of performance to a more proficient level. It is a bridge between what students can do independently and with support from the teacher.

Formative feedback in language learning is a dynamic scaffold that adjusts according to the learner's needs, attending to areas that need improvement and strengthening positive performance (James & Folorunso, 2012; Peterson & Siadat, 2009). For example, in writing tasks, formative feedback could indicate if the student's piece is incoherent, grammatically or lexically problematic, and could also give explicit guidance about how to revise and improve the piece (Bader et al., 2021). Similarly, in speaking activities, formative feedback may focus on aspects such as pronunciation, fluency, and usage of appropriate language forms, and so aids learners to be more conscious of the extent to which they are competent communicators and to be aware of exactly which areas they need to work on. The scaffolding aspect of formative feedback involves helping create a safe environment for students to take risks, make mistakes, and learn from these errors, as communicated by McMillan et al. (2013). Teachers offer children specific, actionable, and timely suggestions that build their confidence, and eventually allow them to internalize the strategies for self-correcting and improving on their own. Through formative feedback, students become more accountable for their learning and develop metacognitive skills and a deeper understanding of the language over time.

2.3. Impacts of formative feedback on student motivation and performance

There is widespread agreement that formative feedback greatly influences student motivation and performance (Lee, 2017; Zahida et al., 2013). When compared to summative feedback, which may evaluate only the final outcome, formative feedback gives continuous assistance and is revealed during the learning procedure (Peterson & Siadat, 2009). Not only does this act as a way for students to see their progress, but it is also a powerful motivational tool. If delivered helpfully, formative feedback can also raise students' intrinsic motivation because they feel supported, valued, and part of their learning process.

Clear and specific feedback comments serve as a way to motivate students by focusing on the learning process rather than just its outcome (Kileri & Listyani, 2021). Camacho et al. (2021) proclaim that feedback that highlights what the student has done well, accompanied by constructive ways to improve, should be used to create a positive learning environment. Instead, this type of feedback serves to redirect a student from a fixed mindset where a student may think that their capabilities are fixed, his or her abilities are fixed, to a growth mindset, where students see that they can improve his [or her] skills and grow with effort and practice (McMillan et al., 2013). Thus, students are more willing to engage in challenges, persevere with difficulties, and spend more effort on their tasks.

Formative feedback also gives students in terms of performance to identify their strengths and weaknesses to make individualized revisions (Camacho et al., 2021; Vedder, 2013). For example, detailed feedback on structure, coherence, and language use in writing tasks can lead to students making specific, meaningful tweaks (Zahida et al., 2013). In speaking activities, formative feedback on pronunciation, fluency, and language choice helps them be more aware of their communicative skills, and better self-correction and gradual improvement follow. Receiving feedback, reflecting on it, and applying what was learned to the next task creates an iterative process, creating deeper learning and skill enhancement.

2.4. Previous studies

This section presents some of the below studies that collectively show the importance of formative feedback in English language teaching and reveal the impact on students in different ways. Vedder (2013) looked at the impact of formative feedback on student attitudes in the Grade 12 English context and determined that it positively influences student self-efficacy and student-teacher relationship but has little influence on attitudes toward course content. Formative feedback shared among the teacher and the students is regarded as a powerful instrument to improve learning and teaching, Al-Shehri (2008). The study analyzed questionnaires completed by students and teachers in a college in Riyadh and shed light on the powerful positive effect of formative feedback on students' and teachers' learning and teaching, specifically in English for Specific Purposes settings. The effects of formative assessment (including feedback) on fifth-grade social studies students have been investigated by Ozan and Kincal (2018). Formative feedback substantially enhanced students' academic achievement and attitudes toward lessons, but its effects on self-regulation skills were limited. According to Nguyen (2023), Vietnamese students' perceptions of teachers' written feedback on their essays reflect that while feedback on their essays motivates them to revise, it also evokes complicated feelings in them, from eagerness to confusion. It implies giving feedback based on what students prefer and what they need. Bader et al. (2024) describe how teacher and peer feedback function in higher education contexts. Based on positive teacher feedback and poor review of peer feedback, Bader et al. (2018) argue for integrating and structuring peer feedback practices well.

Previous research has examined the role and effect of formative feedback within English language teaching from several educational contexts. However, this is true in various educational contexts, which are missing in highly structured specialized contexts such as military universities. Vedder (2013), Al Shehri (2008), and Ozan and Kincal (2018), in one educational context, have provided indications of how formative feedback impacts student self-efficacy, performance, and attitudes overall. However, these studies mainly consider conventional high school and civilian university settings where students have more freedom and fewer extant constraints than military institutions.

Given the particular environment of a military university in Hanoi, there are new, uncharted challenges and dynamics that existing formative feedback work has yet to occupy. Unlike traditional universities, military institutions are strict about discipline, the structure of command, and the learning environment. How students perceive and respond to formative feedback may be shaped by one or more of these factors, resulting in different attitudes than students in less rigid educational contexts. Bader et al. (2024) and Sotlikova (2023) point out the significance of feedback dialogue, as well as individualized support; however, the highly structured nature of military education restricts promotion for such interactions, opening up the room for the use of personalized feedback methods. Beyond, research such as Nguyen (2023) has perceived student emotions and preferences regarding feedback but has not examined how military students, with their somewhat enhanced pressure and stress, make sense

of and utilize formative feedback. Therefore, this study tries to fill the gap by exploring students' perceptions of the effectiveness of formative teacher feedback in a military university setting, providing a new understanding of how feedback can be adjusted to promote language learning in the uniquely educational context of the military university.

3. METHODOLOGY

3.1. Participants

This study sets out the research context of this study, a unique educational context within a military university context in Hanoi. It provides implications regarding language learning and feedback practices in a particular context. The study focused on 57 non-English primary students (38 males, 19 females) with different academic years involving a wide range of learners who have complemented English in their complementary subjects of study and military training. This participant choice becomes crucial; these students are distinct in that their time is divided between language learning and demanding training requirements, which can impact their openness to and use of formative feedback. "New English File - Pre-intermediate" is the primary course material, providing a stable framework for instruction and assessment to all participant groups. The military university setting introduces several distinctive characteristics that set it apart from conventional civilian institutions: Linear and hierarchical communication flows and time pressures associated with military training commitments. The influence of these factors on the dynamics of teacher-student interactions and the delivery and reception of formative feedback are potentially significant.

Additionally, being a specialized institution, the students must both learn English and follow the military protocols that conform to the military protocols used, where students are prepared for another language that will be required for their future military career. The focus on language and military communication creates a unique environment for learning through formative feedback specific to general language competencies and specialized military communication. Together, these elements, specialized institutional context, diverse non-English significant student population, and standardized curriculum framework create a rich environment to explore the operation of formative feedback in military education.

3.2 Data collection instruments

This study used a mixed-method approach with quantitative and qualitative data collection methods to gather a mixed-mode response to students' perspectives regarding formative feedback in the military university context.

In the quantitative component, a questionnaire with a 5-point Likert scale was used, which was modified by Nguyen (2024). The 17 items were grouped into three: scaffolding function (items 1, 6, 11, 12, 13, 16), motivation impact (items 2, 4, 9,10, 14, 15), and performance (items 3, 5, 717). This will allow the instrument to be grounded in the military university context and develop validated measures from past research. This is a pragmatic choice to collect data through Google Forms, which provides easy access for participants and ease of collection. A Likert scale is used so that students' attitudes and perceptions can be measured with one instrument and statistically analyzed and compared to the different aspects of formative feedback.

The qualitative aspect of the methodology involved interviewing seven volunteer students using the Zoom application in semi-structured interviews. The interviews were semi-structured, which gives a good balance between ensuring consistency through the interviews and the flexibility to follow emerging themes or unexpected responses. It was usually about 15 minutes, so only a little time was required! This is especially noteworthy because we decided to conduct the interviews in Vietnamese, rendering the language barrier an obstacle no more and participants able to express themselves more freely and accurately in their language. A limitation of the interview was that participation was voluntary, and therefore, students may have self-selected themselves as a sample that does not necessarily represent the wider student population. The qualitative data could be skewed because volunteers may have stronger opinions and more extreme experiences with formative feedback. Convenience and accessibility aside, it is necessary to analyze how the interview environment in a virtual setting might modulate participant response, especially relative to an in-person setting.

3.3. Data analysis

The reliability of the questionnaire analysis provided a Cronbach's Alpha coefficient of 0.985 for all 17 questionnaire items, which means it has excellent internal consistency reliability. This value is much larger than the generally accepted mark of 0.7 for adequate reliability of social science research. The alpha coefficient is relatively

high, and one may conclude that the items in the questionnaire show very high inter-item correlations and reliably measure the same construct, i.e., the student's perception of formative feedback.

According to Creswell (2013), three main themes and their respective sub-themes were uncovered from the qualitative data analysis describing student's perspectives on formative feedback at the military university. Under the Scaffolding Function theme, three sub-themes emerged: Guided Progress, Error Recognition, and Strategic Support, described in terms of students' ability to notice and comprehend their mistakes and to access specific techniques for independent learning. The Motivational Impact theme was made up of Emotional Response, students' differing responses to feedback in the military environment; Self – efficacy Development, the influence of feedback on developing students' confidence despite the challenges of rigorous standards; and Goal Orientation, showing how feedback connected to students' future military career goals. Performance themes included skill enhancement, specifically military-specific communication; learning strategy adaptation, which demonstrated the changes the learning strategy had undergone in the face of military education constraints; and academic achievement, with feedback contributing to better results.

4. FINDINGS AND DISCUSSIONS

4.1. Students' perspectives of scaffolding function of formative feedback

The quantitative findings indicate generally positive perceptions of feedback's scaffolding function, with mean scores ranging from 3.88 to 3.95 (Table 1).

Table 1. Descriptive statistics of scaffolding function of formative feedback

	N	Mean	Std. Deviation
1. My teacher's feedback helps me understand the steps to improve my English skills	57	3,95	1,301
6. The feedback I receive clearly shows the gap between my current and expected performance in English	57	3,91	1,214
11. My teacher provides examples that help me understand how to improve various aspects of my English	57	3,89	1,291
12. The feedback I get breaks down complex language tasks into manageable parts	57	3,88	1,211
13. Teacher's comments help me identify patterns in my English language errors	57	3,93	1,208
16. The feedback gives me enough support to make improvements on my own	57	3,88	1,196

Students found feedback that expressed clear guidance towards improvement to be particularly valuable (M = 3.95, SD = 1.301), which would indicate the effectiveness of feedback as a developmental tool. Qualitative data from interviews strongly support findings. For instance, one student emphasized the systematic nature of feedback, *I could track my progress through this step-by-step feedback. It makes me feel like, I have a roadmap of how to improve,' rather than my teacher pointing out specific grammar mistakes and how to fix them*" (S4). Another student highlighted the manageable breakdown of complex tasks: "*My teacher did not mark everything wrong, instead, he divided a correction into smaller parts, first grammar, then vocabulary, then organization. This made it less overwhelming*" (S7). The identification of language patterns was also valued highly (M = 3.93, SD = 1.208), as reflected in one participant's comment, and "*from doing that for a while and talking to some folks about what I struggle with most, I started to see some patterns in my mistakes."* For example, for myself, I realized that I tended to make mistakes with article usage and that it allowed me to be more aware of this aspect" (S2). Students appreciated the scaffolding that enabled independent learning (M = 3.88, SD = 1.196), as evidenced by one interviewee's reflection, "*It was not about just corrections but explanations, examples I could use when doing other assignments. "I was able to learn more independently*" (S1) this aided me. The gap identification between current and expected performance (M = 3.91, SD = 1.214) was also significant, with one student noting: "*I got fed back clearly told me where I was, where I needed to go. This clear gap especially made me set realistic goals for improvement.*" (S3)

The results provide strong support for the theoretical framework of formative feedback put forward as a scaffolding tool, according to Vygotsky's (1978) Sociocultural Theory, regarding applying the model in language learning contexts. In Shute's (2007) view, feedback links an undesirable state; positive student responses reflect this conceptualization of feedback as a bridge between current and desired performance levels. However, we find a more pronounced scaffolding effect in the military university context than previously. Contrarily, James, and Folorunso (2012) suggested that the form of feedback provides a dynamic scaffold that adjusts to the learner's need, but the results obtained show that this scaffolding function may be improved by the structured military environment, specifically with the development of independent learning capability. This expands upon those findings by McMillan

et al. (2013), discussing how feedback in a military environment, while disciplined in nature, might actually fortify, rather than impede, the scaffolding process.

4.2. Students' perspectives on motivational impact of formative feedback

The quantitative data reveals consistently positive perceptions of feedback's motivational impact, with mean scores ranging from 3.91 to 4.05, indicating strong agreement with the motivational aspects of feedback (illustrated in Table 2)

Table 2. Descriptive statistics of motivational impacts on formative feedback

	N	Mean	Std. Deviation
2. The feedback I receive makes me feel more confident about using English	57	3,91	1,154
4. My teacher's feedback encourages me to set higher goals for my English learning	57	4,05	1,093
9. I feel more engaged in English classes when I receive regular feedback	57	3,91	1,184
10. The constructive comments from my teacher motivate me to put more effort into learning English	57	4,00	1,069
14. Feedback helps me maintain a positive attitude towards learning English	57	3,96	1,149
15. I feel supported rather than criticized when receiving feedback in English class	57	3,98	1,044

Increased effort (M=4.00, SD=1.069) emerged as the close second and the strongest motivational factor, goal-setting (M = 4.05, SD = 1.093). This is backed by rich qualitative evidence from the interviews. One student emphasized the goal-setting aspect, *"I realized that when my teacher gave me detailed feedback, asking me about which areas I needed to work on, I was greatly motivated to set myself even higher targets."* S3 started to aim for grades beyond passing (S3). Another student reflected on the confidence-building aspect (M = 3.91, SD = 1.154): *"Originally, I was too scared to talk in class, but the positive responses stopped me from being anxious. This has given me more confidence in participating in discussions, ' it reads"* (S5).

The supportive nature of feedback (M = 3.98, SD = 1.044) was particularly appreciated, as illustrated by one participant's comment, *"Feedback was delivered in a very different way. It wasn't a matter of showing what was wrong, but how we could go right. The net effect was that it made me feel supported rather than judged"* (S5). The positive attitude maintenance (M = 3.96, SD = 1.149) was evident in another student's reflection, *"The way that the feedback was given to me, even when I made mistakes, was constructive enough to keep me positive. I was able to see errors as learning opportunities and not as failures"* (S6).

Student engagement through regular feedback (M = 3.91, SD = 1.184) was also highlighted in the interviews, *"Regular feedback stayed my motivator and kept me grounded. In addition, I know my teacher was very close to watching my progress, I wanted to put more effort"* (S1). The constructive nature of feedback's impact on effort (M = 4.00, SD = 1.069) was emphasized by another student, *"Those detailed comments showed that my teacher cared about me and how I was doing. As a result of this, I chose to work more and implement these suggestions"* (S2). One particularly insightful comment captured the overall motivational impact: *"The feedback itself created the positive cycle, the more constructive the feedback I received, the more motivated I became to improve, the better my performance was, and so we received more positive feedback"* (S5).

Results show that the study of what causes motivation falls in line with past research on the motivational effects of feedback but also extends it. In line with Lee (2017) and Zahida et al. (2013), our results confirm that feedback is a positive motivating factor for students. Unlike Nguyen's (2024) observation of redundant, mixed emotional responses to feedback in a Vietnamese sample, our participants showed generally congruent and positive motivational responses to feedback. This could be owing to what Kileri and Listyani (2021) term clear process-focused feedback, which they say is especially effective in the structured military context. Similarly, our results are in addition to Camacho et al.'s (2021) finding that feedback causes a growth mindset; however, our effects could be more potent in the military setting, in which improvement systems are ubiquitous.

4.3. Students' perspectives of performance with formative feedback

Statistics in Table 3 demonstrate strongly positive perceptions of feedback's impact on performance, with mean scores ranging from 3.95 to 4.11 on a 5-point scale.

Table 3. Descriptive statistics of students' performance with formative feedback

	N	Mean	Std. Deviation
3. The feedback helps me develop better strategies for learning English	57	4,02	1,026
5. I can see improvements in my English skills as a result of the feedback I receive	57	3,95	1,093
7. Teacher's feedback helps me apply what I've learned to new language situations	57	3,96	1,017
8. The feedback I get contributes to my overall progress in English	57	4,00	1,035
17. My teacher's feedback helps me develop self-assessment skills for my English learning	57	4,11	1,047

In particular, students rated the acquiring of the self-assessment skills highest (M = 4.11, SD = 1.047), demonstrating that feedback helps learners' autonomy. As one student explained:
"We learned from our feedback how to critique what we do. This allows me to identify my mistakes more easily now that I have not submitted something and was looking at it. I can identify that something needs to work with respect to that assignment" (S3).
Another student elaborated, *"I gained an understanding of how the teacher would assess you through getting feedback, so you appreciate how to be more critical with reviewing your work"* (S5).
Learning strategies (M = 4.02, SD = 1.026) developed another significant benefit. One participant shared, *"The feedback was reflective, and the details helped me pinpoint patterns of mistake and develop individual strategies around the patterns and how to avoid them. For example, I made a list of grammar points to look at before approaching the writing tasks"* (S6). Another student noted, *"I learned to organize my learning better through feedback. 'This last year, I have learned what areas I needed to focus more on and how to approach different types of language tasks"* (S2).
Feedback proved highly influential for students' overall progress (M = 4.00; SD = 1.035). One student reflected:
"I can certainly see how the constant feedback in my earlier and recent assignments has improved me" (S7). The ability to transfer learning to new situations (M = 3.96, SD = 1.017) was also valued highly, *"The feedback held explanations of underlying principles which I could understand. In different contexts, if I face the same language situations, I know what to do"* (S1).
Students consistently recognized the visibility of improvement in their English skills (M = 3.95, SD = 1.093). One student shared, *"How did the systematic feedback help me after all? I could see solid improvements in the usage of vocabulary and sentence structure over time"*. Another emphasized the comprehensive nature of the impact, *"It was never about hitting really bad mistakes. It definitely improved my communication skills"* (S3), but also on a broader principle of how language can be used.
A few students pointed out the extent to which the performance aspects are interdependent. One student articulated, *"This created a complete learning experience through the feedback cycle. Also, it allowed me to assess areas that need improvement and develop strategies to handle them, apply these strategies in novel situations, and track my progress along the way"* (S5). Another student emphasized the long-term impact, *"The second most useful thing was not even that the mistakes were fixed right away, but that I learned how to help myself monitor and improve my performance independently"* (S7).
The results support and extend existing literature. This result is consistent with the importance of continuous feedback, as discussed by Peterson and Siadat (2009), in enhancing learning outcomes. Vedder found different impacts on different aspects of performance; however, in the current study, a more across-the-board improvement in all language skills in the military context. Our results support Bader et al.'s (2024) findings about the effectiveness of teacher feedback and show even more pronounced performance benefits in the structured military environment. Al-Shehri's (2008) research into how feedback affects learning practices is particularly relevant here, with the possibility that feedback would be even more effective in a military context. Moreover, the study goes beyond the findings of Ozan and Kincal (2018), particularly in terms of indicating stronger relationships between feedback and its effect on performance improvement in specialized educational contexts. Our findings differ from their results, where they found less pronounced effects of feedback on self-regulation skills, but we claim that feedback effects in

the military setting may be even more assertive or at least inhibit (relative to other settings, such as laboratories) these effects on autonomous learning and performance self-regulation.

5. CONCLUSIONS

The findings in this study bring to light how military university students perceive and use formative feedback in their English language learning pathway. Findings show formative feedback to be an effective scaffolding tool within this learning environment, where students' self-assessment and strategic learning skills were enhanced. Military education seems to foster, rather than inhibit, the effectiveness of feedback to promote autonomous learning and consistent performance improvement. These findings support our understanding of how specialized instructional environments affect feedback effectiveness and indicate that highly structured contexts may maximize the power of feedback on language learning.

These findings should be interpreted within several limitations. Initially, the generalization of the results to other military or educational institutions is limited by the study's concentration on a single military university in Hanoi. Second, the research was predominantly based on students' self-reported perceptions, which might fail to record the actual feedback impact on the learning outcomes. Furthermore, the study has a cross-section design that produces a picture of students' opinions at a moment in time and not the evolution in perceptions and performance over a significant period. The research did not include variations in methods of feedback delivery by different instructors, which could affect student perception and response.

Several recommendations for practice and research that follow from these findings are also made. It is suggested that practitioners carry on with and improve structured feedback approaches and simultaneously expand upon opportunities for dialogue about feedback between students and teachers. Longitudinal studies are called for in future research to analyze the long-term effect of formative feedback on language development in the military. Also, comparative studies could be made between military and civilian institutions to explore which educational contexts affect feedback effectiveness. Along with perception data, including object measures of learner performance in the research would also enhance our understanding of the actual impact of feedback on language learning outcomes. Lastly, exploring the role of peer and technology-enhanced feedback methods in nontraditional learning contexts, namely military education contexts, might provide new insight into how this learning practice might be maximized in and for unique learning contexts.

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**Management, Economics, Business and Marketing
(IAC-MEBM)**

Comparison of Artificial Intelligence Support to Human Resource Management Regarding Enterprise Size: The Case of Tertiary Sector in Slovenia

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Abstract

Artificial intelligence (AI) is increasingly being integrated into human resource management (HRM) in the tertiary sector, which is crucial for the development of the modern economy, and this integration is no longer limited to large enterprises only. This paper aims to compare the support of AI to HRM between small and medium-sized enterprises (SMEs) and large enterprises in the tertiary sector in Slovenia. The quantitative survey, which used a type-closed questionnaire, also covered the tertiary sector. The results based on the descriptive statistics and Mann-Whitney U test show that AI support for reducing the workload of employees and for appropriate training and development of employees significantly differs between SMEs and large enterprises in most statements describing these two constructs. They also show that there are no statistically significant differences between SMEs and large enterprises regarding AI support for acquiring and retaining talented employees. Based on the findings of the research, there is an opportunity for a strategic enhancement of AI usage in SMEs, particularly in reducing employee workload and accelerating employee training. The proposed innovative solutions, such as implementing AI-driven automation tools and personalized training programs, can enable both SMEs and large enterprises to fully harness the potential of AI.

Keywords: artificial intelligence, human resource management, Mann-Whitney U test, tertiary sector

1. INTRODUCTION

In the tertiary sector, which is the main driver of economic growth in many developed countries based on gross domestic product and is recognized as a potential generator of economic growth in developing countries (Nayyar et al., 2023), artificial intelligence (AI) has been identified as the key driver of digital transformation (Votto et al., 2021). AI is increasingly being integrated into human resource management (HRM) in recent years (Palos-Sánchez et al., 2022). Vrontis et al. (2021) pointed out that AI is revolutionizing various aspects of HRM by automating routine tasks,

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improving decision-making processes, and enhancing employee engagement. The integration of AI in HRM allows for more efficient recruitment, personalized employee training, and the optimization of workforce management (Kshetri, 2021). By leveraging AI, organizations can reduce operational costs, increase productivity, and foster a more agile and responsive human resources (HR) function, which is crucial in today's fast-paced business environment (Yadav et al., 2023). Based on the study on the impact of AI on HRM practices, Nawaz et al. (2024) found that accuracy, computing power and capacity, and personalization significantly influence timesaving and cost reduction. The influence of AI in HRM has been consistently growing, reshaping how HP processes are performed across nearly all major aspects of HRM (Nawaz et al., 2024), including reducing the workload of employees, appropriate training and development of employees, and acquiring and retaining talented employees.

AI extends beyond the automation of repetitive tasks by optimizing workflows and intelligently managing resource allocation. This leads to a substantial reduction in employee workload and mitigates the risk of burnout, while simultaneously enhancing organizational productivity (Gowda et al., 2023). By assuming responsibility for time-intensive administrative functions, AI empowers employees to focus on higher-value, strategic activities, thereby improving job satisfaction and contributing to a more efficient and effective organizational structure (Santhosh et al., 2023). Many professionals are often overworked in the workplace; in service industries, for example, AI has been found to handle routine and repetitive service tasks (Mariani & Borghi, 2024). Wirtz and Zeithaml (2018) summarized that AI contributes positively and significantly to both productivity and customer satisfaction in service enterprises. AI transforms enterprises by enhancing operations and decision-making, while also freeing employees from repetitive, physical, and monotonous tasks, allowing them to focus on more creative work (Zirar et al., 2023).

AI has become a pivotal tool in enhancing the training and development of employees, offering solutions that go beyond traditional methods. By leveraging AI, organizations can create adaptive learning environments that respond to individual learning needs, thereby ensuring that training is both relevant and efficient (Maity, 2019). AI-driven platforms can analyze vast amounts of data to identify skill gaps and recommend targeted training programs, facilitating continuous professional development and enabling employees to keep pace with evolving industry demands (Morandini et al., 2023). Employee training has experienced a rise in the integration of AI (Votto et al., 2021). According to Chen (2022), AI-powered training allows organizations to transform into knowledge-driven entities that can address personalized training requirements and improve the overall quality of learning.

Regarding AI application in HRM, Palos-Sánchez et al. (2022) pointed out that there is growing interest in talents, and the recruitment of highly skilled individuals, which is essential for facing the evolving environment and intense competition. The use of AI in HRM results in a more efficient recruiting process. Votto et al. (2021) also found that tactical recruitment procedures have seen an increase in the incorporation of AI. In addition, Palos-Sánchez et al. (2022) emphasized the use of AI technologies for other functions, such as maintenance and development of talents.

In the tertiary sector, AI is increasingly recognized as a critical driver of innovation and efficiency, particularly in industries such as finance, retail, and customer service. AI technologies are being leveraged to optimize business operations, enhance customer interactions, and enable more precise data analysis. For example, in the retail industry, AI facilitates personalized marketing and dynamic pricing, significantly improving customer engagement and sales performance (Huang & Rust, 2021). In the service sector, AI is rapidly becoming a crucial driver of innovation and efficiency. AI technologies are increasingly used to automate routine tasks, optimize customer service, and enhance decision-making processes. This transformation is especially evident in industries like finance, retail, and telecommunications, where AI applications streamline operations and improve service delivery. For instance, AI-powered chatbots are revolutionizing customer interactions by providing 24/7 service, while predictive analytics enhance personalized marketing efforts (Huang & Rust, 2018, 2021). Furthermore, AI's ability to process large datasets in real-time allows service enterprises to make more informed and faster decisions, contributing to overall sector growth and competitiveness (Huang & Rust, 2021; Link et al., 2020).

The latest research on 'AI in Enterprise', conducted on a sample of large companies in the USA, UK, India, and Spain, has shown that 93% of large companies view AI as essential to success (Viejo, 2024). However, AI in HRM is not limited to large enterprises only. As underlined by Chaudhuri et al. (2022), the adoption of AI by small and medium-sized enterprises (SMEs) offers significant advantages, including increasing productivity, reducing costs, and improving employee experiences. According to Schwaeke et al. (2024), SMEs can elevate customer experiences, promote sustainable practices, and establish themselves as leaders in digital transformation by adopting AI-driven efficiency improvements. However, the implementation of AI in SMEs encounters significant challenges (Schwaeke et al., 2024).

There are differences in the use of AI in HRM between SMEs and large enterprises, as each type of enterprise faces unique challenges and opportunities. Large enterprises, due to their extensive resources, are often able to implement

AI solutions more rapidly on a broad scale, allowing them to automate complex HR processes such as employee data analysis and workforce forecasting (Pan et al., 2021). Additionally, large enterprises can more effectively deploy AI technologies to run advanced talent development programs, giving them a competitive edge in the labor market (Benjamins, 2019). In contrast, SMEs, despite having limited resources, often seek more targeted and cost-effective solutions tailored to their specific needs. This may include using AI to enhance administrative tasks in HRM or adopting more personalized approaches to employee training (Drydakis, 2022). The main aim of this paper is to compare the support of AI to HRM between SMEs and large enterprises in the tertiary sector in Slovenia. For this purpose, the following hypotheses were proposed:

- H1: AI support for reducing the workload of employees significantly differs between SMEs and large enterprises.

- H2: AI support for appropriate training and development of employees significantly differs between SMEs and large enterprises.

- H3: AI support for acquiring and retaining talented employees significantly differs between SMEs and large enterprises.

The structure of the rest of the paper is as follows. The next section introduces the methodology used, both for data gathering and statistical analysis, followed by the presentation of the results obtained for individual variables of the constructs under consideration. The paper concludes with a discussion of the results obtained based on hypotheses verification, proposals for measures in the AI support to HRM with an emphasis on enterprise size, an indication of the identified limitations, and the possibilities of further research.

2. METHODOLOGY

This research is part of a broader study on AI in Slovenian enterprises, in which 473 enterprises from various economic sectors participated. This paper is limited to the tertiary sector in which 276 enterprises from eight service sector activities took part.

2.1. Data gathering, research instrument and sample

A quantitative survey was conducted using a closed-type questionnaire. We formulated it using the statements describing the construct 'reducing the workload of employees with AI' from Qiu et al. (2022), construct 'AI-supported appropriate training and development of employees' from Pillai and Sivathanu (2020), and construct 'AI-supported acquiring and retaining talented employees' from Kambur and Akar (2022). The respondents indicated their agreement with the statements based on a 5-point Likert-type scale by choosing between the following levels of agreement: 1 – strongly disagree, 2 – disagree, 3 – partly agree, 4 – agree, and 5 – strongly agree.

Table 1 presents the structure of participating enterprises according to size and activity. Table 1 shows that the majority, i.e., 58.3 % of participating enterprises are large enterprises, and 41.7 % of them are SMEs. Among the participating enterprises from tertiary activities, those from Wholesale and retail trade, repair of motor vehicles and motorcycles are the most represented, with a share of 26.4 % in the sample, followed by enterprises from Information and communication and Professional, scientific and technical activities (each with a share of 18.5 % of the sample) and Financial and insurance activities (17.8 %). The shares of participating enterprises from other activities are significantly lower as 5.8 % of enterprises are from Administrative and support service activities, 5.1 % from Real estate activities, 4.3 % from Accommodation and food service activities, and 3.6 % of them are in Transportation and storage. It can be concluded that the interest of respondents from a particular activity to participate in the survey reflects a concern for AI support to HRM.

Table 1. Profile of participating tertiary sector enterprises

Characteristic		Number of respondents	Percentage
Size	SMEs	115	41.7
	Large enterprises	161	58.3

Activity			
	Wholesale and retail trade, repair of motor vehicles and motorcycles	73	26.4
	Transportation and storage	10	3.6
	Accommodation and food service activities	12	4.3
	Information and communication	51	18.5
	Financial and insurance activities	49	17.8
	Real estate activities	14	5.1
	Professional, scientific and technical activities	51	18.5
	Administrative and support service activities	16	5.8

2.2. Statistical analysis

The level of the support of AI to HRM in tertiary service sector enterprises was analyzed by individual constructs, namely, for each variable derived from the statement, the mean, the median, and the standard deviation were calculated, regarding enterprise size. When describing the average agreement with the statements, we considered the following intervals of means: from 1 to below 1.5 – strongly disagree, from 1.5 to below 2.5 – disagree, from 2.5 to below 3.5 – partly agree, from 3.5 to below 4.5 – agree, and from 4.5 to 5 – strongly agree.

The impact of enterprise size on AI support to HRM was determined by comparing independent samples. As the results of Kolmogorov-Smirnov and Shapiro Wilks' tests show that the data do not obey the normal distribution for any of the variables studied, mean ranks were presented, and a nonparametric Mann-Whitney U test was used to check if there are statistically significant differences between the two independent samples.

3. RESULTS

In the following, we present in detail the results of the statistical analysis by individual variables of the considered constructs of AI support to HRM.

3.1. Reducing the workload of employees with AI

Table 2 presents the results of the descriptive statistics and the nonparametric Mann-Whitney U test for the comparison of AI support for reducing the workload of employees regarding enterprise size. It can be concluded that, on average, respondents agree with all the statements describing AI support for reducing the workload of employees, both in SMEs and large enterprises. While SMEs, on average, agree most with the statement that the AI technology applied in their enterprise can take orders and complete tasks which reduces the workload of employees, followed by the statement that with AI they reduce the burden on administrative staff in the enterprise, in large enterprises they agree most with the statement that AI can help in getting the job done which saves employees work time, followed by the statement that the AI technology applied in their enterprise can search and analyze information which reduces the workload of employees.

Table 2. Comparison of the AI support to reducing the workload of employees regarding enterprise size

Variable	SMEs				Large enterprises				Mann-Whitney U	Asymptotic Sig. (2-sided test)
	Mean	Median	Std. Dev.	Mean Rank	Mean	Median	Std. Dev.	Mean Rank		
With AI we reduce the burden on administrative staff in the enterprise.	3.67	4.00	0.998	132.00	3.83	4.00	0.924	143.14	10005.0	0.225
The AI technology applied in our enterprise can take orders and complete tasks which reduces the workload of employees.	3.72	4.00	1.232	127.55	4.01	4.00	1.159	146.32	10516.5	0.043
The AI technology applied in our enterprise can communicate with	3.59	4.00	1.270	122.97	4.04	4.00	1.051	149.59	11043.5	0.004

users/customers which reduces the workload of employees.									
The AI technology applied in our enterprise can search and analyze information which reduces the workload of employees.	3.60	4.00	1.356	122.34	4.11	4.00	1.095	150.04	11116.0	0.003
AI can help in getting the job done which saves employees work time.	3.58	4.00	1.389	120.91	4.13	5.00	1.108	151.06	11280.0	0.001

For each statement that describes AI support to reducing the workload of employees, the mean and the mean rank are higher in large enterprises than in SMEs. Except for the statement regarding reducing the burden on administrative staff in the enterprise with AI ($p > 0.05$), the results of the Mann-Whitney U 2-sided test show that the differences between large and SMEs are statistically significant ($p < 0.05$). The biggest difference concerns the help of AI in getting the job done which saves employees work time ($p < 0.01$), which on average they agree with the most in large enterprises and the least in SMEs (Table 2).

3.2. AI-supported appropriate training and development of employees

The results of the descriptive statistics and the nonparametric Mann-Whitney U test for the comparison of the AI support to appropriate training and development of employees regarding enterprise size are presented in Table 3. On average, respondents also agree with all the statements describing this construct, both in SMEs and large enterprises.

Table 3. Comparison of the AI support to appropriate training and development of employees regarding enterprise size

Variable	SMEs				Large enterprises				Mann-Whitney U	Asymptotic Sig. (2-sided test)
	Mean	Median	Std. Dev.	Mean Rank	Mean	Median	Std. Dev.	Mean Rank		
AI technology reduces the time spent on in-enterprise training courses.	3.72	4.00	1.113	129.49	3.94	4.00	1.138	144.93	10293.5	0.097
AI technology reduces the attention deficit that employees experience in classical in-enterprise training courses.	3.77	4.00	1.214	142.77	3.66	4.00	1.235	135.45	8767.0	0.435
AI technology increases accessibility to in-enterprise training courses.	3.71	4.00	1.160	136.42	3.77	4.00	1.142	139.99	9497.0	0.704
In-enterprise training courses with AI technology lead to a successful training program.	3.53	3.00	0.976	117.67	3.98	4.00	0.891	153.38	11652.5	<0.001
Employee professional knowledge will be kept up to date with in-enterprise training courses through AI technology.	3.50	4.00	1.021	104.96	4.25	4.00	0.643	162.46	13115.0	<0.001
When the in-enterprise training courses take place with AI technology, the restrictions regarding the place where the training will be given will be removed.	3.50	4.00	0.892	113.33	4.01	4.00	0.720	156.48	12151.5	<0.001
Employees are provided with the required training to deal with AI applications.	3.60	4.00	0.793	117.85	3.99	4.00	0.720	153.25	11632.0	<0.001

Table 3 also shows that SMEs, on average, agree most with the statement that AI technology reduces the attention deficit that employees experience in classical in-enterprise training courses. This is the only statement where the mean and the mean rank are higher in SMEs than in large enterprises. Although the mean and the mean rank in large enterprises are the lowest in this statement, the difference is not statistically significant (p > 0.05). In addition, the differences between large enterprises and SMEs are not statistically significant in studying that AI technology reduces the time spent on in-enterprise training courses and that it increases accessibility to in-enterprise training courses (p > 0.05). While large enterprises, on average, agree most with the statement that employee professional knowledge will be kept up to date with in-enterprise training courses through AI technology, the average level of agreement with this statement is lowest in SMEs. The results of the Mann-Whitney U test show that the difference regarding this statement is statistically significant (p < 0.001). Statistically significant differences can be observed in the statements that in-enterprise training courses with AI technology lead to a successful training program (p < 0.001), that the restrictions regarding the place where the training will be given will be removed when the in-enterprise training courses take place with AI technology (p < 0.001), and that employees are provided with the required training to deal with AI applications (p < 0.001). At these statements, means and mean ranks are higher in large enterprises than in SMEs

3.3. AI supported acquiring and retaining talented employees

Table 4 shows that, on average, respondents agreed with all the statements describing AI support in acquiring and retaining talented employees, both in SMEs and large enterprises, as well. Moreover, the results of the Mann-Whitney U test presented in Table 4 show that there are no statistically significant differences in the AI support for acquiring and retaining talented employees concerning enterprise size (p > 0.05). The results show that means and mean ranks are higher in SMEs than in large enterprises when it comes to hiring candidates who have the right skills to accomplish their work successfully, are very capable of using AI technologies, are effective in data analysis, processing, and security, and to retaining suitable candidates with help to acquire the necessary skills for their career plan. On the other side, means and mean ranks are higher in large enterprises than in SMEs regarding the advantages of AI in acquiring and retaining talented employees, i.e. the help in conducting primary interviews of bulk candidates using chatbots, the help in a better quality of decision for recruiting and selecting candidates, in saving the monotony of the job done during the process of finding candidates, in reducing the time spent in finding candidates, and in gaining access to more qualified candidates. However, as already noted, these differences are not statistically significant.

Table 4. Comparison of the AI support to acquiring and retaining talented employees regarding enterprise size

Variable	SMEs				Large enterprises				Mann-Whitney U	Asymptotic Sig. (2-sided test)
	Mean	Median	Std. Dev.	Mean Rank	Mean	Median	Std. Dev.	Mean Rank		
AI helps in conducting primary interviews of bulk candidates using chatbots.	3.60	4.00	1.130	135.40	3.65	4.00	1.241	140.71	9614.0	0.573
AI helps in a better quality of decisions for recruiting and selecting candidates.	3.60	4.00	1.213	135.8	3.65	4.00	1.266	140.43	9568.5	0.622
AI technology saves the monotony of the job done during the process of finding candidates.	3.52	4.00	1.300	128.91	3.79	4.00	1.267	145.35	10360.0	0.079
AI technology reduces the time spent in finding candidates.	3.64	4.00	1.164	136.66	3.66	4.00	1.284	139.81	9469.0	0.737
With AI technology we gain access to more qualified candidates.	3.60	4.00	1.296	135.90	3.68	4.00	1.325	140.36	9556.5	0.630
We hire those candidates that have the right skills to	3.62	4.00	1.152	138.66	3.61	4.00	1.124	138.39	9239.5	0.977

accomplish their work successfully.									
We hire those candidates that are very capable of using AI technologies.	3.76	4.00	1.113	142.50	3.68	4.00	1.040	135.65	8798.0	0.466
We hire those candidates that are effective in data analysis, processing, and security.	3.77	4.00	1.060	142.53	3.68	4.00	1.058	135.62	8794.0	0.462
We take care of retaining suitable candidates with help to acquire the necessary skills for their career plans.	3.69	4.00	1.054	140.26	3.65	4.00	1.026	137.25	9055.5	0.748

4. DISCUSSION AND CONCLUSIONS

The results on the AI support to HRM in the tertiary sector in Slovenia show that, on average, respondents agree with all the statements describing the discussed constructs of this support. However, this support statistically significantly differs between SMEs and large enterprises in some of the statements, as summarized and discussed below.

The obtained results let us partly confirm hypothesis H1: AI support for reducing the workload of employees significantly differs between SMEs and large enterprises. Only in reducing the burden on administrative staff with AI no statistically significant differences are detected, while the differences between SMEs and large enterprises in the other four statements describing the AI support to reducing the workload of employees are statistically significant. Moreover, the results of the Mann-Whitney 1-sided U test show that perceptions of taking orders and completing tasks, communicating with users/customers, and searching and analyzing information which reduces the workload of employees with the AI technology applied in their enterprise, together with the help of AI in getting the job done which saves employees work time, are statistically significantly higher in large enterprises than in SMEs. Respondents' perceptions suggest that AI support for reducing the workload of employees (except for the burden on administrative staff) is higher in large enterprises than SMEs in the tertiary sector in Slovenia. According to Oldemeyer et al. (2024), SMEs face significant challenges in adopting AI, primarily due to limited resources, a lack of skilled personnel, and inadequate infrastructure. These challenges hinder the effective deployment of AI technologies in SMEs, resulting in lower levels of AI support in reducing employee workload compared to large enterprises. Schönberger (2023) found out that even though there is recognition of the importance of AI in improving business processes and competitiveness, the actual implementation of AI in SMEs remains limited. This is similar to our findings where SMEs show lower levels of AI support in reducing employee workload compared to large enterprises. To bridge this gap, SMEs need to adopt a phased approach to AI implementation. This could involve starting with less complex AI applications that address specific, high-impact areas, such as automating routine tasks or enhancing customer service, before gradually expanding to more advanced AI technologies. Additionally, SMEs could benefit from forming partnerships with larger enterprises or technology providers to access AI expertise and resources that would otherwise be out of reach (Benjamins, 2019; Oldemeyer et al., 2024).

The results presented in the previous section let us also partly confirm hypothesis H2: AI support for appropriate training and development of employees significantly differs between SMEs and large enterprises. Apart from reducing the time spent on in-enterprise training courses and the attention deficit that employees experience in classical in-enterprise training courses, and increasing accessibility to in-enterprise training courses, there are statistically significant differences between SMEs and large enterprises in other four statements that describe AI support to appropriate training and development of employees. Again, the results of the Mann-Whitney 1-sided U test show that perceptions that in-enterprise training courses with AI technology lead to a successful training program, that employee professional knowledge will be kept up to date with the in-enterprise training courses, and that the restrictions regarding the place where training will be given will be removed when the in-enterprise training courses take place with AI technology, and that employees are provided with the required training to deal with AI applications, are significantly higher in large enterprises than in SMEs. Oldemeyer et al. (2024) emphasize that SMEs often struggle with AI adoption due to various challenges such as a lack of skilled personnel, limited financial resources, and inadequate infrastructure. These challenges are more pronounced in SMEs than in large enterprises, which have better access to resources and advanced technologies (Oldemeyer et al., 2024). Barton et al. (2022) found that SMEs lack

the internal capabilities to effectively implement AI technologies, which is exacerbated by the inability to afford external consultants or specialized staff. To overcome these challenges, it is recommended that SMEs start with less complex AI solutions and gradually build up their capabilities. Forming partnerships with larger enterprises or technology providers is also suggested as a way to access the necessary expertise and resources (Barton et al., 2022; Oldemeyer et al., 2024). This will help enterprises to better navigate digital transformation and create a competitive advantage in the market.

On the other hand, we rejected hypothesis H3: AI support for acquiring and retaining talented employees significantly differs between SMEs and large enterprises. There are no statistically significant differences in any of the statements describing this construct. The results suggest that AI support for acquiring and retaining talented employees is approximately equally well developed in tertiary sector enterprises, regardless of whether they are SMEs or large enterprises. Jha et al. (2020) found that AI's impact on talent acquisition and retention does not significantly vary between SMEs and large enterprises. Both types of enterprises have been integrating AI into their HR processes to similar extents, focusing on improving efficiency in hiring practices, enhancing candidate experiences, and retaining skilled employees. This standardization in AI application suggests that the strategic value and technological capabilities of AI for talent management are recognized and implemented equally across different enterprise sizes. Research by Pan et al. (2021) suggests that AI's role in recruitment and talent management has become more standardized across enterprises of different sizes, as both SMEs and large enterprises increasingly recognize the strategic importance of AI in these areas. This uniformity in perception and application suggests that the potential benefits of AI in talent acquisition and retention are accessible and relevant to enterprises regardless of size. Additionally, Drydakis (2022) found that SMEs, while facing some limitations in resources, can implement AI-driven HRM practices effectively, similar to larger enterprises, by focusing on targeted applications that provide high value. These findings support the idea that AI support for acquiring and retaining talented employees is well-developed across the board, which aligns with our findings that there are no significant differences between SMEs and large enterprises in this regard.

Part of the research on AI in Slovenia described in this paper is limited to the support of AI to HRM, namely in the tertiary sector. It would make sense to extend the research to other countries to be able to compare the development of AI support to HRM, which would also allow for benchmarking. We can also look for possible differences between individual activities within the tertiary sector. Similar analyses can be done for other economic sectors, as well.

Acknowledgements

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A Bibliometric Analysis of Holacracy and Key Trends in Its Research Landscape Across Europe

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Abstract

Holacracy as a concept has gained increasig attention in recent times, both in academic and professional settings, resulting in a growing number of scholarly publications on the subject. This study aims to systematically explore the research landscape in the field of holacracy, providing a comprehensive understanding of the research trends related to holacracy and to closely related concepts, such as self-management, agile management and teal organisations, across European countries, both historically and in contemporary contexts. Through a bibliometric analysis, this article investigates intellectual contributions to holacracy between the period of 1976 and 2024 within Europe, utilising the Web of Science database as the primary source of relevant publications with a sample size of 264 publications. Our research brings a comprehensive view of current topics, using bibliometric analysis and bibliometric program Biblioshiny. This paper aims to advance the academic understanding of self-management practices and holacracy, while contributing to the existing research base. Potential future research possibilities and limitations are also discussed in the paper. As a conclusion to the research paper, we aim to answer the set research questions and provide an in depth insight into the evolution of the academic research of the studied field.

Keywords: holacracy, self-management, management, organisational design, bibliometric analysis

1. INTRODUCTION

Holacracy is a new concept, often referred to as a „new form of organizing" (Farkhondeh et al., 2022). Despite the concept's novel nature, scholars have previously explored similar ideas that can be considered as precursors for holacracy, including self-managing teams, teal organisations and agile management practices. The emergence of self-managing teams as a concept can be dated back to the middle of the 20th century with research done by Fred Emery and Eric Trist, who are prominent figures within the field of organisational development. Later, by the end of the 20th century, more researchers focused on the research of this field, such as Jay Galbraith, Deborah Ancona or Paul Goodman. All these initiatives can be considered on the forefront of the concept of holacracy, which contrasts the traditional hierarchical system, thus offering an innovative, agile and decentralised approach of corporate governance.

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The concept of holacracy was introduced by Robertson in 2007, who later explored this innovative concept in his book Holacracy: The new management system for a rapid changing world. The concept is considered as an innovative organisational structure system that replaces traditional management hierarchies with self-managing teams and distribute the decision-making authority across the organisation (Robertson, 2015). Rapid advancements of culture and technology accelerated global competition among businesses in recent years, prompting companies to seek for innovative organisational practices in order to maintain a competitive edge (Denning, 2018). As a potential solution for this context, holacracy has gained an increasing attention in recent times (Gray, 2014). It has a multidisciplinary nature, as its relevance exceeds a single industry to a diverse range of sectors. The concept can be applied to a wide range of industries. Another prominent scholar in the field, Laloux (2014) emphasises holacracy's ability to enhance corporate efficiency by the distribution of authority across the workforce thus employees gain a new sense of empowerment. Holacracy as a concept represents a paradigmatic shift from conceptual management practices towards innovative perspectives on how a business can utilise its resources in an increasingly competitive landscape. Laloux (2014) introduced the term teal organisations, which marked a significant evolution in organisational consciousness and is based on the core idea of the system explored by Robertson. Despite holacracy's potential for corporate efficiency, there is a lack of extensive research within the field and a wide research gap, which indicates the need for further exploration of the topic.

By conducting a bibliometric analysis, this study aims to contribute to the comprehensive understanding of existing research within the field, while providing insight into key trends and potential future research avenues. For filling the aim, we identified three key research questions:

1. What are the predominant publication trends in the researched field over the time period of 1976 to 2024?
2. What are the themes within the research field that are predominant in the analysed time period, and which topics need further investigation in the future?
3. Which publications from the database used for our research have the greatest impact in the academic field based on global citation trends?

The findings of the bibliometric analysis will aim to answer the research questions, moreover, contribute to a deeper understanding of holacracy, alongside with valuable insight for scholars that have an interest in this field. Ultimately, the study aims to enhance the confidence of adaptation of holacractic organisational strategies into innovative company structures.

2. RESEARCH METHODOLOGY

In this bibliometric analysis, we aim to trace the evolution of academic publications on holacracy, along with its closely related concepts such as self-managing teams, agile management and Teal organisations. With the trend analysis of publications over a specific time, we identify how the interest in such organisational models has grown as a response to the increasing demand for decentralised organisational structures in contemporary organisations. Further, this study highlights the need for more rigorous research needed.

Firstly, we define the core aim of the research with the support of set research questions. Subsequently, we identify the scope of the research, its demographic qualities and expected research results. We use the Web of Science database for data collection, where we define the most relevant key words and search credentials to filter out the most relevant publications. Data is downloaded in BibTex format for data analysis purposes. After the identification of our data set, we screen the publications for eligibility with the help of Bibliometric program Biblioshiny. Subsequently, our data analysis is done through the same bibliometric program. We address the research questions with relevant analysis and identify the relevancy of our findings. The steps of identifying publications via database is illustrated in Fig.1.

Identification of studies via databases

Identification

Records identified from*:
Databases (n = 1)
Web of Science (n = 741)

Records removed *before screening*:
Duplicate records removed (n = 0)
Records marked as ineligible by automation tools (n = 0)
Records removed for other reasons (n = 477)

Screening

Records screened
(n = 264)

Records excluded
(n = 0)

Reports sought for retrieval
(n = 264)

Reports not retrieved
(n = 0)

Reports assessed for eligibility
(n = 264)

Included

Studies included in review
(n = 264)
Reports of included studies
(n = 264)

Fig. 1. Prisma diagram of Identification of studies via database (source: own proceedings[1])

Our bibliometric analysis is based on a sample size of 264 publications, where data is retrieved from Web of Science database. To refine our research dataset, we employed a combination of search queries, where we identified 741 eligible records. For this initial identification, we used the following combination of key words, Research Areas and Web of Science Categories: holacracy (Topic) OR "self-management" (Topic) OR holacractic* (All Fields) OR "teal organisations" (All Fields) OR holacra* (All Fields) OR teal* (All Fields) and Business Economics (Research Areas) and Management (Web of Science Categories). Further identification of eligible records was based on geographical consideration, where we removed 477 records that represented countries associated with authors of publications outside of our research scope. Countries associated with the authors were selected exclusively from European nations from the list available on Web of Science under the conditions of the above-mentioned search parameters. Such countries by name were: England, The Netherlands, Poland, Germany, Finland, Italy, Belgium, Sweden, France, Spain, Switzerland, Denmark, Norway, Scotland, Austria, Romania, Portugal, Greece, Ireland, Slovenia, The Czech Republic, Serbia, Croatia, Hungary, Latvia, North Ireland, Slovakia, Albania, Liechtenstein, Lithuania, Wales,

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[1] Prisma diagram adapted from Creative Commons, used under CC BY 4. Changes were made.

Ukraine (selected in parameter Countries/Regions on Web of Science). The reason for selecting solely European countries stems from the aim to concentrate our research to the specific geographical location.

3. BIBLIOMETRIC ANALYSIS RESULTS

The research covers the period from 1976 to 2024, where we analyse 264 publications from 143 different sources. Publications include journal articles, book chapters and various conference papers. The average annual increase in the number of publications over the period is 6.44% indicating a rather conservative growth over the time. The average age of the publications is 8.29 years. On average, each publication in the data set was cited 20.5 times, which indicate a great academic impact and relevance of analysed publications. The total number of cited references is 12 406. Lastly, 695 key words were identified in the analysed data set, which can be further explored for trend analysis concerning the research topic. This review of the dataset indicates a relevant and highly influential research environment, indicating the importance of the researched field.

Table 1. Summary information of the dataset (source: own proceedings in Biblioshiny)

MAIN INFORMATION ABOUR DATA	RESULTS
Timespan	1976:2024
Sources (Journals, Books, etc)	143
Documents	264
Annual growth rate %	6.44
Document average age	8.29
Average citations per doc	20.5
References	12 406
Document contents	-
Keywords plus (ID)	695

The H-Index is a metric used to measure the productivity or the impact of a researcher's published works (Hirsch, 2005). For a dataset, the H-Index can be a useful metric to indicate the influence and the impact of publications within the data range. Our dataset has an H-index of 38, which indicates that at least 38 publications have been cited 38 times each over the years. Considering the number of publications (n=264) within the report, the score indicates, that a substantial portion of the publications made a significant impact in the academic field. On the other hand, the relatively low amount of academic publication may indicate a lack of extensive research in this field within Europe.

Fig. 2. Summary of dataset statistics and H-Index (source: Web of Science)

3.1 Research trends in analysed field

There are numerous ways to determine publication trends of a dataset. In this research, we determine the citation dynamics based on the number of annual scientific production and the number of citations created among the publications. The annual scientific production chart, as represented in Fig.3., tracks the number of publications created between 1976 to 2024. The figure showcases an initially low development of publication within the research field, with a subsequent steep exponential trend since the early 2000s. The steady increase in publications concerning self-management and holacratic features in the early 2000s can be attributed to the shift in organisational structures and the increased importance for flexibility, autonomy and adaptability. The annual scientific production within the field is closely connected to the increasing demand for decentralised decision-making and innovative work environment.
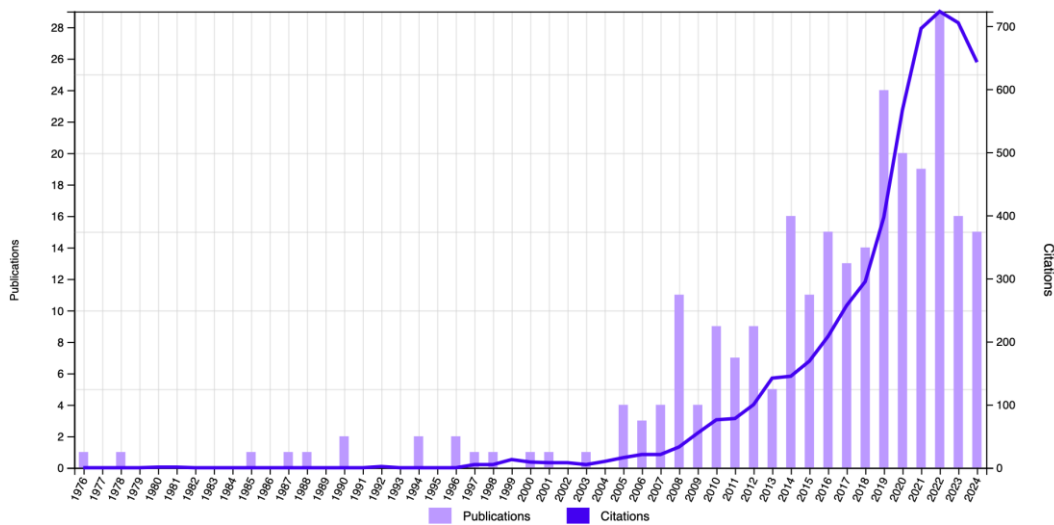
Fig. 3. Annual Scientific Production (source: Web of Science)

The data reflects an average growth rate of 6.33%, signifying a generally steady increase in scientific output over the years. Notably, the year 2022 stands out as the year marks the highest number of publications produced within this field. Afterwards, the figure represents a sharp decline in production outputs, subsequently followed by a rising tendency.
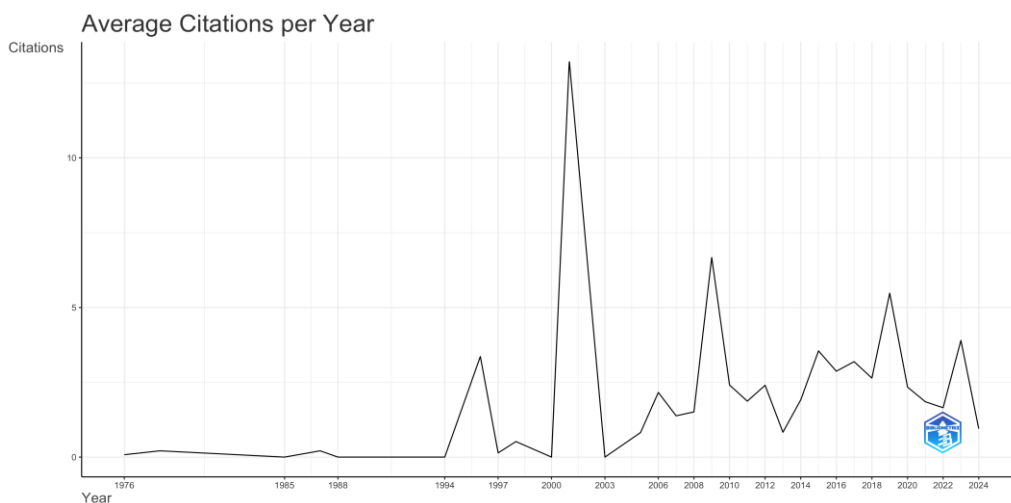
Fig. 4. Average Citation per Year (source: own proceedings in Biblioshiny)

140

The average citations per year for the publications in our data range serve as a mean to evaluate the impact and influence of the publications over time, indicating the frequency of referencing the works by other scholars. Fig.4. shows a fluctuation in the average number of citations per year between the period of 1976 to 2024. The figure reveals periods of low citation activity, while noticeable peaks can be observed in the early 2000s. Subsequently, there is a smaller but consistent rise in citation activity between the period of 2008 and 2022. Statistics suggest that certain publications along the years gained more influence and attention within the academic community. The figure ultimately tracks the impact of research done over time and identifies the years where works had a more widespread recognition. The decline in 2023 may those recent publications haven't had enough time to accumulate citations, or it can reflect a decline in research output in the field.

3.2 Co-occurrence network and key word analysis

In order to identify future research directions in the research of holacracy within the field of organisational management, we aim to identify keyword and topic trends in the research field in order for scholars to understand key topics as well as research directions of the specific field. The Co-occurence map provides a visual representation of the relationships among the key words, authors and terms within the analysed dataset of publications. This tool enables the identification of co-occuring terms, thereby illustrating the interconnections among research topics and ideas.
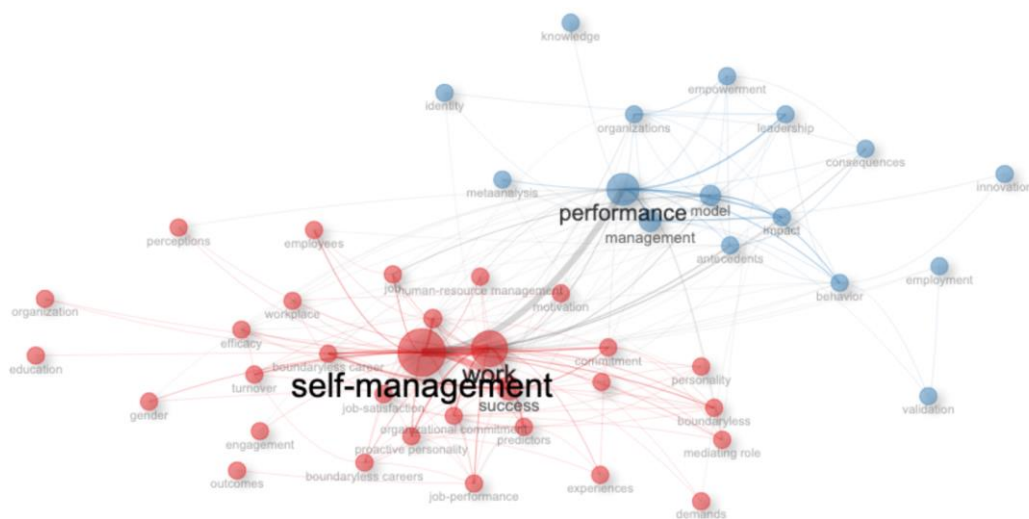
Fig.5. Co-occurrence Network (source: own proceedings in Biblioshiny)

The co-occurrence network of our dataset, as represented in Fig.5., has nodes of different sizes. The size of the node indicates the number of times a keyword appears across the analysed publications. In our dataset, we identified a number of significant terms, such as self-management, work, performance, success, and other. The identified topics strongly correlate to our research field. There are two main clusters identified, represented with red and blue colours. The red cluster centred around **self-management** focuses on concepts such as job-satisfaction, success, commitment, proactive personality, employee turnover, outcomes, engagement, motivation and more. The blue cluster, centred around **performance** emphasises the aspects of organisational performance, management practices and models in connection to organisational design and management strategies. Topics such as leadership, empowerment, consequences, innovation along many belong to this cluster. The central insight to the co-occurrence network suggests that there is a bridge between self-management and performance, highlighting the academic research focusing on how self-management practices link to and affect performance outcomes and the overall success of a company.

Fig. 6. Word Cluster (source: own proceedings in Biblioshiny)

Keyword analysis serves as a tool for identifying the frequency of terms and phrases used in publications, abstracts and documents. The outcome of the analysis is visually represented in Figure x. The most frequently used word was „self-management", followed by the words „work", „performance" and „management".

- The word **SELF-MANAGEMENT** in our analysis emerges as the most frequently used key word within the analysed publications, underscoring its centrality within the research field. The phrase self-management belongs to the earliest phrases connected with the evolution of agile management practices in management. Self-management encompasses autonomy, empowerment and an employee-forward decision making, concepts that are inevitable in a holacractic setting. The prominence of the phrase reflects the increasing interest towards the shift in organisational structures which prioritise team autonomy over traditional organisational models. The phrase is a key indicator of the scholarly focus on agile approaches and holacratic dynamics.
- The word **WORK** and its frequency in the analysed publications reflect its fundamental role surrounding the topic. The term highlights the focus on how tasks are organised and managed in a decentralised organisation that practice agile methods or incorporate a flat hierarchical system. Work may be a frequent term by its nature to impact work processes and outcomes, as well as team productivity and the whole organisational performance. Scholars focus on how holacratic and self-managing structures affect the work and all its related aspects.
- The word **PERFORMANCE** is closely tied to the previous term, further underscoring the focus on examining the effects on work outcomes in holacractic practices. Performance often has a central focus alongside with researching innovative organisational structures. Researchers study, how self-managing teams impact overall organisational outcomes, such as the efficiency, productivity, employee satisfaction or other metrics. Performance as a term has an important position in assessing the practical viability of holacracy to impact organisational success.
- The frequent use of the word **MANAGEMENT** signifies its foundational importance within the research field. As our research concentrates on business management practices, the word management naturally occurs in most of the analysed publications. The term also reflects how holacracy and agile practices redefine traditional management to an unconventional self-organising system. Management is often debated with relations to autonomy, leadership, decision-making and other organisational frameworks.
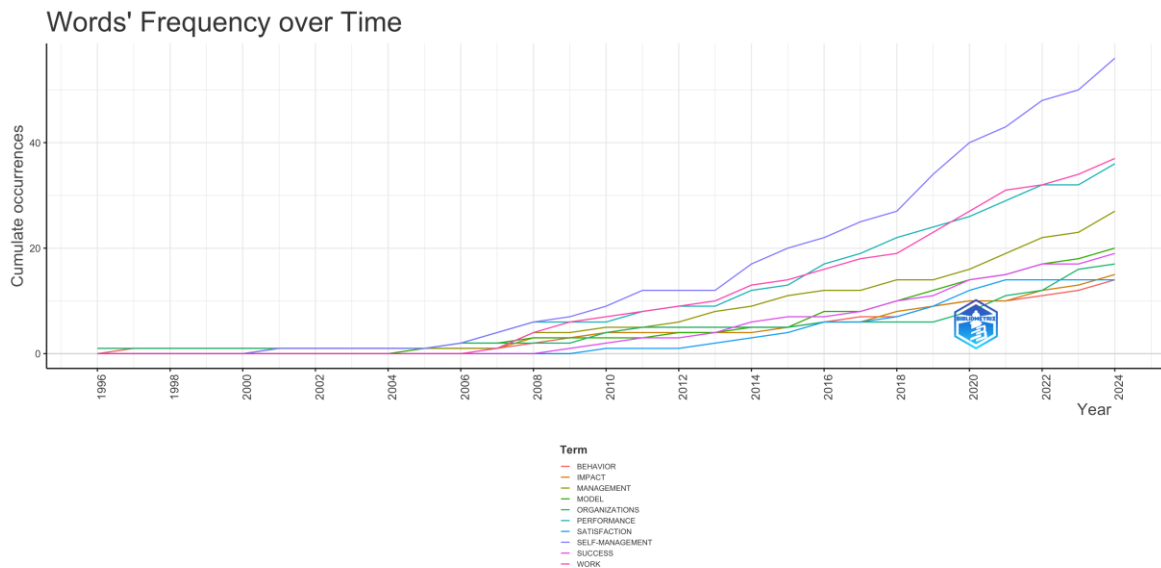
Fig. 7. Word's Frequency over Time (source: own proceedings in Biblioshiny)

Fig.7. represents the most common keyword's frequency over the analysed time period. Many terms show a gradual increase in occurrence since the 2000s. This suggests that the research field experienced growth since the early 2000s. Around 2015, such terms as self-management, performance and work show a particularly strong growth, indicating that more focused research was done on these topics during recent years. The growth may be linked with the emergence of influential thinkers in the field such as Frederic Laloux and Brian Robertson, whose work gained a wide recognition during the period of 2014 and 2015
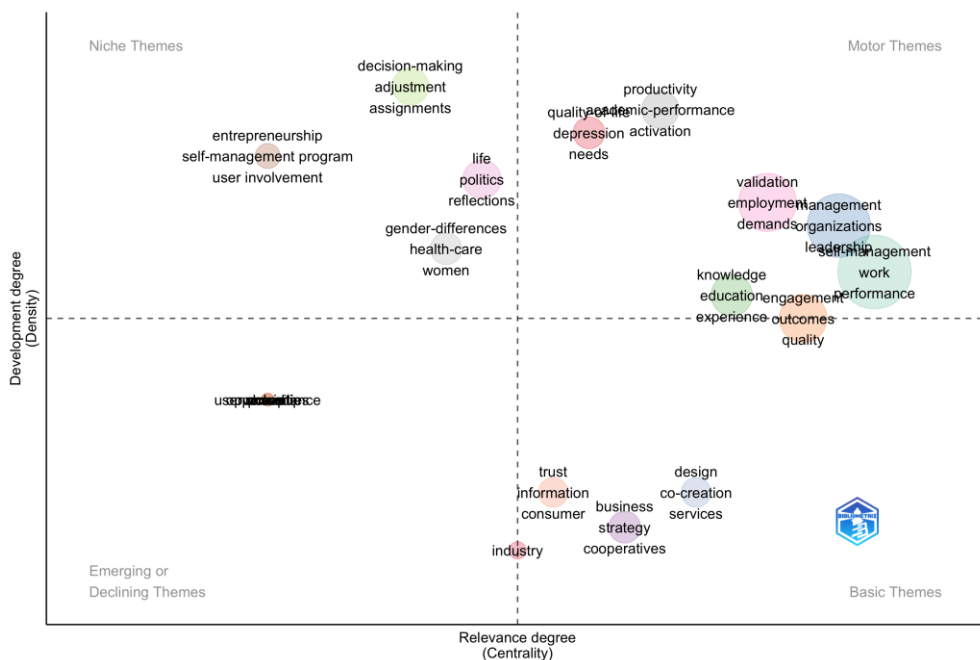
Fig. 8. Thematic Map (source: own proceedings in Biblioshiny)

The thematic map is used for visualising the main themes in the research field. It is a two-dimensional map: **Density** (y-axis; Development degree) and **Centrality** (x-axis; Relevance degree). The map divides individual themes into four quadrants based on individual topics' internal cohesion and relevance in the research field: Motor Themes, Niche Themes, Basic Themes and Emerging/Declining Themes. The concept is based on the application of strategic mapping, focusing on the evolution of relationships between frequently occurring themes in research outputs (Callon et al., 1983).

Based on the analysis, there are 21 clusters across the map, with the most prevalent being quality-of-life, management, knowledge, business, engagement, entrepreneurship, validation, productivity, self-management and trust. Themes such as **productivity** (academic performance, activation), **quality-of-life** (depression, needs, people), **validation** (employment, demand, gender), **management** (organisation, leadership, empowerments), **self-management** (work, performance, success) have high centrality and high density and are considered as well-developed themes of high importance that drive the research field forward. The analysis implies that researchers in the field dedicate a great importance to business process outcomes, meaningful work and work-life balance as well as empowerment and support of team members. Topics such as gender-differences, politics or decision-making are considered as Niche Themes, representing a high specialisation and lower centrality. Business strategy, cooperatives, trust and consumer are considered as Basic Themes, that are fundamental in the research field, but are not yet well-developed or specific enough. Lastly, themes such as power, ownership and crisis are represented as declining themes, suggesting these areas are losing relevance in the research field, respectively do not account for a great amount of research done across the field.

3.3 Analysis of most prominent authors and most influential publications

During our analysis we identified key researchers within the research field based on the number of documents they have published, as seen in Fig.9. The leading contributor in terms of number of publications produced with a total number of 5 publications on the selected topic is Rzepka A., followed by De Vos A. (NP=4), Hirschi A. (NP=4) and Spruk D (NP=4). Table 2 lists several key authors and evaluates their individual research impact based on several metrics such as the H-Index, G-Index, M-Index, Total Citations (TC), Number of Publications (NP) and the starting year of publishing within the research field.

The author's local impact is summarised in Table 2. From the analysis it becomes evident, that authors De Vos A. and Spurk D. have the highest local impact, indicated by an H-Index of 4 and G-Index of 4 in both cases. As per the average citation rate per publication, evaluated by the M-Index, Spurk D. is the leading figure. Dries N. has an H-Index of 3 and G-Index of 3 and leads in total citations (TC=464) despite the lower amount of published research. Hirschi A. has an H-Index of 3 and G-Index of 4, combined with a total citation at 339, which makes the researcher remarkable within the field as well. Overall, we can see that there are several successful publishers within our research segment.
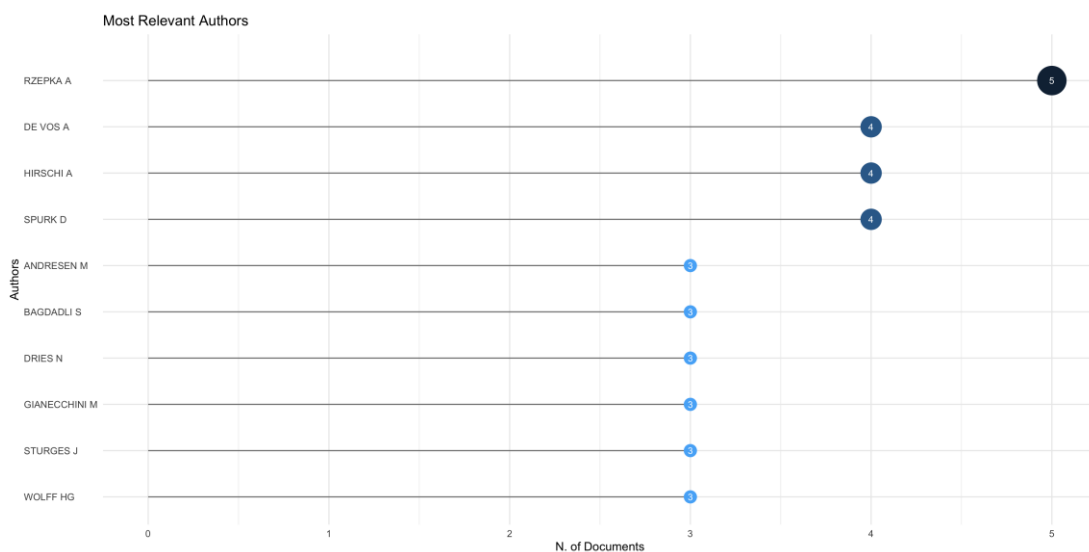
Fig. 9. Most Relevant Authors (source: own proceedings in Biblioshiny)

Table 2. Author's local impact (source: own proceedings)

Author	H-Index	G-Index	M-Index	TC	NP	PY_start
DE VOS A.	4	4	0.25	309	4	2009
SPURK D.	4	4	0.667	364	4	2019
DRIES N.	3	3	0.176	464	3	2008
HIRSCHI A.	3	4	0.5	339	4	2019
WOLFF HG.	3	3	0.231	121	3	2012
AKKERMANS J.	2	2	0.2	99	2	2015
ANDERSEN M.	2	3	0.333	101	3	2019
BAGDADLI S.	2	3	0.333	101	3	2019
BARALDI E.	2	2	0.4	15	2	2020
BARUCH Y.	2	2	0.111	149	2	2007

After the author analysis, we identified and further analysed the most prominent publications in the field. The document analysis includes the examination of the frequency of citing each publication, which serves as a tool for identifying the influence of each publication within the researched field. Our analyses yielded in identifying the 10 most influential publications in our research field based on the total number of global citations, summarised in Table 3. Each publication is characterised by its Total Citation (TC) and Total Citation per Year (TC/Y).

Table 3. Most prominent publications in the field (source: own proceedings)

Title of publication	Journal	Year	Total citation	Total Citations per Year
Future work design research and practice: Towards an elaborated model of work design	Journal of Occupational and Organizational Psychology	2010	317	13.21
Antecedents and outcomes of objective versus subjective career success: Competing perspectives and Future Directions.	Journal of Management	2018	276	46.00
Coevolving Systems and the Organization of Agile Software Development	Information Systems Research	2009	199	12.44

Contextualizing co-production of health care: a systematic literature review	International Journal of Public Sector Management	2016	156	17.33
The Conduct of Management and the Management of Conduct: Contemporary Managerial Discourse and the Constitution of the 'Competent' Manager	Journal of Management Studies	1996	144	4.97
Proactive career behaviours and career success during the early career	Journal of Occupational and Organizational Psychology	2010	132	8.25
The changing role of the health care customer: review, synthesis and research agenda	Journal of Service Management	2017	127	15.88
The impact of autonomy and task uncertainty on team performance: A longitudinal field study	Journal of Organizational Behavior	2010	114	7.60
The nomological network of self-management strategies and career success	Journal of Occupational and Organizational Psychology	2010	108	6.35
Successful Aging at Work: The Active Role of Employees	Work, Aging and Retirement	2015	103	10.30

1. (Parker, 2001) TC=317, TC/Y=13.21 The author proposes a theoretical framework that identifies five categories of work design across individual, group and organisational levels. The research incorporates contemporary work characteristics and analyses the processes of work characteristics that affect outcomes. The core idea suggest the use of work design variables tailored to the specific organisational context.

2. (Spurk et al., 2019) TC=26, TC/Y=46.00 Spurk et al. in this research paper explores perspectives on the theoretical approaches that focus on career success. There is a distinction between career success (OCS) and subjective career success (SCS). The paper suggest that career success is not only the outcome, but the influence on one's career and life results. Results showcase a range of theoretical approaches. Identification of career success outcomes involve withdrawal, career attitudes, health and well-being, reactions from the work environment and self-concept. Future research recommendations are included for a more comprehensive understanding of links between causes and outcomes of career success.

3. (Vidgen et al., 2009) TC=1999, TC/Y=12.44 focus in their article on agile methods in software development, and the debate on its true nature. The debate stems from a limited understanding of agile practices and concepts. In the research paper, a framework for organising agile software development is created, where factors are identified that enable or inhibit agility. The developed framework is based on three principles: matching coevolutionary change rate, maximising self-organisation and balancing of exploitation with exploration. At core, the paper identifies capabilities of agile teams, such as team learning and collective mindfulness.

4. (Palumbo, 2016) TC=156, TC/Y=17.33 Palumbo in this work contextualises the concept of "service co-production" and "value co-creation" within the healthcare sector. The paper systematically reviews 65 papers from an initial database of 254 records.

5. (duGay et al., 1996) TC=144, TC/Y=4.97 examine the evolving role and the behaviour of managers within the organisational change, with a special focus on how management competencies are used to reshape the managerial work. The core idea explores modern organisational reforms, including HR management, total quality management, business process re-engineering and anti-bureaucratic structures. Managers are required to have new capabilities and competencies that encourage not only self-management but the fostering of individualised business functions within the organisation.

6. (De Vos et al., 2009) TC=132, TC/Y=8.25 The publication is oriented on examination of relationship between proactive career behaviours and career success among fresh graduates that transition from college to work. The study investigates the underlying influences on career success by career goals, planning and networking behaviours. Sample testing was used, where the findings support the proposed model, supporting the claim that career progress goals at graduation influence career planning, thus positively affecting networking behaviours. Networking at early stages of career was linked to objective and subjective career success. Findings signify the importance of proactive behaviour in shaping career success in the early stages of career.

7. (Mccoll-Kennedy et al., 2017) TC=127 TC/Y=15.88 aims to examine the evolving role of health care customers, where the authors analyse key practice approaches and shifts in the customers role. Over time their role has become more active, shifting from passive compliance with medical professionals to co-creating value alongside the healthcare providers. The focus shifts on greater customer involvement in health care decisions. The paper also highlights various practice approaches and offer insight for future studies within the field.

8. (Cordery et al., 2010) TC=114, TC/Y=7.60 explore the inconsistent empirical support in the positive relationship between team autonomy and performance with the help of investigating the role of task uncertainty. Task uncertainty is defined as the lack of prior knowledge in a team that is linked to the occurrence of operational problems. In the analysed case study, a higher level of task uncertainty correlated to a reduced performance, on the other hand an increase in team autonomy resulted in overall performance improvements. With enhanced autonomy, a positive relationship between task uncertainty and team performance was showcased.

9. (Abele et al., 2008) TC=108, TC/Y=6.35 investigate the impact of self-management strategies on career success linked to the evolving labour market demands. The paper analyses self-management strategies, like goal selection and optimisation or career planning. A sample size of 1 185 professionals were used, and set hypotheses were confirmed. Generalised strategy of optimisation was found to be linked to strategies of career planning and career success. As a result, implications on career research and counselling have been found.

10. (Kooij, 2015) TC=103, TC/Y=10.30 The author explores the topic of successful workforce aging from a sustainability perspective. Continuous alignment between the changing individual and the evolving work environment is emphasised with the aim to help employees to maintain their health, motivation and work abilities. The author suggests that the integration of proactive behaviours is essential to achieve this alignment.

4. CONCLUSION

This research paper and analysis conducted a bibliometric analysis by utilising the program Biblioshiny, where we analysed 264 individual publications gathered from the database Web of Science after a thorough filtering based on predetermined parameters. The analysis has shown that the research field of holacracy and related topics (agile management, teal organisations) within the territory of Europe has become increasingly important in recent times. After a comprehensive bibliometric analysis, we can answer the research questions set earlier:

1. What are the predominant publication trends in the researched field over the time period of 1976 to 2024?

The general trendline of publications within the research field show an increasing trend since 1976. The peak year of publications was 2022, after what there was a slight decline in creation of new publications. From analysed data it becomes clear that scholars started to put greater emphasis on the field of modern organisational management practices since the early 2000s. We identified that there was a shift towards demand of flexibility, autonomy and adaptability within organisational context, which could have initiated a paradigmatic shift in the way of thinking in organisational context. The annual scientific production correlated to the increased attention on decentralisation and innovative solutions. Data furthermore revealed that publications around the year 2000 gained significant attention in terms of average citation per annum. An overall growth of 6.33% can be observed in researching this specific academic segment.

2. What are the themes within the research field that are predominant in the analysed time period, and which topics need further investigation in the future?

For identification of prominent themes and topics we used a variety of tools, such as co-occurrence mapping, word cluster, word frequency over time and thematic mapping. The most prominent research themes across the research field is self-management and performance, which strongly correlates to the intended focus of this research paper. Our main aim was to research holacractic aims and related topics in academic publications across Europe within the specified time period. We identified, that on contrary to the lack of usage of the word *holacracy* in more recent publications, researchers indeed focus on the core concept of this topic. We propose that future research on holacracy focuses primarily on the following areas:

- Research on the effectiveness of holacracy in companies. Currently, more empirical studies are needed to examine organizational performance, employee satisfaction, and the long-term sustainability of this model.

- The appropriate type of leadership for a holacratic organization. Future research could focus on studying how leaders can adapt their management style to the conditions of holacracy.
- Research on the application of holacratic principles across different types of businesses—from startups to family businesses and large corporations.

3. Which publications from the database used for our research have the greatest impact in the academic field based on global citation trends?

The last part of our researched focused on prominent researchers and most relevant publications in the research field. We identified numerous relevant researchers in the field that produced a number of significant publications along the years. The most prominent author was Rzepka H., with an H-Index of 4. Our document analysis involved the top ten most relevant publications across the field. Among those, the most cited publication (TC=317) was with the title *Future work design research and practice: Towards an elaborated model of work design* (Parker, 2010), a publication that incorporates contemporary work characteristics and links it to work outcomes. On the other hand, the publication *Antecedents and Outcomes of Objective Versus Subjective Career Success: Competing Perspectives and Future Directions* (Spurk, 2019) can be accounted for the highest number of total citations per year (TC/Y=46). Overall, analysed publications and authors revealed several relevant research initiatives and publications within the field.

Moreover, despite considerable efforts by researchers to advance the research field of holacracy and related concepts, the volume of publications within this specific field and geographic area remains limited. The relatively small number of identified publications in the research field, particularly those directly addressing the concept of holacracy, highlights the need for future research. It is important to note, that the limited set of analysed publications may result from the narrow geographic focus. For future analysis, a broader geographical scope should be considered.

Acknowledgements

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Bibliometric Analysis on Women in Leadership: Factors Affecting the Overcoming of Gender Barriers

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Abstract

Gender inequality and the underrepresentation of women in leadership positions remain pressing global issues with profound social and economic implications. This study conducts a bibliometric analysis using Biblioshiny on a sample of 260 documents from the Web of Science database, focusing on the topic of women's leadership. The analysis reveals an annual growth rate of 2,51% in publications related to this topic, indicating increasing academic attention. Our review identifies three major research streams: (1) the influence of societal and organizational stereotypes on women's career advancement, (2) structural and institutional barriers impeding women's progression into leadership roles, and (3) interventions such as mentoring and inclusive policies that aim to enhance gender diversity in leadership. Additionally, we highlight critical gaps in the literature, especially the need for further exploration of how personal factors, beyond gender, affect leadership opportunities. This comprehensive analysis provides valuable insights into the existing body of research and underscores the importance of continuing efforts to address gender disparities in leadership.

Keywords: gender inequality, women in leadership, career advancement, organizational barriers, diversity, gender equality, mentoring

1. INTRODUCTION

The underrepresentation of women in leadership roles continues to be a pervasive challenge across various sectors, despite decades of advocacy for gender equality. Globally, women account for nearly half of the workforce, yet their presence in top leadership positions remains disproportionately low (Eagly & Carli, 2007). This disparity is often attributed to persistent societal and organizational stereotypes that shape perceptions of women's capabilities in leadership roles. Research indicates that gender-based stereotypes, such as the belief that women are less competent or decisive than men, hinder their career progression, creating a "glass ceiling" effect (Heilman, 2012). Additionally, the notion of leadership is frequently associated with traditionally masculine traits, making it more challenging for women to ascend to executive roles (Koenig et al., 2011).

Another significant factor impeding women's advancement is the structural and institutional barriers that exist within organizations. These barriers include unequal access to professional development opportunities, limited availability of flexible working conditions, and the lack of inclusive policies that support work-life balance.

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Organizational cultures that emphasize long working hours and constant availability disproportionately disadvantage women, especially those with caregiving responsibilities (Catalyst, 2020). Furthermore, institutional norms often perpetuate male-dominated networks that exclude women from critical informal opportunities for mentorship and sponsorship (Ibarra et al., 2010). While some progress has been made, existing research has not fully addressed the specific ways in which societal stereotypes, organizational structures, and interventions such as mentoring and inclusive policies intersect to either support or hinder women's career progression. This research gap highlights the need for a more nuanced understanding of the interplay between these factors and how they can be strategically addressed to promote gender diversity in leadership.

This study seeks to advance our understanding of existing research on the impact of societal and organizational stereotypes on women's career advancement through a bibliometric analysis. This article aims to fill this gap by examining three key research questions:

1. How do societal and organizational stereotypes affect women's career advancement?
2. What are the structural and institutional barriers that prevent women from progressing into leadership roles?
3. Which publications from the database used in our research achieve the most significant impact in the academic sphere based on global citation trends?

The results of the bibliometric analysis will provide answers to research questions and identify key barriers hindering women's advancement into leadership positions. The study will offer practical recommendations for organizations seeking to increase the representation of women in leadership.

2. RESEARCH METHODOLOGY

This study focuses on a bibliometric analysis of research on women in leadership positions, examining the factors that influence the overcoming of gender barriers. We analyze publication trends to identify the most frequently studied topics and research questions in this field. Our goal is to identify key factors that support women in achieving leadership positions and overcoming systemic barriers. By analyzing publications from the Web of Science database, we gain an overview of the development of research in this area and identify research gaps. The results of our study can contribute to a better understanding of the complex factors that influence women's representation in leadership and provide a basis for further research and practical applications in the field of promoting gender equality. We will proceed by first defining specific research questions and setting analysis objectives. Subsequently,

First, we define the primary research objective and formulate specific research questions. Subsequently, we identify the scope of the research, including its demographic characteristics and anticipated outcomes. For data collection, we utilize the Web of Science database, defining relevant keywords and search criteria to filter the most pertinent publications. The extracted data is downloaded in BibTeX format for subsequent analysis. After identifying our dataset, we assess the eligibility of publications using the Biblioshiny bibliometric software. Subsequently, we conduct our data analysis using the same software. We address the research questions through relevant analysis and identify the significance of our findings. The steps involved in identifying publications through the database are illustrated in Figure 1.

Table 1. Steps in the Literature Review Process for Women's Leadership Research

Step	Details
Step 1: Criteria for reviewing existing literature (inclusion and exclusion)	**Classification**: Articles from peer-reviewed journals on the topic of women's leadership. **Exclusion**: Dissertations, book reviews, and case studies
Step 2: Literary research	**Database**: Web of Science, **Terms**: "women's leadership," "gender equality," "leadership styles," "women in management"
Step 3: Refine the selection of literature studies	**Analysis**: Focus on excluding articles not related to women's leadership in management **Final sample of articles**: 260
Step 4: Reducing the scope of the study sample	This refining process involved excluding studies that did not meet the predefined inclusion criteria, such as those not directly addressing leadership issues or focusing only on theoretical perspectives without empirical data. As a result, **157 unique sources** formed the final basis of the bibliometric analysis.

Step 4: Analysis of selected articles	The selected articles were systematically analyzed using bibliometric methods, focusing on publication trends, keyword frequency, and authorship patterns. Themes related to societal stereotypes, structural barriers, and interventions promoting women in leadership were identified.
Step 5: Presentation of findings	The findings revealed key research streams: the role of societal and organizational stereotypes, structural barriers impeding women's career progression, and the impact of mentorship programs and inclusive policies on promoting gender diversity in leadership roles.

Table 1 outlines a structured approach to reviewing literature on women's leadership. It begins with establishing criteria for inclusion and exclusion, focusing on peer-reviewed articles related to women's leadership while excluding dissertations, book reviews, and case studies. A literary search was then conducted using the Web of Science database with terms like "women's leadership," "gender equality," "leadership styles," and "women in management."

This selection process was refined by excluding articles not directly related to women's leadership in management, resulting in a final sample of 260 articles. Further narrowing of the scope involved excluding studies that did not meet predefined criteria, leading to 157 unique sources for bibliometric analysis. The selected articles were systematically analyzed using bibliometric methods to identify publication trends, keyword frequency, and authorship patterns. Key themes emerged, including societal stereotypes, structural barriers, and interventions promoting women in leadership. Ultimately, the findings revealed crucial research streams, highlighting the impact of societal and organizational stereotypes, barriers to women's career progression, and the benefits of mentorship programs and inclusive policies in enhancing gender diversity in leadership roles.

3. BIBLIOMETRIC ANALYSIS RESULTS

This research provides a statistical summary of academic publications from 1994 to 2022. It includes 157 sources with 260 documents and an annual growth rate of 2.51%. The average document age is 12.3 years, and each document has an average of 84.56 citations, with a total of 12,441 references. There are 795 Keywords Plus entries and 626 author-provided keywords. In total, 979 authors contributed, including 52 who authored single-authored documents. Collaboration shows 53 single-authored documents, with an average of 4.01 co-authors per document and 20% international co-authorship. Document types consist of 222 articles, 2 articles that are also book chapters, 4 proceedings papers, 10 editorial materials, 1 letter, and 21 reviews.

Table 2. Summary information of the dataset (source: own proceedings in Biblioshiny)

MAIN INFORMATION ABOUT DATA	
Timespan	1994:2022
Sources (Journals, Books, etc)	157
Documents	260
Annual Growth Rate %	2.51
Document Average Age	12.3
Average citations per doc	84.56
References	12441
DOCUMENT CONTENTS	
Keywords Plus (ID)	795
Author's Keywords (DE)	626
AUTHORS	
Authors	979
Authors of single-authored docs	52
AUTHORS COLLABORATION	
Single-authored docs	53
Co-Authors per Doc	4.01
International co-authorships %	20
DOCUMENT TYPES	
article	222
article; book chapter	2
article; proceedings paper	4
editorial material	10
letter	1
review	21

3.1 Research trends in analysed field

The "Annual Scientific Production" graph presents the yearly fluctuations in the number of scientific articles published between 1994 and 2022. The data shows an overall increase in publications, peaking in 2015, followed by a decline towards 2022. This trend suggests variability in research output over time. In the context of this study, I will examine the factors contributing to these fluctuations, particularly focusing on societal and organizational influences that may have affected research production related to women in leadership roles. The aim is to explore whether these trends reflect broader changes in gender-related research and leadership topics.
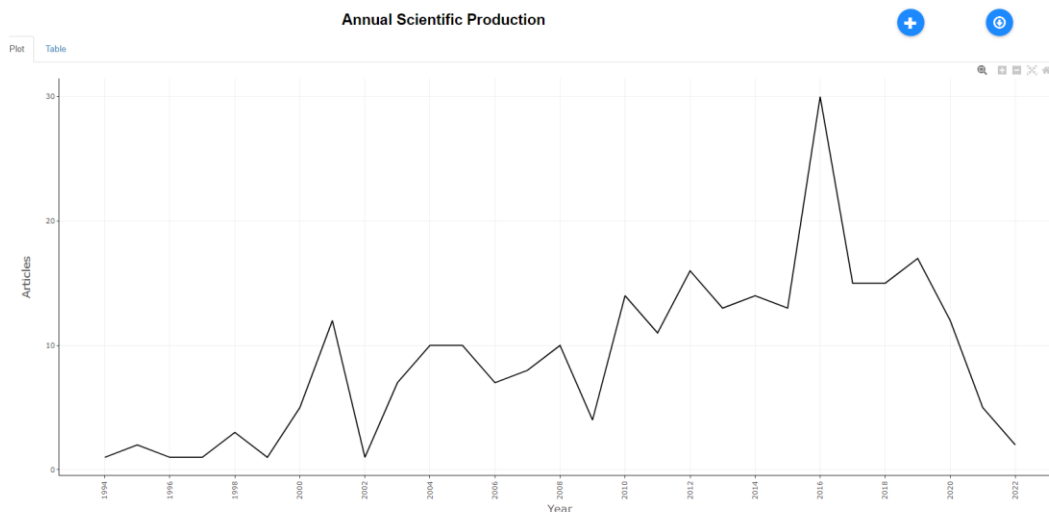
Fig 1. Annual Scientific Production ((source: Web of Science*)*

The data reveals an average growth rate of 2.51%, indicating a general upward trend in scientific citations over the years. Notably, the highest citation peak is observed around 1998, marking it as a period of significant academic attention within the field. This peak is followed by fluctuations, with intermittent rises and declines over the following years.
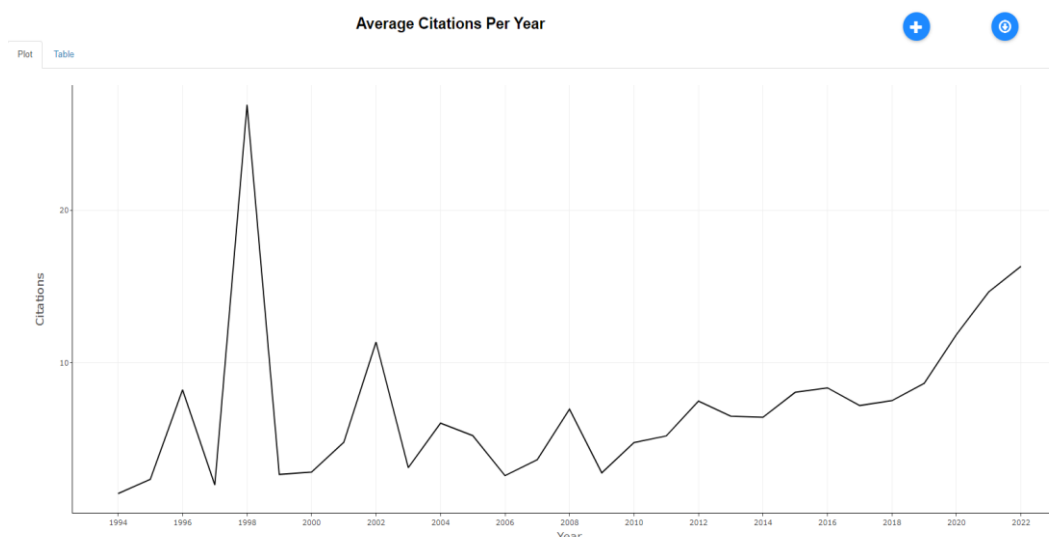
Fig. 2. Average Citation per Year (source: own proceedings in Biblioshiny)

The average citations per year in this data set serve as a gauge of scholarly impact, showing how frequently these works were referenced by other researchers over time. As shown in Fig. 2 citations generally follow a pattern of

sporadic activity in earlier years, peaking sharply in 1998, followed by another smaller peak in the early 2000s. After a period of relative stability from 2008 onward, there is a consistent upward trend post-2016, peaking again in 2022.

This chart ultimately provides insight into the academic influence of publications over time, highlighting periods when research garnered increased recognition. The potential decline or stabilization in recent years might reflect either the delay in citation accumulation for newer publications or a dip in overall research output in the field.

3.2 Co-occurrence network and key word analysis

To identify future research directions in holacracy within organizational management, our objective is to analyze keyword and topic trends within the field. This will provide scholars with a clearer understanding of key themes and emerging research paths in this specific domain. The co-occurrence map visually represents the relationships among keywords, authors, and terms within the analyzed publication dataset. This tool enables the identification of frequently co-occurring terms, highlighting the interconnections among research topics and ideas.
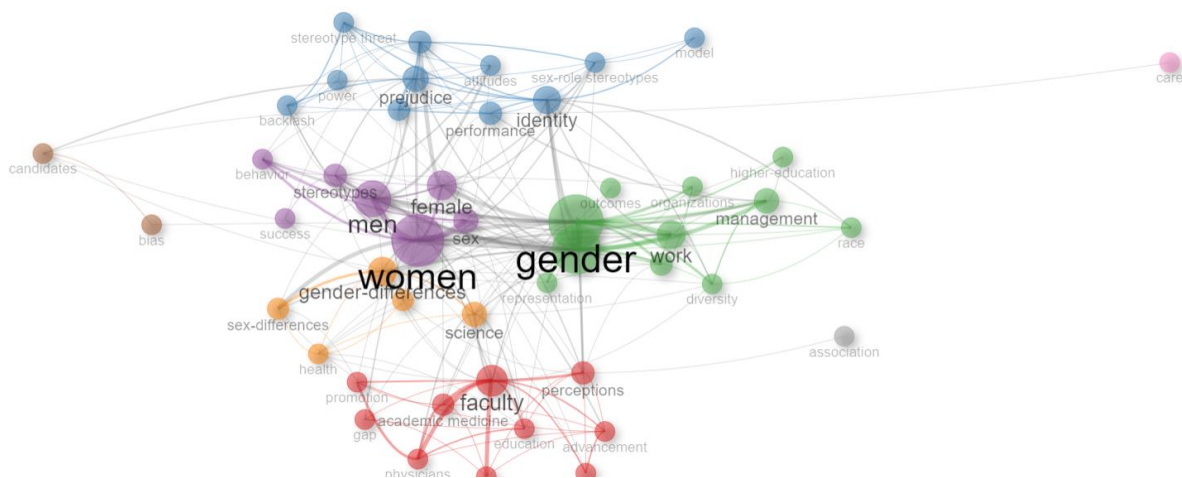
Fig. 3. Co-occurrence Network (source: own proceedings in Biblioshiny)

The co-occurrence network of our dataset, shown in Fig.6, highlights the key terms "gender," "women," "faculty," and "management," which align closely with the research focus. The size of each node represents the frequency of a keyword's appearance across the analyzed publications, with several significant clusters emerging. The most prominent cluster, shown in green and centered around "gender," includes topics related to diversity, workplace dynamics, and organizational contexts, highlighting issues such as equality and inclusion within professional environments. A red cluster focuses on "faculty" and "academic medicine," addressing gender disparities in academia and medical education. This cluster covers themes such as career advancement, compensation, cultural influences, and representation, emphasizing gender-specific challenges in these fields. Meanwhile, a blue cluster explores terms like "stereotype threat" and "prejudice," examining the impact of gender stereotypes and biases on professional opportunities and personal identity.

Overall, this network illustrates the intersection of gender equality and diversity with organizational management and academia, emphasizing connections between workplace conditions, career progression, and gender representation.

Fig 4. Word Cluster (source: own proceedings in Biblioshiny)

The result of the analysis is visually represented in Figure x. The most frequently used word was "gender," followed by "woman," "leadership," and "female."

- The word **GENDER** appears as the most frequently used term in our analysis, confirming its fundamental significance in this context. Discussion of gender issues is crucial for understanding dynamics in leadership and their impact on organizational cultures. The topic of gender is increasingly important in the context of enhancing women's representation in various professions. This term encompasses the social and cultural constructs that define roles, behaviors, and expectations associated with being male or female.

- The term **WOMEN** also appears with considerable frequency in the analysis, highlighting the interest in issues of female representation in leadership and management. This term is closely linked to discussions about the barriers women face in achieving leadership positions and underscores the need for creating more inclusive environments. It reflects the growing awareness of the challenges women encounter in the workplace and the importance of advocating for their representation at all levels of decision-making.

- The term **LEADERSHIP** is another key term that indicates how gender issues influence dynamics in management. Studies focus on how women are perceived as leaders and the impact of their representation on organizational outcomes. Leadership encompasses various styles, practices, and roles within organizations, and is crucial for understanding how gender norms shape perceptions and practices in this domain. It highlights the evolving nature of leadership in response to changing societal attitudes toward gender equality.

- Frequent use of the term **MANAGEMENT** in relation to our research highlights the significant connection between managerial practices and gender issues. This term reflects how traditional approaches to management are changing in response to gender challenges, leading to necessary adjustments in workplace policies and practices. Management encompasses the processes, strategies, and frameworks used to lead and coordinate an organization. It becomes a key framework for discussing fairness and equality in professional spheres, emphasizing the need for equitable practices that support both men and women in leadership roles.
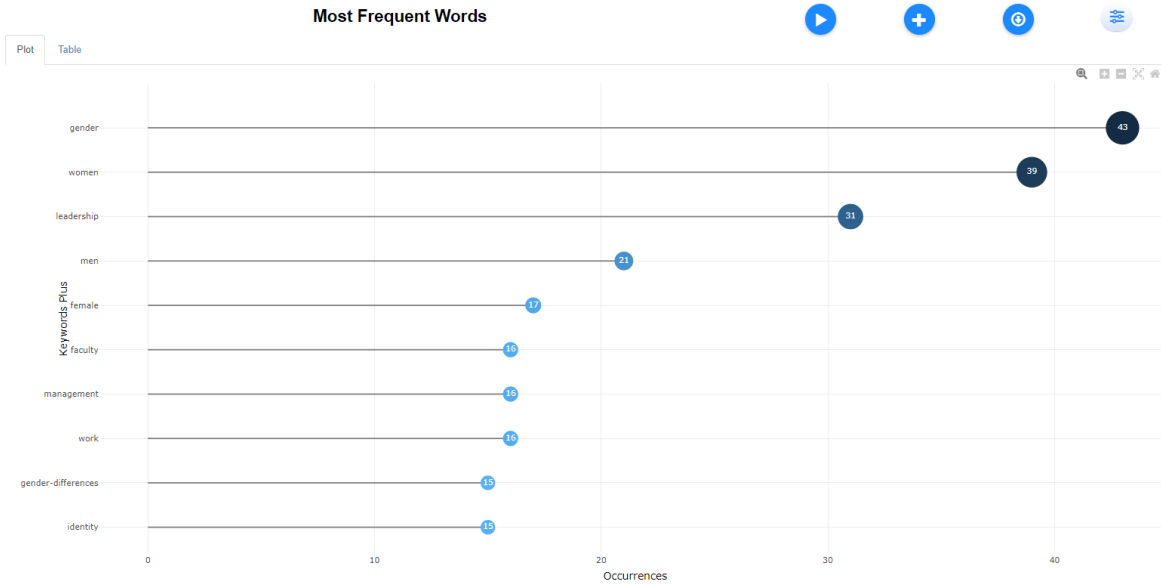
Fig. 5. Most Frequent Words (source: own proceedings in Biblioshiny)

Key analysis presented in the bar chart "Most Frequent Words" highlights key terms (Fig. 5) related to gender and leadership. The term "gender" (43 occurrences) is the most frequently mentioned term, followed by "women" (39 occurrences), indicating a strong focus on female representation and related challenges. Other significant terms include "leadership" (31 occurrences), "female" (17), and "management" (16), emphasizing gender themes in professional and academic settings.

The disparity between "women" and "men" (21 occurrences) suggests an exploration of female representation and the unique challenges women face in leadership roles. Overall, this data underscores the importance of addressing gender issues and equity across various sectors.
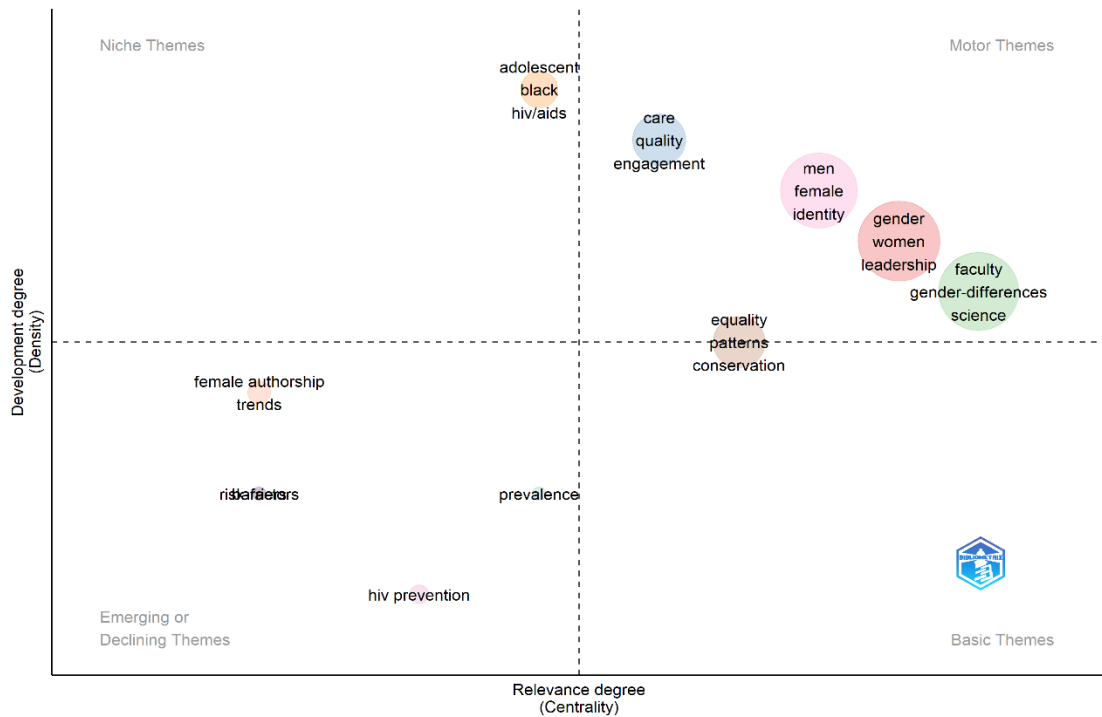
Fig. 6 Thematic Map (source: own proceedings in Biblioshiny)

The thematic map is used for visualizing the main themes within the research field. It is a two-dimensional map with Density on the y-axis (Development degree) and Centrality on the x-axis (Relevance degree). The map divides individual themes into four quadrants based on their internal cohesion and relevance: Motor Themes, Niche Themes, Basic Themes, and Emerging/Declining Themes. This approach relies on strategic mapping to capture the evolving relationships between frequently occurring themes in research outputs (Callon et al., 1983).

Based on the analysis, several significant clusters are identified, with the most prevalent themes being gender, women, faculty, leadership, and science. Themes such as gender (including gender-differences), women, leadership, and faculty have high centrality and density, classifying them as Motor Themes. These well-developed themes play a crucial role in driving the research field forward, focusing on central topics related to gender roles, representation, and identity within academic and professional settings. Topics like adolescent, black, and HIV/AIDS appear as Niche Themes. These topics have high internal cohesion but lower centrality, indicating they are highly specialized and relevant in specific subfields. They address demographic-focused or context-specific issues, often delving deeply into particular population studies or health concerns. Basic Themes, including prevalence, equality, and conservation, are foundational yet less developed themes. These themes, while crucial to the field due to their high centrality, lack the density required to fully support cohesive research streams and require further exploration.

Finally, Emerging or Declining Themes like female authorship, trends, and risk factors are positioned in the quadrant of low density and low centrality, suggesting that these areas may be losing relevance or have not been sufficiently explored in recent research. This quadrant points to areas that could benefit from renewed research interest or re-evaluation to understand their relevance to the field. Overall, the thematic map underscores that central themes like gender representation and leadership remain vital pillars within the research landscape, while areas in the Basic and Emerging/Declining quadrants highlight opportunities for deeper exploration or shifts in focus.

3.3 Analysis of most prominent authors and most influential publications

In our analysis, we identified key researchers within the field based on the number of documents they have published, as shown in Fig. 7. The leading contributors in terms of publication count include Carnes M. and Morahan PS, both with a total of 5 publications. They are followed by Cardinali G. (NP=4), Chang S. (NP=4), Hoyt CL (NP=4), Magrane D. (NP=4) and Morley L (NP=4). Table 3, several key authors are evaluated for their individual research impact using various metrics such as the H-Index, G-Index, M-Index, Total Citations (TC), Number of Publications (NP), and starting year of publishing within the field.

Fig. 7 Most Relevant Authors (source: own proceedings in Biblioshiny)

The author's local impact is summarized in Table 3. From the analysis, it becomes evident that authors Carnes M. and Morahan PS have the highest local impact, indicated by both an H-Index and G-Index of 5. This high index value signifies that they have a substantial number of influential publications, with Carnes M. accumulating a total citation (TC= 450) and Morahan PS reaching total citations (TC=251) across their respective 5 publications. As per the average citation rate per publication, evaluated by the M-Index, Cardinali G. and Chang S. emerge as leading figures with an M-Index of 0.308. Although they have a lower total publication count (NP=4), they maintain a significant impact, as

shown by their H-Index and G-Index of 4 and total citations at 181 each, further marking their influence within the field. Overall, these metrics reveal a number of successful and impactful authors within our research segment, each contributing significantly through high citation counts and influential publications.

Table 3 Author's local impact (source: own proceedings)

Author	H-Index	G-Index	M-Index	TC	NP	PY_start
CARNES M.	5	5	0.278	450	5	2007
MORAHAN PS	5	5	0.208	251	5	2001
CARDINALI G.	4	4	0.308	181	4	2012
CHANG S.	4	4	0.308	181	4	2012
HOYT CL	4	4	0.222	278	4	2007
MAGRANE D.	4	4	0.308	181	4	2012
MORLEY L.	4	4	0.333	465	4	2013
ASGARI S.	3	3	0.143	595	3	2004
DASGUPTA N.	3	3	0.143	595	3	2004
HELITZER DL.	3	3	0.273	143	3	2014

Following the author analysis, we identified and closely examined the most impactful publications within the field. This analysis included reviewing the citation frequency of each publication, which helps to gauge its influence in the studied area. Our findings led to the identification of the top 10 most influential publications in our research domain, based on their total global citations, as summarized in Table 4. Each publication is described by its Total Citations (TC) and Citations per Year (TC/Y).

Table 4 Most prominent publications in the field (source: own proceedings)

Title of publication	Journal	Year	Total citation	Total Citations per Year
Seeing is believing exposure to counterstereotypic women leaders and its effect on the malleability of automatic gender stereotyping	Journal of experimental social psychology	2004	443	21.095
Women's health and women's leadership in academic medicine: hitting the same glass ceiling?	Journal of womens health	2008	221	13
The rules of the game: women and the leaderist turn in higher education	Gender and education	2013	211	17.583
Lost leaders: women in the global academy	Higher education research \& development	2014	168	15.273
When do counterstereotypic ingroup members inspire versus deflate? The effect of successful professional women on young women's leadership self-concept	Personality and social psychology bulletin	2012	101	7.769
Female leaders: injurious or inspiring role models for women?	Psychology of women quarterly	2011	87	6.214

Are female applicants disadvantaged in national institutes of health peer review? Combining algorithmic text mining and qualitative methods to detect evaluative differences in r01 reviewers' critiques	Journal of women's health	2017	77	9.625
Leadership efficacy and women leaders' responses to stereotype activation	Group processes \& intergroup relations	2007	76	4.222
Women, men, and leadership: exploring the gender gap at the top	Social and personality psychology compass	2010	74	4.933
Innovative mentoring programs to promote gender equity in academic medicine	Academic medicine	2001	68	2.833

1. (DASGUPTA N, ASGARI S., 2004) TC=443, TC/Y=21.095 The authors conduct two studies to examine how social environments influence automatic gender stereotypes among women. In the first study, a laboratory experiment tests whether brief exposure to biographical information about prominent female leaders can reduce these stereotypes. Results suggest that even short-term exposure to female role models can lessen automatic stereotypic beliefs. In the second study, a year-long field study compares students at a women's college and a coeducational college to explore the impact of frequent exposure to female leaders on automatic stereotypes. Findings reveal that environments with regular exposure to female leaders, particularly in female-dominated settings, significantly reduce gender stereotypes, while male-dominated academic environments tend to reinforce them. These studies underscore the powerful role of social contexts and female leadership in shaping unconscious gender beliefs.

2. (CARNES M., 2008) TC=221, TC/Y=13 The author explores the "glass ceiling," describing barriers that hinder women's advancement into leadership despite no visible obstacles. This concept, applied in academic medicine, is examined in relation to women's health progress. The paper discusses the historical link between women's health advancements and leadership, the slow rise of women in leadership roles, and signs of stalled progress in women's health. It concludes with recommendations to address systemic, unconscious gender biases that limit women's leadership and health progress, advocating for institutional changes beyond simply "fixing the women."

3. (MORLEY L., 2013) TC= 211, TC/Y= 17.583 The author engages with Diana Leonard's work on gender in academia, offering an international review of feminist perspectives on how gender and power intersect with leadership in higher education. The paper examines the "leaderist turn," where leadership has become a dominant organizational concept in academia and explores frameworks analyzing women's leadership aspirations and their underrepresentation. It seeks to reveal the hidden "rules of the game" behind academic meritocracy, questioning the persistent undervaluing of women's leadership and advocating for a broader understanding of leadership suited to the university of the future.

4. (MORLEY L., 2014) TC = 168, TC/Y=15.273 The author examines data from British Council seminars in Hong Kong, Tokyo, and Dubai on the topic of "Absent Talent: Women in Research and Academic Leadership." The research explores academic women's experiences and explanations for their under-representation as knowledge leaders within the global academy. Drawing on perspectives from participants across South and East Asia, the Middle East, North Africa, Australasia, and Europe, the study highlights key enablers and barriers while capturing shared aspirations for change through a Manifesto for Action. The core focus is on understanding whether women are aspiring to, dismissing, or being excluded from senior leadership roles in academia.

5. (ASGARI, S., DASGUPTA, N., & STOUT, J. G., 2012) TC = 101, TC/Y=7.769 The authors conduct three experiments to investigate whether exposure to female leaders can enhance women's implicit leadership self-concept and under what conditions this occurs. Experiment 1 explores if women view leaders as similar or different from most women, while Experiment 3 examines leaders with similar or different educational backgrounds to participants. Experiment 2 uses feedback to suggest participants are similar to women leaders. Findings show that exposure to

female leaders reduces implicit self-stereotyping, but only when leaders are portrayed as similar to participants' ingroup or personal background. In cases where leaders seem dissimilar, implicit self-stereotyping either remains unchanged or increases, negatively affecting career goals and leadership beliefs. These results highlight the importance of perceived similarity in fostering women's implicit and explicit leadership self-beliefs.

6. (HOYT CL., 2011) TC =87, TC/Y=6.214 The author investigates the impact of female role models on women's leadership aspirations and self-perceptions across two laboratory studies. Study 1 found that exposure to high-status female leaders reduced women's self-perceptions compared to male leaders and controls. Study 2 showed that this effect also diminished leadership aspirations, whereas nonelite female leaders had a positive influence, encouraging counterstereotypic thinking. Together, these studies reveal both potential downsides of elite female role models and the benefits of relatable female leaders in stereotype-sensitive contexts.

7. (CARNES M., 2017) TC = 77, TC/Y=9.625 The author examines gender bias in R01 grant renewals from the NIH, using text mining and qualitative analysis on critiques of 51 renewals at the University of Wisconsin-Madison (2010-2014). Findings show that male investigators were described as "leaders" and "pioneers" with "highly innovative" research, while female investigators were noted for "expertise" in "excellent" environments. Men received higher scores in priority, approach, and significance, independent of productivity. This suggests that gender stereotypes may influence peer review, favoring men as scientific leaders and impacting women's grant renewal success.

8. (HOYT CL., 2017) TC = 76, TC/Y=4.222 The author investigates the role of leadership efficacy in women's responses to stereotype-based leadership expectations through two laboratory studies. Participants, selected based on leadership efficacy, led virtual groups, with half primed with gender leadership stereotypes. Results show that women with high leadership efficacy responded positively to stereotype activation, exhibiting higher perceived performance, rated performance, domain identification, and well-being compared to low efficacy leaders. Additionally, perceived performance mediated the effects on domain identification and well-being, highlighting the moderating role of leadership efficacy in women's responses to stereotype-based expectations.

9. (HOYT CL.,2010) TC= 74, TC/Y= 4.933 The author examines gender disparities in elite leadership, focusing on obstacles women face in attaining and being seen as effective in top roles. Through research on the "leadership labyrinth" or "glass ceiling," the discussion addresses differences in leadership styles, the impact of domestic responsibilities and organizational culture, and the role of stereotypes and discrimination. The article concludes with recommendations to promote gender parity in leadership.

10. (MORAHAN PS, 2001) TC=68, TC/Y= 2.833 The authors describe four mentoring programs launched in 1998 at U.S. medical schools to support faculty career advancement, initiated by the Office on Women's Health (OWH) based on recommendations from the National Task Force on Mentoring for Health Professionals. These programs, located at MCP Hahnemann, UC San Diego, East Carolina University, and Meharry Medical College, emphasize institutional commitment and mentor recognition. Intended as models for other institutions, the programs aim to foster faculty diversity, enhance supportive academic environments, and train healthcare providers sensitive to the needs of diverse patients and colleagues.

4. CONCLUSION

This research paper and analysis conducted a bibliometric analysis using the program Biblioshiny, where we examined 260 individual publications gathered from the Web of Science database, filtered according to predetermined parameters. The analysis highlights that the research field concerning women's leadership and career advancement in the context of societal and organizational stereotypes has gained significant attention in recent years. After a thorough bibliometric review, we can address the research questions posed earlier:

How do societal and organizational stereotypes affect women's career advancement?

The analysis reveals that stereotypes around leadership and gender roles, as demonstrated in studies by Dasgupta, Asgari, and Hoyt, often reinforce traditional gender expectations. High-status female role models can, at times, produce mixed impacts on women's self-perception and leadership aspirations. For example, exposure to female leaders who counter stereotypes positively influences women's self-concept, but high-status comparisons can sometimes deflate self-perceptions, depending on how relatable these role models are. Furthermore, biases in academic and research grant evaluations, as seen in Carnes' study on NIH grants, show that stereotypes can influence perceptions of innovation and significance, often favoring male over female investigators. These societal and organizational stereotypes pose significant challenges for women, impacting their career progression.

1.   What are the structural and institutional barriers that prevent women from progressing into leadership roles?

To identify structural and institutional barriers that hinder women's advancement into leadership roles, we utilized tools such as co-occurrence mapping, word clustering, and thematic mapping. The predominant themes within this research field include gender stereotypes in leadership, the influence of organizational culture, and biases in recruitment and promotion practices. These themes highlight the persistent structural barriers that affect women's career progression.

The analysis reveals that stereotypical expectations about women's leadership styles often conflict with traditional views of authority, which impacts hiring and promotion decisions. In addition, the lack of female mentors and role models in senior positions presents a significant barrier to advancement. Despite progress, these institutional constraints indicate a continued need for change within organizational frameworks to ensure equal opportunities for women.

We suggest the following areas for future research to address these barriers:

- **Empirical studies on the impact of mentorship and sponsorship programs**: More studies are needed to assess the role of mentorship and the specific impact of female mentors in enhancing women's leadership progression within organizations.

- **Exploration of bias-reducing hiring and promotion practices**: Research could focus on examining and promoting hiring and evaluation methods that mitigate gender bias.

- **Comparative studies on leadership trajectories in different organizational structures**: Examining leadership pathways across diverse organizational types, from corporate to academic and non-profit sectors, could provide insights into effective policies that support women's leadership advancement.

2.   Which publications from the database used in our research achieve the most significant impact in the academic sphere based on global citation trends?

The final part of our research focused on identifying prominent researchers and influential publications within the field. We identified several key researchers who have produced impactful publications over the years. The most prominent authors, based on their H-Index and G-Index scores, include Carnes M. and Morahan PS, each with an H-Index and G-Index of 5, indicating substantial contributions and a strong presence in the field. Carnes M. leads with a total of 450 citations, while Morahan PS has 251 citations.   Our document analysis included the ten most impactful publications within the field. Of these, the most cited publication (TC=443) was *Seeing is believing exposure to counterstereotypic women leaders and its effect on the malleability of automatic gender stereotyping* (DASGUPTA N, ASGARI S., 2004) which presenting participants with profiles of these leaders, the study finds that even limited exposure can lessen stereotypic beliefs, suggesting the potential of such interactions to challenge ingrained stereotypes. This publication not only had the highest total citations but also the highest citations per year (TC/Y=21.095). By presenting participants with profiles of these leaders, the study finds that even limited exposure can lessen stereotypic beliefs, suggesting the potential of such interactions to challenge ingrained stereotypes.

Despite significant efforts by researchers studying gender stereotypes and women's career advancement, the scope of publications in this field and within the given geographic area remains rather limited. The relatively low number of studies directly examining the impact of gender stereotypes on women's career progression highlights a need for further research. It is important to note that this limited set of publications may be due to a narrow geographic focus. In future analysis, a broader geographic context would be beneficial for a more comprehensive examination.

Acknowledgements

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An Intuitionistic Fuzzy Decision Framework for Evaluating the Advantages of Sustainable Marketing

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Abstract

Nowadays, sustainability principles are becoming more and more important in all sectors. In a period where companies keep up with competition, they develop marketing strategies based on sustainability. This approach takes social, environmental and economic factors into consideration by developing products and services. Sustainable marketing focuses on the goal of creating long-term value rather than the goal of making revenue. In this study, the advantages of sustainable marketing are evaluated, and their importance are determined. Intuitionistic fuzzy cognitive map is a suitable tool due to the presence of interrelationships among evaluation criteria, fuzziness, vagueness, and hesitation in data. The application is illustrated through a case study, which is conducted in a firm that performs in Turkiye.

Keywords: Sustainable marketing, intuitionistic fuzzy cognitive map, hesitation

1. INTRODUCTION

The 1992 United Nations Conference on Environment and Development, known as the Rio Summit, played a significant role in making sustainable development a global priority. At this summit, world leaders developed strategies towards sustainable development goals and adopted the action plan known as "Agenda 21." During this period, the foundations of sustainable marketing principles were established. From the late 1990s and early 2000s, sustainable marketing strategies began to become widespread. Companies started fulfilling their environmental and social responsibilities within the framework of corporate social responsibility, driven by increasing concerns about climate change. Additionally, the signing of the Kyoto Protocol in 1997 was considered an important step towards reducing global greenhouse gas emissions [1].

The Global Sustainable Development Report, published in 2023, noted that Turkiye has made progress, particularly in transitioning to renewable energy sources and reducing carbon emissions. However, it also highlighted that Turkiye still faces significant challenges in areas such as urbanization and industrial pollution [2].

The European Union harmonization process has contributed to improving environmental regulations and standards in Turkiye. During this process, sustainable marketing in Turkiye has significantly developed due to increased environmental awareness and the impact of international agreements. The 2023 Turkiye Report highlighted significant

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advancements in Turkiye's sustainable marketing, especially in environmental policies and renewable energy investments. However, it emphasized the need for better coordination of environmental and climate policies and substantial investments [3].

This work introduces an intuitionistic fuzzy cognitive map (IFCM) technique to determine the importance degrees of the advantages of sustainable marketing. The presence of interrelationships among evaluation criteria, fuzziness, vagueness, and hesitation in data led us to employ IFCM methodology as an appropriate tool.

The remaining sections of the paper are organized as follows. Section 2 explains briefly intuitionistic fuzzy cognitive map methodology. The following section illustrates the application via a case study conducted in a Turkish company that performs in fast moving consumer goods sector. Final section delineates conclusions and future research directions.

2. INTUITIONISTIC FUZZY COGNITIVE MAP TECHNIQUE

Intuitionistic fuzzy cognitive map (IFCM) technique includes intuitionistic fuzzy numbers into cognitive maps in order to determine the power of cause-and-effect relationships [4]. First, concept nodes and power of causal links among them are defined by obtaining experts' opinions. Second, the power of causal links is represented by intuitionistic fuzzy numbers that are associated with intuitionistic fuzzy scale. Hence, membership, non-membership, and hesitation values are identified. Finally, N x N weight matrix is formed by employing the information collected from the experts.

The following iterative formulation of IFCM is run until the system is stabilized, in other words, all factor weights will converge [5]. In this way, the concepts' values are computed.

$$A_i^{(k+1)} = f\left(A_i^{(k)} + \sum_{\substack{j \neq i \\ j=1}}^{N} A_j^{(k)} w_{ji}^{\mu} - A_j^{(k)} w_{ji}^{\pi} \right) \tag{1}$$

where $A_i^{(k)}$ is the value of concept Ci at kth iteration, w_{ji} is the weight of the connection from C_j to C_i, w_{ji}^{μ} and w_{ji}^{π} denote the weight matrices that show membership values and hesitation values of causal links, respectively, and f is a threshold function, which is considered as sigmoid function for this work.

3. CASE STUDY

This work presents an IFCM approach for evaluating the advantages of sustainable marketing. The case study is conducted in a firm performing in the fast moving consumer goods sector of Turkiye through three experts' opinions. Initially, factors that are determined by interviewing the marketing and sales managers of the case company and Google search, are delineated in Table 1.

Table 1: Advantages of sustainable marketing

Label	Concept
C_1	Environmental awareness
C_2	Brand image
C_3	Customer loyalty
C_4	Competitive advantage
C_5	Cost savings

The experts provide their opinions by reaching a consensus and they used the linguistic scale shown in Table 2.

Table 2: Linguistic Scale

Linguistic term	Intuitionistic fuzzy number
VH	<0.95,0.05>
H	<0.70,0.25>
M	<0.50,0.40>
L	<0.25,0.70>
VL	<0.05,0.95>

The linguistic data, membership values, non-membership values, and hesitation values for causal relationships, are given in Tables 3, 4, 5, and 6, respectively.

Table 3. Linguistic Data for Causal Relationships

	C_1	C_2	C_3	C_4	C_5
C_1	-	H	VH	M	-
C_2	VL	-	-	VH	-
C_3	-	H	-	H	-
C_4	-	-	L	-	-
C_5	-	-	-	VH	-

Table 4. Membership values

	C_1	C_2	C_3	C_4	C_5
C_1	0	0.7	0.95	0.5	0
C_2	0.05	0	0	0.95	0
C_3	0	0.7	0	0.7	0
C_4	0	0	0.25	0	0
C_5	0	0	0	0.95	0

Table 5. Non-membership values

	C_1	C_2	C_3	C_4	C_5
C_1	0	0.25	0.05	0.4	0
C_2	0.95	0	0	0.05	0
C_3	0	0.25	0	0.25	0
C_4	0	0	0.7	0	0
C_5	0	0	0	0.05	0

Table 6. Hesitation values

	C_1	C_2	C_3	C_4	C_5
C_1	0	0.05	0	0.1	0

C_2	0	0	0	0	0
C_3	0	0.05	0	0.05	0
C_4	0	0	0.05	0	0
C_5	0	0	0	0	0

IFCM technique is employed, and importance weights are obtained by running the formulation (1) until it will be stabilized, and the values of concepts will remain same. FCMapper software is used for these operations. The concepts' values are given in Table 7.

Table 7: Importance weights

Label	Concept	Weight
C_1	Environmental awareness	0.671418
C_2	Brand image	0.863753
C_3	Customer loyalty	0.840993
C_4	Competitive advantage	0.933961
C_5	Cost savings	0.659046

4. CONCLUSIONS

To obtain the importance weights of the advantages obtained through adapting sustainability in marketing processes, evaluation criteria are determined through expert opinions and then algorithm of the work is reported by considering IFCM technique. Importance weights of concepts are assigned by applying IFCM methodology, competitive advantage is the most influential factor however cost savings is the least effective criterion. Accordingly, from the point of view of the firms that aim to achieve competitive advantage, it will be appropriate to incorporate sustainable marketing processes. However, for those who are supposed to save money, it is not very definite that sustainable marketing will provide that aim.

Future research will focus on proposing group decision making approaches for this evaluation.

Acknowledgements

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Artificial Intelligence in Public Administration: Opportunities, Challenges, and the Path Forward

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Abstract

This paper examines the integration of artificial intelligence (AI) in Albania's public administration, focusing on this digital transformation's progress, benefits, and challenges. E-government has become essential for more efficient delivery of public services, where AI plays a crucial role in modernizing processes, reducing bureaucracy, and increasing transparency. The paper analyzes the main AI initiatives in Albania, such as the virtual assistant on the e-Albania platform and the digitization of public procurement, highlighting the efforts led by the National Agency for the Information Society (AKSHI). Although significant progress has been made, several challenges remain, including integrating AI with existing systems, ensuring data security and privacy, addressing ethical concerns, and developing a skilled workforce. The study uses a qualitative research approach, content analysis, and the multiple perspectives approach (MPA) to assess IA implementation in Albania's public sector. The findings suggest that while AI can significantly improve public services, successful integration requires significant investments in infrastructure, legal framework, and human resources. The paper concludes with recommendations for overcoming barriers and maximizing the impact of AI, including strengthening regulatory measures, investing in digital skills development, and improving international cooperation. In addition, throughout this paper, AI techniques were meticulously applied to organize the overall structure systematically and refine the related methodologies, ensuring clarity and coherence in the presentation of ideas.

Keywords: Artificial Intelligence (AI), Public Administration, E-Government, Digital Transformation, Data Security

1. INTRODUCTION

E-government is critical to delivering government services efficiently and affordably, benefiting citizens and governments by increasing access and reducing costs. Despite technological advances, challenges remain in effectively implementing these services (Nnaji et al., 2023). Technologies such as AI and IoT can improve the efficiency and security of e-government by mitigating risks such as data privacy breaches and improving various applications, including e-health and e-payments (Asemi et al., 2023).

Albania's digital transformation has placed artificial intelligence (AI) at the center of public administration modernization. Recent advances, highlighted at the Electronic Procurement System conference, show the country's progress in reducing bureaucracy and increasing transparency. Over 1,239 electronic services are now available on the e-Albania platform, covering 95% of all public services. Integrating AI and machine learning in critical areas

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such as public procurement promotes equal business treatment. It automates procedures, reducing human error and increasing efficiency and fairness in the public sector.

This paper examines AI's impact on Albanian public administration, analyzing the progress, benefits, and challenges encountered. It also provides a comprehensive overview of the government's key initiatives and strategies for digitizing public services.

Specific objectives:
- Identification of the main projects that use AI in public administration.
- Analysis of the main benefits of AI in improving public services.
- Assessment of the technological, ethical, and security challenges of implementing AI.

The paper is structured in several main chapters, starting with the **Introduction**, which describes the importance of Artificial Intelligence (AI) in Albania's public administration and presents the study's main objectives. The **Literature Review** chapter examines existing research on AI in governance, analyzing global applications and specific challenges in the public sector. The **Methodology** chapter explains the qualitative research approach used, including data collection methods and applying the Multiple Perspectives Approach (MPA) for a comprehensive analysis. The **Results** section examines the progress and implementation of important AI projects in Albania, such as the virtual assistant on the e-Albania platform and the digitization of public procurement. The **Discussion** chapter explores the benefits and challenges associated with the role of AI in improving public services, focusing on ethical, technological, and security considerations. Finally, the paper ends with **Conclusions and Recommendations**, summarizing the findings and offering suggestions for future development, such as investing in human resources, improving digital infrastructure, and creating regulatory frameworks for AI governance.

2. LITERATURE REVIEW

Artificial intelligence (AI) is a technology that develops computer systems capable of performing tasks that require human-like intelligence, such as reasoning, learning, problem-solving, and language processing. In public administration, AI helps improve efficiency and transparency, automate processes, improve decision-making, and provide services to citizens. Applications include virtual assistants, data analysis, and resource management (Dwivedi et al., 2021). The history of IA dates back to the mid-20th century, with the field being formally established in 1956 at the Dartmouth Conference by pioneers such as John McCarthy. Early efforts focused on problem-solving and symbolic reasoning. In the 1970s, expert systems were developed in fields such as medicine, but technological limitations slowed progress. AI experienced a revival in the 1990s with advances in machine learning, such as IBM Deep Blue, which defeated Kasparov in 1997. The 2000s brought deep learning and big data, leading to breakthroughs like AlphaGo in 2016, and today, AI is widely used in sectors such as health and finance (S. L., Andresen, 2002).

1956-1970	1970-1980	1990	2000	2010-Present
• Early AI and Symbolic AI	• Expert System and AI winter	• Resurgence with Machine Learning	• Data Driven AI and Deep Learning	• Modern AI and Ubiquity
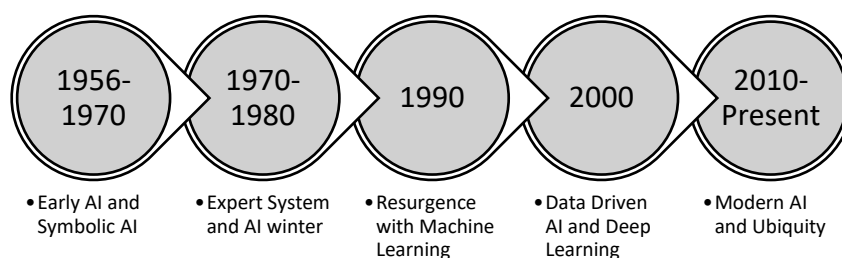
Fig. 1. (a) first picture

Many challenges have been identified in the implementation of IA in public administration. Research by Tangi et al. (2023) highlights five main categories: AI Society, Ethics, Laws and Regulations, Technology Implementation, and a new category, Organizational Change, which focuses on the difficulties of integrating AI into daily operations due to resistance to change and workflow adaptation. Mergel et al. (2023) address the practical challenges for public managers implementing AI, noting that integration faces societal concerns, ethical issues, legal frameworks, and technological limitations. They emphasize the importance of organizational reforms, skills development, and governance measures to mitigate risks and increase trust. Alhosani and Alhashmi (2024) emphasize the potential of AI to improve public services by increasing efficiency and reducing administrative burdens. However, they point out

that the need for a standardized definition of IA makes implementation easier. Effective governance of AI in the public sector requires a balance between efficiency and ethical considerations such as fairness and transparency. In developing regions such as Albania, the adoption of AI presents specific challenges, including technological limitations, legal gaps, and cultural resistance. As Heeks and Bhuvaneshwari (2020) point out, more digital infrastructure is needed to ensure the implementation of AI. Floridi et al. (2018) emphasize the need for robust data protection laws, while Aghion and Tirole (2019) underline that organizational culture significantly influences technology adoption. Early AI projects in Albania show potential but need more funds and expertise (Bego & Xhaferi, 2022).

3. METHODOLOGY

This paper used a qualitative research design to explore the complexities of integrating AI into public governance. As Prendi L. et al. (2023) suggest, data were collected primarily from secondary sources such as scholarly articles, government publications, and online sources and then organized into thematic categories for clarity and coherence. The study used a combination of content analysis and the Multiple Perspectives Approach (MPA) to comprehensively understand the integration of IA in public management in Albania. MPA provided flexibility in examining different aspects of IA implementation from multiple perspectives, enriching the analysis with different perspectives. The research focused on the descriptive aspects of the role of AI in governance, using a critical approach to identify the challenges and obstacles encountered in the Albanian context, including infrastructural limitations, policy gaps, and ethical issues.

Furthermore, this methodology enabled a deeper examination of policy-making processes, assessing how IA solutions fit within the existing governance framework and how they could be further optimized. Based on secondary data sources, the study gained insight into the current state of AI in Albania, enabling a comparison with best practices from other countries and sectors that can guide the development of the Albanian government's AI strategy. The combination of content analysis and MPA provided a detailed overview of the opportunities and risks associated with adopting AI in the public sector.

4. RESULTS/FINDINGS

This chapter examines the implementation of artificial intelligence (AI) in Albania's public administration, focusing on this process's progress, benefits, and challenges. The main initiatives based on Law No. 43/2023 on Electronic Government include projects such as the virtual assistant, the digitization of public procurements, and the involvement of the National Information Society Agency (AKSHI) in supervising and implementing the IA strategy. Also, the chapter will discuss the advantages and difficulties encountered in efforts to improve governance and public service delivery. Albania has made significant progress in implementing AI within public administration, focusing on projects that will enhance efficiency and transparency in the provision of public services. These efforts include digitizing processes, improving decision-making, and reducing the burden on administrative workers, with AI positioned as a vital tool for advancing governance and services to citizens. AKSHI leads the development of the country's AI strategy, which aims to position Albania as a regional center for AI innovation, promoting economic growth, social welfare, and sustainable development while respecting ethical standards and social inclusion (Çekani, 2024).

Albania has digitized 95% of public services, including public procurement, to facilitate adaptation to EU directives and improve transparency. Major IA projects include:

- Virtual Assistant in e-Albania: Developed with Microsoft and Azure Open AI, this tool provides access to over 1,237 electronic services, helping users fill out forms and suggesting services. Plans are for an improved version 2.0 that includes voice and video (Saraci, 2023).
- Digital Procurement Transformation: Law No. 162/2020 and Decision No. 285/2021 digitalized the procurement process using AI and machine learning, facilitating evaluations and increasing transparency.
- AI in the Judicial System: Albania is developing an AI algorithm to assist judicial processes by analyzing complex data and providing recommendations. The aim is to improve the efficiency of decision-making and the quality of justice (EuroSpeak Albania, n.d.).

Electronic government brings many benefits to citizens, businesses, and public administration. The main advantages include:

- Increased Efficiency: With the implementation of e-government services, administrative processes become faster and simpler. According to Article 6 of Law No. 43/2023, the "one-time delivery" principle reduces repeated requests for the same information, making it easier for citizens and businesses to receive services quickly.
- Data Availability and Interoperability: Article 8 of Law No. 43/2023 emphasizes the need to develop infrastructure that ensures data availability from public registers and system interoperability. This improves data sharing between institutions, leading to better decision-making and less duplication of effort.
- Transparency and Open Data: Article 7 promotes using open data principles to increase transparency and support the development of a data-based economy. Making data publicly available helps improve accountability and can reduce corruption.
- Security of Personal Data: According to Article 5, protecting personal data and securing information infrastructures are essential for building trust in electronic government. Ensuring data protection is a critical component of creating reliable digital services.
- Legal Equivalence of Electronic Documents: Article 15 confirms that electronic documents have the same legal status as physical documents, making it easier to conduct official business digitally and reducing reliance on paper-based processes.
- Centralized access through e-Albania: Article 14 defines the e-Albania platform as the central access point for online public services. This consolidation simplifies the user experience, enabling access to a wide range of services from a single platform.

The implementation of Artificial Intelligence (AI) in the Albanian public administration, according to Law No. 43/2023 on Electronic Government, faces several main challenges:

- Integration with existing systems: One of the main challenges is integrating AI with existing governance systems. Traditional public administration systems are often not built to support new technologies like AI. For this reason, a great effort is required to ensure interoperability between legacy systems and IA (Article 2, ç).
- Data security and privacy: Article 5 emphasizes personal data protection and information infrastructure security, including AI systems. This challenge is essential as AI processes a large amount of data, including citizen data. The implementation of IA must follow security standards to protect data from cyber-attacks and misuse.
- Ethical issues: Implementing AI in public administration raises ethical concerns such as transparency, fairness, and accountability. Article 12 regulates using personal data only for specific purposes, requiring that IA decisions be transparent and manageable to avoid possible bias.
- Technological infrastructure: Article 37 describes the need for a sustainable technological infrastructure to support IA. AI requires large capacities for data processing and storage. This section of the law requires the government to invest in infrastructure to ensure continuity of services, including recovery centers and data protection.
- Development of human resources and competencies: The success of AI implementation in public administration also depends on the preparation of human resources. Article 9 emphasizes the need to ensure that administrative staff are trained to use and manage AI technologies. Without a continuous development of technological capabilities, public administration will face difficulties in successfully using AI.
- Legal and regulatory compliance: Article 39 stipulates that AI technology should be used where possible but also requires that the technical and methodological standards set by the Council of Ministers be applied. This challenge concerns IA's obligations to comply with domestic and international legislation and ensure its use is transparent, fair, and ethical.

Legal background for AI in Albania:

- Law No. 10128, dated 11.05.2009, "On Electronic Government," regulates the use of information and communication technology in the provision of public services, including the bases for using artificial intelligence in administrative processes.
- Law No. 9918, dated 19.05.2008, "On Electronic Communications in the Republic of Albania" (amended) – This law may be related to the use of advanced technologies, including AI, in electronic communications, which are part of the public administration.
- Decision of the Council of Ministers No. 294, dated 10.05.2018, "On the Approval of the National Strategy for Information and Communication Technology 2018-2022" – The strategy includes using new technologies, including AI, to improve the functioning of public administration.

- Law No. 119/2014 "On the Right to Information" – This law is essential in public administration as it establishes the framework for access to information and transparency. Meanwhile, artificial intelligence can help improve access to information and the efficiency of this law.
- Se 20k (amended) – This law regulates personal data protection, a critical aspect when artificial intelligence is used in public administration to process and analyze sensitive data.
- National Strategy for Information Society and Communication Technology (ICT)—This strategy includes using new technologies, including AI, in public services.

Prospects for the use of Artificial Intelligence in Albania:

Increased transparency and efficiency: AI can significantly reduce bureaucracy and response time in administrative procedures. By automating some processes, AI significantly improves efficiency, eases administrative workers' work, and increases decision-making transparency. AI can identify patterns and make more objective decisions through data analysis, reducing corruption risks and unfair practices.

Automated and personalized services: AI enables personalized public services for citizens and businesses. Advanced AI systems can analyze individual requests and provide specific solutions in real time. Automating services such as filling out documents or responding to common requests will significantly improve the user experience and reduce service waiting times.

Technological advancement and digital transformation: By investing in AI technology and developing digital capacities, Albania can become a model for the region. This technology could help the country adapt quickly to EU directives and increase its capacity to cope with large data flows. If AI is used effectively, the Albanian public administration can step towards a more advanced and fully digitized governance.

5. CONCLUSIONS

This paper highlights Albania's notable progress in integrating Artificial Intelligence (AI) into public administration, evidencing benefits such as increased transparency, improved efficiency, and reduced bureaucracy. The country has achieved a high level of digitization, with 95% of public services available through the e-Albania platform, including key projects such as public procurement and virtual assistance. Despite these achievements, some significant challenges remain. These include integrating AI with existing systems, building a solid digital infrastructure, developing a skilled workforce, and addressing ethical and data security issues. AI also raises ethical issues that require clear legal and regulatory frameworks.

To address these challenges, the Albanian public administration should focus on investing in human resource development, ensuring that staff are equipped to manage AI technologies effectively. Protecting data security and privacy is essential to building public trust, requiring strong measures in line with international standards. Strengthening the digital infrastructure will further support the integration of AI, while the government should continue to develop regulatory frameworks to address ethical and legal considerations related to AI. A long-term strategy for adopting AI will position Albania for sustainable digital innovation and a modernized public administration.

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Publıc Organızatıon and Its Role in the Tourısm Sector in Turkiye

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Abstract

The organization of the tourism sector is crucial in Turkiye, one of the leading tourism countries in the world. Tourism mobility has influenced tourism activities in the public sector throughout history.The most significant steps in this organization were taken in the 1980s and continue in various forms today. The structure established as the Ministry of Culture and Tourism at the highest level directs the country's tourism. Another aspect of the tourism organization at the national level is the tourism offices established by local governments.The tourism sector in Turkiye, which is very robust, effectively operates through its sub-sectors, including accommodation, tourist guidance, food and beverage, and transportation. To oversee this entire process, the Turkish Tourism Promotion and Development Agency (TGA) was established on July 15, 2019. The accommodation, tourist guidance, and transportation services are governed by strong legal regulations in the public sector.The primary objectives of organizations in the tourism sector are to enhance inter-institutional cooperation, strengthen governance activities, address various issues faced by tourism, and contribute to the sector's development. The Ministry's main goal as the highest public organization is to protect and preserve tourism resources, especially cultural values, ensure their future viability, and transform them into tourist products. Additionally, it aims to make informed decisions that create economic value while enhancing the social and cultural aspects of tourism products. Ultimately, the goal is to guide public institutions and organizations related to tourism, collaborate with these entities, and advance the country's tourism by integrating local governments, non-governmental organizations, and the private sector.

Keywords: Turkiye, tourism, development, organization

1. INTRODUCTION

   Tourism is one of the most dynamically developing sectors of the global economy and national economies, considerably affecting the macroeconomic effects, measured by the share in the gross domestic product or the level of employment in entities involved in the creation of the tourist product. It is therefore an important area of socioeconomic policy. Specialized entities operate at individual policy levels, possessing competencies and instruments that enable shaping market relations in the tourism economy. Relations between policy actors and policy addressees (tourism enterprises and organizations operating in tourist areas) serve as a model and are shaped by the

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scope and manner of using the instruments (e.g. increasing interference or deregulation). Important functions in the system of tourism policy entities are performed by local self-government units: municipality, district and voivodeship. Their primary task is to influence socio-economic development, including tourism development, and on improvement of the competitiveness of tourism products. Regional and local tourist organizations and other organizations in this field have a special place in the subjective system of tourism policy. The role of these entities covers issues related mainly to supporting real processes on the tourism market and shaping cooperation between entities of the regional and local tourism economy. The activity of competent tourism policy entities in practice constitutes public tourism management at individual levels of public administration: government and selfgovernment and in macro- and mesoeconomic approaches.[1]For these reasons, countries that are ambitious about tourism must have the right organizational model to be successful.

It can be seen that the public sector has played a dynamic role in tourist activities, mainly in the construction of basic infrastructure and support equipment, aiming at the development and growth of this sector in the various tourism territories. On the other hand, it is the responsibility of territorial managers (governments and local authorities) to draw up strategic plans for tourism through specific public policies for the sector.The private sector is also essential in the affirmation of tourism, since it offers a large part of services and activities related to tourism, namely at the level of the subsectors that make up the value chain of this sector. The entrepreneurs through their investments on the territory will dynamize the sector of tourism at local, regional and national scale. It should be noted that public policies are fundamental in any territory geared to tourism, namely, the political strategies to adopt for tourism development and the defence of tourism products and resources that sustain the tourism phenomenon. It is the responsibility of public managers to determine priorities, create development models aimed at the short, medium and long term, and hotel entrepreneurs have the responsibility of creating the accommodation network.[2]

Organization is defined as a kind of shaped and regularized system in order to ensure that the work can be carried out more efficiently through the employees of a whole or an organization. Organization is a need for the individual and society, as well as an important need for those who hold the management. Because in modern management systems, the organization's goals are taken into consideration, as well as the demands and expectations of the employees. Understanding and implementing the importance of organization in terms of the individual and society can lead all individuals and those who hold the authority to beneficial results.

Structures that can organize their organizational systems according to the demands and needs of the employees, developments in the world and organizational goals have been successful and productive. This can increase scientific understanding, cooperation and productivity in society. It is important for individuals to have organizational awareness. Those with authority also need to understand the meaning and importance of organization. For these reasons, countries that are ambitious in tourism must have the right organizational model to be successful. Turkiye has a structure that is gradually strengthening in the field of tourism. It has realized this process with the organizational model it has implemented both inside and outside the country.

2. PUBLIC ORGANIZATIONS AND THEIR ROLES IN THE TOURISM SECTOR IN TURKIYE

With the historical development of the tourism sector in Turkiye, the need for organization of the public and private sectors has increased. In order to meet this need, tourism stakeholders, especially the state, have established various organizations. In the tourism sector, where accommodation, transportation and marketing processes are experienced in a basic sense, institutions and individuals who perform these professions have been organized. These organizations have emerged as public, semi-public and private sector organizations.

When evaluated specifically for Turkiye, the Ministry of Culture and Tourism is public, TÜRSAB and TUREB are semi-public, and institutions such as TÜROB and TÜROFED can be given as examples of organizations for the private sector. In addition to these four institutions, there are associations, foundations, unions and associations that contribute to the development of the tourism sector.[3] The largest of these organizations are as follows.

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[1] Aleksander Panasiuk Tourism management by public administration institutions Scientific Journal of the Military University of Land Forces ISSN: 2544-7122 (print), 2545-0719 (online) 2019, Volume 51, Number 2(192), Pages 364-376 DOI: 10.5604/01.3001.0013.2610

[2] Lemos Baptısta, M. Pocınho, F. Nechıta "Tourism And Public Policy" Bulletin Of Thetransilvaniauniversity Of Braşov Series V: Economic Sciences • Vol. 12 (61) No. 1 – 019 https://Doi.Org/10.31926/But.Es.2019.12.61.1j.M. s.366

[3] Yayla İ. Ulusal ve Uluslararası Turizm Örgütleri, Nobel Yayıncılık, Ankara 2023 s.5

2.1. The Ministry of Culture and Tourism

The Ministry of Culture and Tourism consists of central, provincial and overseas organizations and affiliated institutions. The central organization includes main service units, advisory and auditing units, auxiliary units and affiliated institutions.

The Ministry of Culture and Tourism was established by the Presidential Decree No. 1 on the Organization of the Presidency dated 10.07.2018. The duties and authorities of the Ministry of Culture and Tourism are as follows: (ktb.gov.tr,15.11.2024)[4]

a) To research, develop, protect, sustain, evaluate, disseminate, promote and adopt national, spiritual, historical, cultural and touristic values and thus contribute to the strengthening of national unity and economic development,

b) To guide public institutions and organizations related to culture and tourism issues, to cooperate with these organizations, to develop communication and cooperate with local governments, non-governmental organizations and the private sector; to provide cash assistance to projects to be carried out by associations and foundations whose main purpose is culture, art, tourism and promotional activities, and private theatres, except for associations established by local governments, public institutions and organizations or to support public personnel and foundations established for the same purposes in accordance with the Turkish Civil Code No. 4721 dated 22/11/2001,

c) To protect historical and cultural assets,

ç) To evaluate, develop and market all tourism-friendly opportunities of the country in order to make tourism a productive sector of the national economy,

d) To direct all kinds of investment, communication and development potential in the fields of culture and tourism,

e) To procure real estates related to culture and tourism investments, to expropriate them when necessary, to conduct or have them conducted,

f) To carry out promotional activities for Turkiye's touristic assets in all areas and to conduct promotional services related to culture and tourism by utilizing all kinds of opportunities and tools,

g) To perform other duties assigned by laws or presidential decrees.

The Ministry of Culture and Tourism of the Republic of Turkiye acts as the sole decision-making authority in matters related to tourism in the country. It also has various fields of activity under its authority and responsibility. The Ministry of Culture and Tourism of the Republic of Turkiye carries out all work within its field of activity through its central, provincial and overseas organizations. It is responsible for the execution, coordination and supervision of tourism activities in and outside the country through Provincial Directorates of Culture and Tourism located in 81 provinces throughout the country and Foreign Culture and Promotion Consultancies located in 46 different cities in 43 countries.[5]

The current tourism organization in Turkiye, consisting of the Ministry and provincial organizations, seems to be far from the ability and possibilities to effectively and efficiently fulfill many of the tasks and functions assigned to the tourism organization by the relevant Law. Unfortunately, the current system is seen to be a bureaucratic and formalistic organizational structure that is far from professionalism and functionality, cannot promote and market in accordance with the norms required by globalization, and is based on shallow incentive use practices. This study, which proposes a destination-based communication, tourism promotion and marketing organization model for Turkiye, focuses on a dynamic organizational system that will prevent the repetition of old perspectives in the sector. This system is based on an organization that is capable of producing the necessary communication strategies, tactics and policies for the development of tourism in Turkiye and its ability to produce economic and social benefits.

2.2. The Association of Turkish Travel Agencies (TURSAB)

The Association of Turkish Travel Agencies was established in 1972 with the law numbered 1618 and is a professional organization with the qualifications defined in Article 135 of the Constitution and has the status of a public institution. Since the title of "Travel Agency" cannot be acquired without being a member of TÜRSAB, it is one of the largest professional organizations in Turkiye, organized in 36 regions, of which all travel agencies in Turkiye are members[6].

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[4] https://www.ktb.gov.tr/TR-96130/kurulus-ve-gorevler.html
5 Katırcıoğlu, E., Pelit, E., & Keleş, Y. Türkiye Cumhuriyeti tarihinde turizmde kamu düzeyinde örgütlenme ve istihdam ile ilgili sorunlar. Balıkesir Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 26(49-1), 611-627.
6 The Association of Turkish Travel Agencies 15.11.2024

The vision of TURSAB is as follows:

TÜRSAB has been developing a sustainable and innovative system which is suitable for the digital age to provide, a more active, stronger, and better role for their members in the national and international platforms; to contribute to the profession of Travel Agency and the tourism industry in Turkiye. With this perspective, the Association has embarked on the Global Ethic Codes for Tourism which are determined by the Turkiye Tourism Goals, United Nations Sustainable Development Goals, and World Tourism Organization (UNWTO).

The missions of TURSAB is as follows.

The Association effectively represents the tourism sector and increases social consciousness. It takes an active role in developing legal restrictions. In addition to that, it helps to develop the performance of their members and staff. It regulates the environment of competition. It raises the service standards in the sector by organizing training activities that will contribute to the professional development of Travel Agencies. The values of TURSAB is as follows: Reliability, Impartiality, Transparency, Stability, Accessibility, Proactive, Team Spirit, Quality Orientation, Social esponsibility, Environmentally Friendly

TURSAB's Quality Politics basic duties are as follows:
• It complies with law and legislation as a source of law.
• It contributes to and supports the professional development of its members (travel agencies).
• It works to rise the motivation and productivity of its employees.
• As an institution, it follows the technological developments in the world and acts under its requirements.
• Takes care to protect human health and safety and the environment and acts towards this purpose.
• It carries out its activities by making all its processes sustainable and continuously improving them. It also undertakes to take the necessary actions to implement the conditions and standards that will develop in this field.

TURSAB is one of the oldest tourism organizations established in Turkiye. It is the legal authority for the establishment and operation of travel agencies. It is a professional association that draws attention to the problems experienced in the tourism sector and draws the attention of relevant institutions and organizations. The association, which aims to inform the public about the developments and problems experienced in tourism, also aims to contribute to the development of the travel agency profession.

2.3. The Tourist Guide Association (TUREB)

The Tourist Guides Association (TUREB) works with all its units established in accordance with the Tourist Guides Profession Law No. 6326 to ensure that guides take a more effective and competent role in the country's tourism, to promote the country in line with its cultural and tourism policies, and to prevent illegal guide activities. The purpose of this law in Law No. 6326 is to regulate the procedures and principles regarding admission to the tourist guide profession, the practice of the profession, and the establishment and operation of tourist guide professional organizations. Its other purpose is to cover the procedures and principles regarding admission to the tourist guide profession, in-service training and the practice of the profession, the establishment of tourist guide chambers and tourist guide chamber unions, the qualifications and elections of their bodies, the cases and procedures for losing their organ status, their duties and authorities, their working procedures, their mutual rights and obligations with their members, their income and expenses and budgets, the duties and authorities of the Ministry of Culture and Tourism regarding the profession, cooperation with professional organizations, and the supervision of tourist guide professional organizations by the Ministry[7].

The union carries out various activities in order for tour guides to see the value they deserve and to take an active role in tourism. The main objectives of the union are to ensure that tour guides are introduced in line with the country's cultural and tourism policies and to prevent illegal tour guide activities. The union also organizes specialty certificate programs and individual certificate programs to ensure the development and training of tour guides.[8] The center of the union is in Ankara.

Within the scope of Article 4 of the Tourist Guide Profession Regulation No. 28568 dated 23 February 2013, TUREB, together with TURSAB, is responsible for the training of guides needed by the sector by organizing national or regional certification programs under the supervision of the Ministry, conducting trainings regarding the field specialization of tourist guides, and conducting inspections that are repeated at intervals to prevent

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[7] https://www.tureb.org.tr/Sayfa?id=12 15.11.2024
[8] Şahin, S., & Ünal, A. (2016). Uluslararası ve Ulusal Turizm Kuruluşları. 2016 - Paradigma Akademi Yayıncılık s.271

irregularities that may cause guides to lose their rights under the supervision of the Ministry. 9 (tureb.org.tr, 15.11.2024).

TUREB works with the ministry, universities, other professional organizations and stakeholders in the development of policies aimed at strengthening and developing the tourist guiding profession, which plays an important role in the sector. It determines the fee schedules of its members who practice the guiding profession and undertakes the task of announcing them to the sector. TUREB carries out cooperation activities with international professional associations. In this context, it is a member of the World Federation of Tourist Guides Associations (WFTGA) and the Federation of European Guides Associations (FEG).

2.4. Turkish Hoteliers Association (TÜROB)

TUROB is a non-governmental organization founded by representatives of the accommodation sector. It was established as an association and aims to contribute to the development of the sector. It was formed by the coming together of hotel operators who are very important in the tourism sector.

ÜROB was founded in 1971 with the name of Marmara Region Tourist Hoteliers Association (T.O.D) and 13 people. This association, which operated until 1983, continued its activities as Tourist Hoteliers, Operators and Investors Association (TUROB) upon the change in the Associations Law. TUROB officially took the name of Turkiye in 2015 and continues its activities as TÜROB (Turkish Hoteliers Association).[10]

The main purpose of TÜROB is;

• To conduct scientific and practical studies on tourism-related issues, problems and solutions and to contribute to such studies,

• To ensure the development of tourism and touristic facilities in accordance with the requirements of tourism and changing trends,

• To ensure coordination among its members and with departments, institutions, organizations and individuals related to tourism,

• To represent its members within and outside the sector,

• To work on necessary measures, planning and projects by following national and international developments.

On the other hand, in line with the changing dynamics, TÜROB provides continuous and up-to-date information flow in many areas, primarily education, investment, promotion & marketing, development of sector standards, auditing, innovation, information/data/analysis/reporting, sustainability, law and financial consultancy, and conducts lobbying activities domestically and internationally to protect the interests of the sector.

The Turkish Hoteliers Association TÜROB; is a dynamic, comprehensive and deep-rooted non-governmental organization of Turkish tourism, with qualified hotel and tourism businesses that are aware of acting together as members since the day it was founded in 1971.

TÜROB is a member of the Board of Directors of TUGEV (Tourism Development and Education Foundation), ICVB (Istanbul Convention and Visitors Bureau) and TURÇEV (Turkish Environmental Education Foundation) and carries out joint projects and studies with all public institutions and the private sector, especially non-governmental organizations operating in the tourism sector.

In the international arena, TÜROB is a member of the European Hotels, Restaurants and Cafes Association (HOTREC). TÜROB, which has many touristic facilities throughout Turkiye, is the most established non-governmental organization representing the accommodation sector, provided that it has an Investment/Operation Certificate from the Ministry of Culture and Tourism of the Republic of Turkiye. The organization established as an association, its operation, main purpose, membership acceptance, management and audit board memberships, representations, etc. processes are explained in the statute. The center of the association is Istanbul.

2.5 Turkiye Tourism Promotion and Development Agency (TGA)

TGA is a relatively new organization in terms of its establishment history. It is an organization established with public support to contribute more effectively to the development of the tourism sector. It consists of management, executive and advisory boards.

The Agency, established by law, is an organization of the Ministry of Culture and Tourism, which is the public authority in the field of tourism in Turkiye. It is governed by private law rules. Members of professional organizations related to tourism in Turkiye and the Ministry of Culture and Tourism are involved in the formation of the Agency.

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[9] https://www.tureb.org.tr/Sayfa?id=12 15.11.2024
[10] https://www.turob.com/tr/hakkmzda/tuerob-hakkinda/ 20.11.2024

The Turkiye Tourism Promotion and Development Agency (TGA), established on July 15, 2019, continues its work with the aim of making Turkiye a brand and center of attraction in the domestic and international tourism market, discovering, developing and promoting tangible and intangible natural, cultural, biological and human heritage, increasing Turkiye's tourism capacity and the share of tourism investments in the country's economy and service quality through short, medium and long-term communication/marketing studies. The agency will carry out all promotion/marketing/communication activities regarding Turkiye's achievement of tourism targets, promotion and marketing of existing tourism opportunities worldwide, and discovery, development and introduction of potential tourism opportunities in line with the tourism strategies and policies determined by the Ministry of Culture and Tourism.[11]

The Board of Directors consists of 18 people who have come together under the presidency of the Deputy Minister of Culture and Tourism of the Republic of Turkiye. The Executive Board, which is the executive body, consists of 5 people, including the Deputy Minister responsible for the General Directorate of Promotion, the General Director of Promotion, and 3 people selected by the Minister from among the Board Members.

The Board of Directors consists of a team that is experienced and has a say in the field of tourism. The Turkish Tourism Promotion and Development Agency (TGA) aims to contribute and reinforce Turkiye's position in the international market and to make Turkiye a globally talked-about brand with all its activities. It works to increase the number of tourists coming to the country and their profitability, to facilitate the implementation of potential investment projects for the tourism sector and to contribute to the development of cities.

The agency obtains funds from within the sector in order to carry out tourism activities. 85% of the agency income is used to promote the country's tourism, while 15% is used for other work and transactions. The agency's income consists of 5 different sources and according to Article 6 of the Law on the Promotion and Development Agency of Turkiye, the agency obtains funds from some tourism enterprises under the name of "Tourism Share".[12] (Türkiye Tanıtım ve Geliştirme Ajansı Kanunu, Madde 6).

The Turkish Tourism Promotion and Development Agency (TGA) was established based on the Law. TGA has mobilized a dynamic promotion and marketing approach by taking into account the developing information technologies in tourism. It has become an organizational model that creates funds for public activities. In this way, the ministry has gained the opportunity to act as a private sector on behalf of the public. It has been authorized to develop strategies for tourism, which is a dynamic sector, to determine the needs of the sector, to activate tourism potential, etc. and to carry out activities quickly and in accordance with the purpose. Considering the fields of activity of TGA, which can be considered new, it is evaluated that it will undertake an active role in the organization of Turkish tourism.

2.6. Other Tourism Organizations

Apart from the tourism organizations mentioned above, there are many organizations that aim to contribute to the sector. The main ones are the Turkish Hoteliers Federation (TÜROFED), Turkish Truing and Automobile Association (TTOK), Turkish Tourism Investors Association (TTYD), Tourism Development and Education Foundation (TUGEV), Tourism, etc., which operate at the country level.

There are approximately 17 unions under the title of "accommodation and entertainment businesses" in the tourism sector among the business lines where unions can be established. The number of unionized members is 53,568 and the sectoral rate is stated as 3.96%.[13]

In addition, in recent years, municipalities that want to be present in the tourism sector have established tourism units within their own structures. Municipalities, especially metropolitan municipalities, that want to create a competitive advantage in the tourism sector are establishing tourism organizations. Good examples of this can be seen in many municipalities in Turkiye, especially Konya Metropolitan Municipality.

2. CONCLUSION AND SUGGESTIONS

The tourism sector in Turkiye also consists of stakeholders with different interests. There is a need for organizational models based on public, mixed and private sector cooperation. Turkiye, which has seen this gap in the last 10 years, has established TGA. Thanks to this agency, it carries out its promotional and marketing activities faster and more effectively. The organization is the center of the interactions, interdependencies and cooperation network between public, mixed, private and social actors. The ministry, which is the central tourism authority, wants

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[11] https://tga.gov.tr/hakkinda 18.11.2024
[12] Türkiye Tanıtım ve Geliştirme Ajansı Kanunu, Madde 6
[13] https://sendikadata.com/iskolu/18-nolu-iskolu-18 15.11.2024

to make other stakeholders active together with the agency. The development of Turkish tourism starting from 1980 can be explained by the existence of these tourism organizations. Therefore, thanks to the organization, the principles, norms, procedures and practices for coordination and cooperation in the realization of the goals collectively agreed on about common goals have been implemented faster and more effectively.

Non-governmental organizations operating in the field of tourism in Turkiye can also operate with different organizational structures such as federations, unions and associations. Especially professional organizations such as hotels, investors, food and beverage businesses, travel agencies and tourist guides have contributed to the development and sustainability of professional standards.

Tourism, which affects many sectors, has faced intense competition at the global level. In this period when world tourism activity is increasing, each country is looking for more successful organization models for itself. It has focused on new management, implementation, decision-making processes and marketing studies that will create competitive advantage. The main purpose of the organization systems of countries is to ensure that the tourism products they have reach the right target audience in a sustainable way. Turkiye's tourism organization system is to carry the tourism potential to the future in an effective, efficient and sustainable way. The organization process is developing by taking into account the tourism organization models in the world. [14]. Developing information technologies can change the understanding and forms of organization.

The organization of tourism in the public sphere in Turkiye has been shaped within the framework of a central understanding. The growth of the tourism sector and the differentiation of the functioning in the sector as a result of the increasing responsibility have also made governance difficult. However, although there is a differentiation in the works according to the needs in connection with the increase in tourism diversity, no change has been made regarding the management of these works with the central management understanding; all authority and responsibility have been gathered within the body of the Ministry of Culture and Tourism of the Republic of Turkiye.[15]

Today, tourism organizations have become important institutions that guide the tourism sector, identify the problems of the sector and try to develop solution suggestions, bring together sector representatives and businesses under the same roof and increase communication and cooperation.[16]. The importance of tourism is increasing both nationally and internationally. The effects of tourism on the economic, social and physical environment also mobilize local governments. Especially the widespread use of destination-based tourism has led to the establishment of strong tourism units in municipalities. Non-public organizations reduce the burden on the public and provide them with support. The dynamic nature of tourism sometimes creates problems between organizations. The solution to these problems is that the organizations have the status of ministries, agencies, federations, foundations, unions, unions and associations.

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A Research to Determine the Thoughts of Hotel Managers About Gastromi Tourism

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Abstract

The aim of this study is to determine the perceptions of hotel managers about gastronomy & tourism relationship and their thoughts on gastronomy tourism. Although there are many studies on gastronomy and gastronomy tourism in the literature, there are not many studies on the ideas of hotel managers on the subject. In this context, the study is important and is thought to contribute to the relevant literature. In order to collect data, the interview method, one of the qualitative research methods, was used. In the study, the relevant literature was rewived and an interview form was created based on the literature. Five -star hotel managers in Konya, one of the important cities of Turkey in terms of history, culture and art, were asked questions, answers were recorded, evaluated and results were reached through face -to -face interviews. In the study, it was concluded that hotel managers have positive perceptions of gastronomy tourism, and at the same time, hotel managers think that gastronomy elements are useful for hotel businesses for promotional, marketing, competitive advantage and different types of customers. In addition, although hotel managers think that gastronomy activities in the region contribute to the fullness of hotel rooms and the hotel's profitability, it was concluded that there are not enough activities for gastro tourists in hotel businesses. Recommendations were made to hotel managers in line with the results obtained.

Keywords: Gastronomy, gastronomy tourism, hotels, hotel management

1. INTRODUCTİON

In the tourism sector, the kitchen is starting to gain a feature that includes traditional values as well as traditional values with the rapidly differentiating customer trends in recent years. These values are shown as respect for culture and tradition, a healthy lifestyle, originality and sustainability. Gastronomy plays an active role in the development and diversification of the tourism sector. Although gastronomy tourism is encouraging in economic development of the local people, it creates new employment for different professional sectors such as manufacturers, suppliers,

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chefs, markets and therefore becomes an indispensable element in the culture and lifestyle of a region in recent years [1].

"The phenomenon of eating to live, living for food" with the transformation of the situation in recent years, the understanding of eating has been changing and people have eating habits in different places outside their homes. Thus, eating becomes a social purpose beyond a physiological need. The realization of the tasting of new, different and local flavors, the creation of awareness of the region and the recognition and experience of them by visitors also play an important role in the preference of the region or region for some visitors. In addition, regions with rich culinary culture frequently benefit from gastronomy to distinguish the country and geography in which they are located [2].

In a study conducted by the *"Türkiye Gastronomy Association",* the increase in the interest of tourists in gastronomy tourism increases the amount of expenditure for food and beverage. Foreign tourists coming to the country for holiday purposes allocate 20 % of the total expenditures to eating, while foreign tourists who come for gastronomy tourism devote 27 % of their expenditures to eating. Gastronomy tourists spend 1 and a half times more money for other foreign tourists on eating and drinking. This shows that gastronomy tourism offers a good solution to increase revenues from foreign tourists. Gastronomy tourism is an effective tool in the development of the economy, so it can be concluded that gastronomy is a very important expenditure item in the tourism sector [3].

Gastronomy activities are also used by hotel businesses to attract tourists and make a difference in competition. In addition, gastronomy activities provide a positive image to hotels and play an active role in the formation of customer loyalty [4]. At the same time, hotels, usually the first stop point of people on travel, the first food experience areas in the destinations they have gone, it is necessary for hotel managers to have sufficient knowledge of gastronomy and gastronomy tourism and use this information in business management. For this reason, a research is conducted to determine the thoughts of five -star hotel business managers in Konya on gastronomy tourism. The research is firstly scanned by the relevant literature and then the information is obtained from the managers by interview method and the results are evaluated and the results are reached..

2. CONCEPTUAL FRAMEWORK

2.1.Gastronomy

Firstly, the term gastronomy used by French writer Joseph Berchoux in 1801, as a word meaning in Latin [5], *"Gastros"* (stomach) and *"nomos"* (rule) or the word *"Nomy"* derived from the word "*Food La*w", Means *"law or regulation"* [6], [7].

Gastronomy is defined as a discipline that examines the relationships between food and culture. Regarding gastronomy; It is also possible to make definitions such as "*fondness for good food",* "the art of good food" and "food science [8]. In short, the subject of gastronomy, which means *"eating and drinking"* and *"setting up table",* constitutes the subject of renewable substances ready to eat in accordance with eye pleasure and health ([9]. In addition, Gastronomy, according to a French definition in Larousse Gastronomique (1988); "Curiosity to eat well", "suitable for health", "well -edited", "pleasant and delicious kitchen", "food layout and system" means [10].

Hundreds of years of food experience and taste accumulation, It transforms the food, which is a requirement of life, into a phenomenon of pleasure and pleasure. The pleasure of flavor and visuality ensures the recognition of the importance of gastronomy term today and causes this term to be seen as a science. Gastronomy, which is seen as science, is also interacted with various disciplines such as anthropology, sociology, economy, chemistry, agriculture, environment-science and medical sciences [6].

Although it is a discipline that investigates and examines the relationship between gastronomy, culture and food [5]. it is generally focused on the food dimension of gastronomy. The concept of gastronomy dates back to a very well -established past. Therefore, it should not be considered only as food. The process since the existence of human beings to the present day requires gastronomy as a culture. When the cultural dimension of gastronomy in the historical development process was examined, it led the discovery of agriculture after *"hunting"* and *"gathering",* and it enabled the identification of power structures with the enrichment of the culture of eating and drinking of societies. In short, all developments in the life of human beings have a culture of eating and drinking. The concept that develops with the understanding of eating good food over time includes a process in which the products used in food production are collected from the fields, the collected products are processed and cooked by making them harmoniously and cooking and caressing the pleasure of the people [11].

Gastronomy, which expresses all the rules and norms related to eating and drinking, is blended with culture, history, talent and experience. The concept of gastronomy also means local products, culture, lifestyle and sustainable values. For this reason, the concept of gastronomy includes all values such as culture, healthy lifestyle,

traditions, originality, sustainability and experience. In short, gastronomy; Describing how to use the materials used in food and beverage, revealing the similarities and differences between different culinary cultures, the taste taken from a meal to the peak point and to present history, culture and dinner together is a branch of science [12].

2.2 Tourism and Gastronomy Relationship

Tourism; According to Brotherton & Wood (2000: 137-143); It is defined as hosting guests, taking care of them, providing them with their comfort, meeting the needs of accommodation and eating and drinking. This definition is the traditional hospitality concept defined as *"Presentation of Food, Drink and Accommodation or, in other words, to meet the basic needs of the person while it is away from the person's home"*. This concept is evaluated in "cultural tourism" in foreign literature. Eating and drinking usually occurs in sub-purposes during a visit to a destination of tourists. However, recently preference has been among the alternative tourism types as the primary purpose of gastronomy tourism with special interest tours created by the preparation, cooking and presentation of local food and beverages [13]

Tourism activities have been carried out for many years within the scope of sand, sun and sea tourism. Over time, changes in tourism trends have directed people to alternative tourism types. As a result of the relationship between gastronomy and tourism, alternative tourism types and gastronomy tourism have emerged. For this reason, when it is evaluated from a tourist point of view, gastronomy is referred to as a type of tourism and covers all kinds of eating and drinking activities specific to any touristic destination visited. Gastronomy tourism sees to explore, taste and feel all gastronomic products as the main purpose. In addition, gastronomy tourism; Learning all kinds of information about gastronomy tourism is also defined as traveling to a certain destination to experience experience [14],[15]. In short, gastronomy tourism creates their experiences that tourists will gain through tourist destinations, especially by enjoying food and learning the kitchen processes in each region. At the same time, gastronomy tourism has effects on culture, society, environment and economy. For this reason, gastronomy is of great importance in modern tourism, which constitutes the basis of the strategies and policies of every country that includes the tourism and accommodation industry[16].

Gastronomy tourism, for the first time by Long in 1988 by the aim of expressing tourists can experience other cultures through meals was put forward [17]. Over time, it was used with different expressions such as *"Culinary Tourism", "Tasting Tourism"* and *"Food Tourism"*. In terms of gastronomy, tourists are divided into two separate groups. Tourists in the first group, tourists who visit the region and engage in activities such as consuming local products and purchasing products and cookbooks during their visits, and those in the second group are tourists visiting gastronomic values professionally with the awareness of gastronomy tourism. In addition, various gastromi festivals and symposiums are organized within the scope of gastronomy tourism. Within the scope of these activities, loyal guests can be created and gastronomy activities contribute to the prolongation of the tourism season [18], [19],[20].

With the economic added values of the increasing competition and tourism sector to the economies of the country between the touristic regions, local, cultural and traditional values become an increasingly valuable resource to attract and entertain tourists [15]. For this reason, gastronomy contributes to both touristic destinations and the possibility of increasing tourism revenues by using the gastronomic elements they have and the formation of new tourism markets in terms of destinations [11]. At this stage, local products and gastronomic values come to the forefront in tourism, the desire to experience different products from new and existing tourist products, the return to the place of the place and the increase in interest day by day makes gastronomy a target part of a regional visit. In recent years, gastronomy against globalization movements have become the center of attention of the masses with the demands of sensitive consumers who are in the desire to return to the localization. The interest in tourism experiences and charm, including the food element, has grown in recent years [15].

Gastronomy tourism is a form of tourism to gain new and sometimes traditional food experience. The rapid disappearance of cultural values reveals the necessity of traditionalizing cultural values to future generations. Among the cultural values, the meals specific to the region and the presentations of these dishes are special day celebrations and presentations in these celebrations are starting to gain great importance all over the world. Tourism activities lead to the spread of gastronomy tourism and destinations provide competitive advantage. Some countries begin to evaluate gastronomy tourism as the most important part of the cultural values of their countries and the tendency of gastronomy tourism all over the world is increasing day by day [12]. In addition, the phenomenon of eating outside is interpreted by the tourists on vacation as the experience of the local heritage by consuming and compared to the experiences experienced while visiting the historical places and museums. When tourists return to their homes, they contribute to gastronomic mobility by creating a demand in their own countries in their own countries. The fact that the share of gastronomy in the travel budget is large, the high income creative power in

terms of tourism, the support of local development, the fact that it is a cultural heritage that provides cultural heritage and alive for sustainable practices makes it attractive to evaluate gasronomer as a touristic product [15].

In general, some of the benefits of gastronomy activities in terms of tourism enterprises can be listed as follows [1], [15], [21].

Creating new sources of income to regions,

- Increasing the attractiveness and awareness of destinations,
- Provides competitive advantage to destinations
- Helping to recognize cultural values,
- Helping accommodation time to prolong,
- Can be applıed ın all season,
- Extending the tourism season,
- To contribute to the marketing and promotion of accommodation businesses,
- To positively affect guest satisfaction in accommodation businesses,
- Diversify tourism,
- To ensure equal distribution of tourism demand between different destinations within the country,
- To create new infrastructure and services or to be an activating factor for the development of existing services and infrastructure,

2.3. Hotel businesses and gastronomy relationship

There is a strong interest in food in terms of gastronomy and kitchen tourism, and often food is the primary motivation in the travel preferences of tourists. In some cases, when gastronomy is considered an integral part of tourism experience, it plays a decisive role in the selection of destination as the main travel motivation of tourism. In order to ensure the growth of the tourism sector and to increase the diversity and to attract the audience which is defined as 'quality tourists ,, the attractiveness of gastronomy is also used [22], [23]. For the overall success of the destination, there should be a good cooperation between all stakeholders (hotels, manufacturers, fishermen, markets, fish markets, restaurants, tour operators, public, etc.) in the value chain of gastronomy tourism [1].

Although gastronomy was thought to be related to the hotel industry until the 1990s [24]. Gastronomic values are generally produced in food and beverage units of hotels in terms of gastronomy tourism. Accommodation is one of the important needs for travels within the scope of gastronomy tourism. Gastronomy has a strong impact on guests' evaluations of the hotel quality and also affects the quality of touristic destinations. Gastronomy has an impact on hotel enterprises on high price payment of consumers [25], [26]. Hotels are also one of the important actors of gastronomy branding. Hotels are located at the intersection of tourism and gastronomy fields and has a great potential in terms of the creation and promotion of gastronomic space brands [27].

Hotel gastronomy activities; Individual and group customers staying in hotels, conferences, symposiums, company activities, business meetings, dinner -oriented celebrations, feasts, buffets, family trips and other dinner activities, etc. activity types. The service range offered by hotel restaurants varies depending on a number of factors such as the quality, size, location of the hotel and the quality of the market. Restaurants operated by hotels increase the quality of the total hotel experience by providing extra income to hotels and providing additional employment, as well as providing quality dishes to hotel guests and other customers. A good hotel restaurant improves the general image of a particular hotel. In order to succeed in a very competitive market, hotel owners must face various difficulties. At the same time, consumer expectations are increasing. This increase increases the pressure on hotels. It is based on customer satisfaction in the field of hotel services such as success, accommodation, food and other services in the hotel sector. Hotel guests consider restaurant services when choosing a hotel [28]. Based on this situation, accommodation and gastronomy services cannot be considered different from each other.

When the literature is reviwed, it can be achieved that studies are carried out on different subjects including gastronomy and gastronomy tourism. Some studies are as follows; .

Rural tourism and gastronomy [2] sustainable gastronomy tourism [22], gastronomy concepts and gastronomy tourism [18], [21], [51], gastonomi tourism experiences and thoughts of tourists in Turkey [14], [29], gastronomy and education [30], [31], destination and gastronomy tourism [32], gastronomy festivals in the development of gastronomy tourism [33], gastronomic destinations, local kitchen relationship [34], gastronomic ımage [35], foreign harmony and country Gastronomy [36] gastronomy and entrepreneurship [37]. At the same time, gastronomy tourism features of different regions and gastronomy and cultural tourism examination of the subject of the study [38], [39], [40], [41], [42], [43].

Some studies and results of gastronomy tourism and hotel businesses are as follows;

Kapera (2015) conducted a research on *"Hotel Gastronomy as Viewed by Customers"*, and 44 percent of the participants have reached the results that the quality of restaurant services are partially effective in the hotel elections, the quality of food and the gentle of the personnel in the selection of hotel restaurants [28].

Gordin, Trabskaya & Zelenskaya (2016). They conducted a research on "The Role of Hotel Restaurants in Gastronomic Place Branding" and concluded that gastronomic branding increases the attractiveness of hotels, restaurants and destinations in general [44].

Demirbilek, Şengül & Akoğlu (2018) In a five -star foreign chain hotel business operating in Ankara, they conducted a research on "Evaluation of Gastronomy Tourism Perspectives of Hotel Managers" to determine the views of the managers of that business on gastronomy tourism and gastronomy tourism in the study It has been achieved that there is a competition tool in marketing for hotel businesses, that the coordination of hotel departments will be successful in gastronomy and that they have important to include local products in their menus [45].

Gajic et.al., (2022), *"Gastronomy offer ın a functıon of creatıon and co-creatıon of a recognızed hotel brand - ıllustratıons from Hotel Crnı VrH"* including a research. They have reached the conclusions that gastronomic elements are effective in re -visiting the destination [46].

Espino-Rotriguez & Berdejo-Farina (2023) *"The Barriers and Enablers Affecing Innovation in Hotel Gastronomy and Its Impact on Performance"* they have done a research on the performance of gastronomic innovation, but there is no significant negative impact of the internal and external obstacles, they have reached the result. In addition, it is concluded that focus on gastronomic innovation increases financial and non -financial performance according to research findings [26].

Labibe, Morsy & Zaki (2023) conducted a research to examine the management perception of food tourism concept and marketing role and to determine the benefits and difficulties of food tourism in "Luxor" and "Aswan" hotels. According to the findings of the research, the majority of managers the concept of gastronomy tourism; "It is any touristic experience in which the brand's brands are tried or consumed". In the study, it is concluded that the dishes are not recognized by the managers sufficiently, the lack of marketing, the cautiousness of guests to try food, and the lack of gastronomy festivals are seen as a problem in terms of gastronomy tourism. Either ways, foods and beverages have a significant contribution to touristic activities, and the inclusion of some traditional foodstuffs to menus is a good idea for the accommodation industry in Egypt [47].

Leite-Pereira, Brandão & Costa, R. (2023) have done a research to know what the preferences of the guests and how it changed according to their characteristics. They have reached the results of their preferred dairy products [48].

In general, there is not much studies for hotel businesses or hotel managers on gastronomy and gastronomy tourism issues in the relevant literature.

2. METHODOLOGY

In the study, qualitative research approach was used. Qualitative research; *"It is a method of researching methods such as interview, observation, and document analysis, to understand the events in a holistic and realistic way in the natural environments of the events and to examine the events in depth"* [49]. Thus, it is thought that the views of hotel managers about gastronomy tourism can be examined in depth and detailed data on the evaluation of the perceptions of gastronomy tourism can be reached.

3.1. Working Area, Importance and Purpose of the Study

Konya has existed to the present day as one of the most important ancient cities in the world throughout history. It is understood that the settled city life started in the prehistoric (prehistoric) era, which is located close to the city center, Çatalhöyük is known as the oldest and most developed Neolithic Period Settlement Center. Çumra Çatalhöyük is known as the center where agriculture was made for the first time in the world, fire was used, settled life started, food culture started and common defense against wild animal attacks. Similarly, neolithic traces of Çatalhöyüğı are found on the *"Hill of Alaaddin"*. During the excavations in the region, the findings of Phrygian, Hellenistic, Roman, Byzantine, Seljuk and Ottoman settlements were obtained. Ethnic group differences in the structure of belief and thought brought about the region and designed the region in the light of differences [50]. During the periods of history, the Hittites found a large empire in Anatolia and Syria territory and dominated Konya. Konya, which is an important trade and mansion center on the Silk Road of the Seljuk State extending from the Chinese border to the Byzantine trains, is also an important center where the Islamic scholars such as *"Mevlana"* grows [55].

The aim of the study is to determine the perceptions of 5 - star hotel managers about gastronomy and tourism relationship and their thoughts on gastronomy tourism. Although there are many studies on gastronomy tourism in the literature, there are not many studies on the ideas of hotel administrators on gastronomy tourism. In this respect, the study is important and is thought to contribute to the relevant literature.

The universe of the research is the five -star hotel managers in Turkey. Since it is difficult to reach all the five -star hotel managers in Turkey, the five -star hotels in Konya, which is one of the important tourism centers with its history, culture, nature, handicrafts, gastronomic values and thematic parks in Turkey, are taken as samples. All of the hotels were reached and ten administrators were discussed face -to -face.

3.2. Data Collection Method and Data Analysis

In semi -structured interviews, the participants can speak freely according to various perspectives on the subject [52]. For this reason, the method of interviewing from qualitative research techniques was used in the collection of data in order to identify the ideas of hotel managers about gastromi tourism ". The interviews were performed face - to -face using the "semi -structured interview form". In the preparation of the interview form, the relevant literature was reviwed, Demirbilek, Şengül & Akoğlu (2018) were used, and the final version of the questionnaire was given by discussing with the experts of the subject. [45]. Participants (K1, ……. K10) coded, the answers given to the questions were noted and evaluated by analyzing.

2.3. *Finding*s

There are ten five-star hotels in Konya [56]. In this section, the demographic characteristics obtained from the interviews with five - star hotel managers and *" the data obtained from eleven questions asked to determine the ideas of the managers about the contributions of gastromi tourism and gastronomy elements to hotels ".*

Table 1: Findings on the demographic characteristics of the participants (K)

K ↓	Gender	Age	Marital status	Title in the workplace	Graduation status	Service time in the sector
K1	female	28	Single	Sales & Marketing Manager	University graduate	5
K2	female	28	Single	F&B Manager	University graduate	6
K3	male	44	Married	General Manager	University graduate	29
K4	male	55	Married	General Manager	University graduate	30
K5	male	42	Married	F&B Manager	University graduate	21
K6	male	32	Married	F&B Manager	University graduate	16
K7	male	31	Single	Deputy general manager	University graduate	12
K8	male	46	Single	F&B Manager	University graduate	18
K9	male	35	Married	Front Office Manager	University graduate	18
K10	male	36	Married	Sales Manager (Feast)	University graduate	17

According to Table 1, the majority of the participants are male (7), married (6 of them) and General Manager or F&B. In addition, all of the participants are educated (university graduate) and experienced (just K1 and K2 have less than 10 years of experience).

To the participants; Three questions were asked about the relationship between gastronomy tourism and gastronomy and tourism. The questions and the answers of the participants are as follows;

1. To the participants; *"What does gastronomy tourism mean to you?"* The question was asked. K3 and K5, one of the participants, expresses *"gastronomy tourism as a part of life"*, while K2 *"universal diversity",* K7 *"most important ladder of the service sector"*, K9 *"identification of the region with food"*, K4 and K6

"new flavors in terms of tourism and new tastes Trying Visuals ", K8 *" A Tourism Tendency increasing day by day "*, K1 *"A highly effective tour of the city and the country for the global and local promotion of the city"* and the *K10 "Tourism Form that has the desire to travel to experience a new food and beverage experience"* they expressed.

2. To the participants; *"Is there a relationship between gastronomy and tourism? How do you think this relationship is? "* The question was asked and all of the participants stated that there were relationships and they generally touched upon different dimensions of the relationship. To the question; K1 and K2 have stated that tourism and gastronomy are connected to each other, K1 *"is absolutely connected, especially in terms of the relationship between the flavor - service environment"*, K2 *"Both are connected to each other. Gastronomy is effective in terms of reflecting the characteristics of destinations "*. To the question, K3 *"This relationship; The basic needs of people are in the form of contributing to the economy "*, K4 *"Gastronomy is a tourism attraction element in terms of food, presentation and visuality "*, K5 *"gastronomy is an indispensable element in terms of tourism"*, K6 *"The heart of tourism passes through gastronomy"*, K7 *" gastronomy is the development of tourism"* K8 is an important tool, because one of the most important needs of people on vacation is realized thanks to gastronomy, gastronomy is a powerful element in the development of tourism, K9 *"The taste of people who come to the city to visit the city"*, K10 *"actually, there is not much difference between them, someone discovering new places"*, The other is to explore new tastes.

3. To the participants; *"What are your views on the fact that Turkey's gastronomic elements are included in the menus of hotel businesses?* The question was asked and all of the participants stated that the gastronomic elements of Turkey should be included in the menus of hotel businesses. To the question; K1 *"I think it is important to introduce and survive the tastes of our country. Tourists want to try different flavors "*, K4 *"I think it is useful to have gastronomic products in every hotel. Tourists are interested in local dishes "*, K5 *"should be included in the menus"*, K6 *"Most of the hotels in Turkey have local menu external dishes, it would be better if there are local meals"*, K7 *"gastronomy tourism is carefully carefully to increase the potential of domestic and international guests contains strategies to be applied. Every hotel is applied "*, K9 *"Hotel menus need to include gastronomic products. The guests coming from outside should see the food culture and visual dishes of the city in the hotel "*, K10 *"demand for local dishes, our local kitchen service will be realized in our hotel* soon "*, K8 *"I do not find it natural to use local dishes frequently. I think the menu should be determined according to the portfolio of those who stayed at the hotel. In our hotel, especially foreign guests have demands for local dishes, they want to taste the food "*.

Four questions were asked about the introduction, marketing, competitive advantage of gastronomy tourism businesses to the hotel and gourcing of gastronomy tourism to hotel businesses. These questions;

1. To the participants; "What are your thoughts about the contribution of gastronomy tourism to the promotion of hotels?" The question was asked. All of the participants stated that gastronomy tourism contributed to the promotion of hotels. K1, K4, K6, K7, K7 and K10 from the participants answered "they contribute to hotel promotion", K2 "Of course I think it has a positive contribution", K3 "Yes, there are direct arriving for the restaurant", K5 "Restaurants create direct gravity power", K8 "Yes, they have great contributions".

2. To the participants; *"What are your thoughts about the contribution of gastronomy elements (such as local food and beverages) to the marketing of hotel businesses?"* The question was asked. The majority of the participants stated that gastronomy elements would be effective in the marketing of hotel businesses. To the question; K1 *"contribution and impact is very important, especially in the marketing of city hotels"*, K2 *"Gastronomy is an important factor in marketing, K3" yes are positive reflections "*, K4 *" I think it can be positive. At least about the world markets "*, K6 *"I think ye*s", *K8 "Of course it will contribute"*, K9 *"will definitely contribute. Advertising can be made through local delicacies and people can be aroused in people "*, K10 *"contribute, especially with Konya cuisine. This is the case. Although our guests who do not know the cuisine of Konya and who want to taste new tastes can arouse curiosity "*, they give answers to the K5 *" accommodation* budgets "*, K7 *"but hotel management continues with dynamic cycles "*.

3. To the participants: *"What are your thoughts about gastronomy elements to create a competitive advantage among competitor hotels?"* The question was asked. All of the participants stated that gastronomy elements would create a competitive advantage among hotels. To the question; K4, K6, K8, K9, K10 *"I think that it creates a competitive advantage "*, K3 *"Creates a competitive advantage, as a corporate hotel, we are experiencing this situation in terms of our hotel "*, K1 *"gastronomy elements do not greatly compete, but encourage competition"*, K2 *"is an advantage, but this does not create a great*

competitive advantage for hotels in the region", K7 *"gastronomy tourism alone is not enough for the competitive advantage. However, it provides advantage ".*

4. What are your thoughts about the contributions of gastronomy tourism activities in hotels to attract different types of tourists to the hotel?" The question was asked. The majority of the participants answered "contributes". K3, K8 "It absolutely contributes", K4, K6, K7 "contributes", K1 'contributes, different tastes appeal to different masses", K5 "Domestic and foreign tourists can attract hotels", K10 " It is an advanced country that has developed itself ", K2" You can please the guests who come to the hotel with these activities, but I don't think it is a sufficient element alone ", K9 may attract attention for local tourists, but unfortunately for foreign tourists".

Four questions were asked to the participants about visitor attractiveness of gastronomy tourism and Gastro Tourism Practices. These questions;

1. To the participants; "Does gastronomy create a strong enough to attract visitors to a hotel business alone? The question was asked. 50 %of the participants (K1, K3, K4, K5, K6) to the question "Yes, it is a powerful element, while 50 %of the participants; K2 "The targeted mass is an important factor when selected correctly, but I do not think it will be sufficient alone", K6 "No, not", K7 "not alone or not sustainable, K9" No, the city is related to the gastronomy ", K10" not literally " He gave his answers.

2. To the participants; *"Are there any applications for gastro tourists in your business? Do you think it is enough? "* The question was asked. Participants; K3, K4, K5 *"Yes, there is a sufficient level"*, K1 *"various applications are made from time to time"*, K9 *"Yes, applications are available, we give importance to local delicacies as we can"*, K8 *"Of course, but I think it is not enough"*, K6 *"not available"*, K2 *"Menus contains different cultural dishes. But it can be improved not enough. There is no significant work in our hotel "*, K7 *"We offer local foods, but not at a sufficient level due to the concept "*, K10 *"If requested, yes, there is no constant products, but only for breakfast, local Konya products are served to guests"*.

3. To the participants; *"Are there tourists who come to your province within the scope of gastronomy tourism? The question was asked. All participants answered the question "yes".*

4. Participants; *"Are gastronomy organizations (gastronomy festival, gastronomy feast, etc.) in your province? What benefits does it provide to your business if it is done?"* Questions were asked. Participants; K1 *"Yes, it provides mobility in the context of accommodation"*, K6 *"Yes. It is the contribution of accommodation "*, K9 *" is done and regulated every year. Contributed. We welcome the participants in hotels "*, K10 *"Yes is happening, there are requests for accommodation"*. K4, K4 *"Promotion and Ad Opportunities"*, K5 *"is in the form of intense accommodation demands and different organizations"*, K7 *"Yes, accommodation is increasing and the vision of the personnel is expanding"* , K8 *" is held regularly every year. Advertising is becoming more guests "*.

5. CONGLUSİONS AND SUGGESTİONS

In the study, it is concluded that all hotel managers have positive perceptions of gastronomy tourism. This consequence supports the idea that Kilela and Crotts (2005, p. 39) are a strong connection between gastronomy and tourism [53].

In the work of Lopez-Guzman, Hernandez-Mogollon & Dı-Clemente (2014) in Spain, they concluded that gastronomy ranks second among the important travel motivations for foreign tourists to visit Spain [54]. According to the results of the study conducted by Demirbilek, Şengül & Akoğlu (2018), service is a whole in hotel businesses. Customers who come for accommodation benefit not only from kitchen service but also other services [45]. Therefore, the role of gastronomy is less in hotels. In the study, it is stated that the relationship between gastronomy and tourism is important by the participants that gastronomy is not a strong enough to attract visitors to a hotel business alone. This situation; It is similar to the results of the research conducted by Lopez-Guzman et al. (2014) and Demirbilek, Şengül & Akoğlu (2018).

In the study, the participants think that gastronomy elements are useful in terms of introducing, marketing and competitive advantage compared to other hotels and providing different types of customers to hotels. Participant views show that gastronomy tourism is very important for hotel businesses. In addition, the participants thought that gastronomy activities organized in the region contributed to the increase in the fullness of hotel rooms and the profitability rates of the hotel, but it was concluded that there is not enough activity for gastro tourists in hotel businesses. This result shows that hotel businesses should pay more importance to gastronomy tourism activities. For the development of gastronomy tourism, not only destinations and gastronomy activities should be applied in hotels. In line with these findings, the recommendations that can be developed for the results of the research are as follows;

- National and international gastronomy activities should be organized in hotel businesses and ads of events should be supported by media support
- For the development of gastronomy tourism, hotel employees should be informed about gastronomy and gastronomy tourism, and the personnel are subject to trainings from relevant institutions such as related associations and universities.
- Gastronomy activities should be done in hotel businesses such as "*cooking with famous chefs*", " *organizing food competitions* "and *"organizing local product days "*
- Different applications should be made for gastro tourists in hotels such as arrangement of menus in accordance with their demands.
- Especially in hotels that appeal to foreign tourists, local dishes should be included in the menus..

The study is limited to the opinions and thoughts of hotel managers in Konya due to cost and time constraints. In order to generalize the findings, it can be made for hotel managers in different areas of the region and the country. The subject can even be investigated in the context of hotel guests.

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Factors Affecting Gen-Z's Shopping Behavior on Tiktok at the Tertiary Level in Vietnam

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Abstract

The purchase decision across generations drives the need to understand Gen-Z's shopping behaviors as TikTok shifts into an exciting digital storefront. The factors that are the subject of this study discuss the TikTok shopping intentions of the Gen-Z of tertiary-level students across Vietnam. Based on Technology Acceptance Model (TAM) by Davies (1989) the study establishes that Perceived Usefulness (PU), Perceived Ease of Use (PEU), Risk Attitude (RA) and Subjective Standards (SS) are influential factors towards shopping with the Internet. The research design involved the use of quantitative research method with questionnaire adapted from Nguyen and Nguyen (2022). The results show that both PU and SS are important in the context of Gen-Z's shopping behaviors. CC and PEU also have significant parts, although slightly better outcomes of RA were observed. Some of the limitations are inadequate sample size and the research depends on the participants' responses. Further research should include wider samples with regard to demographic characteristics and examine temporal shifts in the nature of shopping.

Keywords: Gen-Z, shopping behavior, tertiary level, TikTok.

1. INTRODUCTION

TikTok, a short-video sharing app at its inception, has also gradually turned out to be a remarkable e-commerce site. TikTok was once limited to mere 15-second videos as a creative space; however, Wang and Herrando (2019) note that it has transformed into a factory of content and brands thanks to easy-to-use audiovisual features like in-camera speeding, split screen or image tracking composites which are so simple even a child can operate them. A prominent feature of TikTok is its algorithm, which provides contact based on activities such that when one logs in, their feed is guaranteed to be unique (TikTok, 2021). This content, in tandem with this style of monetization, has helped TikTok leverage a growing buzz of social commerce, especially among the youth (Putri et al., 2023).

The surveyed TikTok applications have now become an everyday social media platform, specifically for Gen-Z Vietnamese consumers. This challenge of user-generated content and short form videos of this platform matches the agenda of Gen-Z which is looking for real life, creativity, and fun. According to Etrata et al. (2022), TikTok enables brands to leverage the engagements and interests of their users by providing a steady stream of entertaining videos aligned with the users' preferences. Therefore, TikTok can attract users' attention to the advertised brands. Hence,

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sponsoring the so-called creators has proved to be an efficient approach at TikTok, for example, letting brands utilize their audience and attention from the creators to advertise products effectively. This could be seen through the fast growth of the e-commerce element of the TikTok application in Vietnam. By 2023, TikTok Shop has around 68,000+ Stores and 42.1 Million Products Sold in merely one quarter due to its daily solid revenue figure to VND 56.6 billion (Metric, 2022, cited in Nguyen & Nguyen, 2022, p.575). This success also demonstrates the social shopping trends in Vietnam, which is claimed that Gen-Zs are the one who wants better and more fun approaches of online shopping. TikTok contributes to bridging and distilling the differences between brands and consumers, as well as fun and shopping, so that it takes part in e-commerce balance in Vietnam's frontier and other emerging markets.

Thus, understanding the motives on shopping through Tiktok are crucial particularly among tertiary students which are a significant of digital consumers. They simply spend too much time in the digital and social media, especially TikTok – for the university generation, and it is also with this social media that they are most motivated to shop (Ngangom, 2020). This generation prefers expediency, fun, and realness in any offering. This is where TikTok and its user-generated content and elements of e-commerce come in handy for persuasion to purchase. More so, being tertiary level students, these young people have increasing buying power and are almost determining how online shopping will be in the future. Therefore, knowing how they shop on platforms like TikTok offers brand managers the necessary information to target them and develop relevant campaigns for them to adapt (Woods, 2013). Even with the rapid ascension of TikTok as a commerce app, its marketing capabilities towards Gen-Z, especially in the case of Vietnam, need to be adequately studied. A number of academicians, especially in the field of business, is studying social media, particularly the e-commerce. Reasonably, the use of e-commerce in TikTok is related to entertainment than the commercial purpose. Following the literature review presented in this paper, ideas concerning social commerce remain insufficient to explain Gen-Z's behavior regarding content consumption and purchasing on TikTok. Moreover, even less commonly, studies have been conducted on tertiary-level students, who are not only digital natives but also comprise a pertinent consumer demographic within Vietnam's rapidly developing e-commerce market. This underscores the importance of emphasizing more targeted research investigating particular determinants of Gen-Z's shopping intention for TikTok.

2. LITERATURE REVIEW

2.1. Consumer behavior

Consumer behavior is defined as the specific search, purchase, and evaluation of products or services in terms of meeting need. Lamb et al. (2009) present a systematic account of how consumers make decisions in the purchase, use and disposal of any good or service. This behavior commences once the customer realizes a want and is prepared to assess the available alternatives and make a choice. According to Solomon et al. (2013), all considerations and actions of the buyer towards and about the goods and services, including their procurement and use, as well as all feelings and experiences with them, should all be included under the header of consumer behavior. The process contains several steps: information search, alternative evaluation, purchase decision, and post-purchase evaluation. Keller and Kotler (2016) remark that buying behavior is formed by consumers' cultural, social, and personal characteristics. Of these, cultural aspects are the most dominant in affecting consumer tastes and appetites more profoundly. This marketing variable emphasizes on how the consumers perceive the attributes of the product or style, quality or price, convenience, or time in influences their decisions on whether to purchase the product and which brand to go for (Keller & Kotler, 2016). Hence, there is need to pay more attention to consumers since it assists the business organizations to come up with ways and means that can satisfy the wants and needs of the consumers to ensure satisfaction and consumer loyalty.

2.2. Generation-Z and characteristics

Gen-Z demographic has been defined as individuals born between 1995 and 2010. They are referred to as the Internet generation and are the first generation that has only known the digital world. They can be called faithful digital natives as technology, smartphones, and social networks have been around since their time (Francis & Hoefel, 2018). This unique generation has been brought up in a world of internet and social interactions, which has affected their ways of communication and expectations concerning consumption practices; consumers, especially Gen-Z, value actual brands and genuine relationships over marketing efforts (Fromm & Read, 2018). Because of their upbringing, they act and believe differently from previous generations.

Such a generation consists of some crucial points shaped by growing up faced with technology. They look for actual things, for a person who is seen as original and not a performer who goes along with their age (Handley, 2018).

Different from the prior generations, Gen-Z prefers to create interactions with influencers and people with content since they do not try to be perfect but connect with their audiences on a different level than older actors (Handley, 2019). They are quick learners of every new system that turns out and are highly efficient in locating and integrating information available on the web (Lauring & Steenburg, 2019). Also, this group of people has an inclination towards escapism as much time is spent watching social media and playing with entertainment technologies (Wood, 2013). Constant exposure to virtual relationships and access to digital content means being able to choose stimulation that requires no effort for satisfaction. Thus, the rising demand from Gen-Z for their information sources has made them interactive and appealing in terms of digital features and creativity.

Attention should be focused on the purchasing tendencies of Gen Z, as they possess certain characteristics that can elucidate their shopping patterns due to being born digitally. They spend considerable time to make decisions, for instance, they have to go online search or ask fellow family members, friends, or influencers for recommendations on products before making purchase (Accenture, 2017). They obtain social information from social networks and other Internet sources to buy products from micro-social media influencers that are rapidly gaining popularity among Gen Z due to their influence on the decision to purchase (Gupta & Mahajan, 2019). Social commerce makes consumers more productive than they already are: Before buying, they care about looking for product reviews and reviews, accurate content, and many more. For them, convenience is key in their purchasing behavior, and they change to mobile gadgets, expect the products to be offered fast, and appreciate orders being delivered immediately (Woods, 2013). Additionally, young people pay more attention to political, social, and environmental information and attempt to take such factors into consideration when purchasing, which differentiates them in the digital economy in two spheres, as buyers and as responsible consumers (Lauring& Steenburg, 2019).

2.3. E-commerce and TikTok

TikTok has quickly grown from a simple social network limited to the broadcast of short videos to an active participant in the e-commerce market. Originally designed as a video editor for creative self-expression using 15-second clips, it is now equipped with convenient marketplace features like marketplace, live shopping, product links, etc. (TikTok, 2021). The transformation is mainly due to its capability of targeting the appropriate advertisements to the right audience and the outward market or internal market integration, which enhances the ability of the sellers and the influencers to develop effective marketing strategies (Li et al., 2023). TikTok has enhanced the shopping experience by introducing the 'Yellow Basket' feature, which makes it easy for users to go directly from seeing a product to buying it without being directed out of the app (Xiao et al., 2023). Such functions have helped the platform evolve from a conventional social media site to a more sophisticated ecosystem that enhances user interaction and encourages them to purchase.

Social commerce primarily through TikTok is significant in reaching the target consumer, especially the Gen-Z consumer. Social commerce is a social network integrated with e-commerce where members can share, recommend, and engage in product-promoting practice within their sphere. Gen-Z has impressive digital skills and tends to engage with much content, and that is why they are drawn to the entertainment shopping culture offered on TikTok. Through these feeds, stories, and live streams, Gen-Z consumers can seek shopping ideas and information about items (Statista, 2023). It is also simple for users to like and comment on products and suggestion; this influences buying behavior (Li et al., 2023). In addition to that, the hedonic and utilitarian motivations for using TikTok which includes fun, excitement, and delicious shopping experiences within the perception of Gen Z also provide the demonstration of TikTok as a social commerce platform (Zhang et al., 2022).

2.4. Theoretical framework

2.4.1. Technology Acceptance Model (TAM) by Davies (1989) and its adaptation for TikTok e-commerce

The Technology Acceptance Model (TAM) introduced by Davies (1989) forms the basis for this study, which focuses on factors determining how and whether people accept and utilize technology. TAM argues that two such constructs, Perceived Usefulness (PU) and Perceived Ease of Use (PEU), determine an individual's attitude to use a technology, which may cause the individual to have an intention of using it. PU, one of the determinants of social/cultural acceptance, deals with users' perceptionsusers' perception of the system and its potential benefits. In the case of the social commerce atmosphere, particularly the social media video platform (TikTok), TAM plays a vital role in comparing the Gen-Z buying behaviour in the TikTok application.

More specifically, Davies (1989) has asserted that full blown technology acceptance models have yet to materialize given the on-going general acceptance of social commerce as an entirely novel method for trading, let

alone the acceptable modes of making purchases. Equally, acceptance attitude (AA) is a disposition that influences the purchasing behavior of TikTok users since it determines if users will buy and the shopping features of the platform (Kim et al., 2009). Consumer Confidence (CC) is also critical as it represents users' confidence in the essence of undertaking such buying through the internet, and thus committing to making the given decision (Han et al., 2022). Consumers' trust in secure payment systems and guaranteed deliveries is a facilitator or barrier to their confidence and purchase decisions.

Further, Risk Attitude (RA) entails the level of risk a consumer is willing to take regarding the outcome when purchasing products online. About TikTok, it is evident that RA affects purchasing decisions to a large extent. Those consumers willing to take a high risk would shop on TikTok even when unsure of the products or the delivery services' dependability. Other than that, Subjective Standards (SS), or social influence, are also crucial for Gen-Z consumers who usually consider their peers, idols, and trends during shopping. Also, the social proof of TikTok influencers and recommendations can strongly depend on consumer behavior (Nguyen & Nguyen, 2022).

In addition, Future Intention (FI) is a customer's willingness to use TikTok for additional purchases and refresh their current purchases. This construct is critical in analyzing long-term consumer involvement with the platform. FI is defined by prior experiences and perceived satisfaction which are derived from PU and PEU. However, Consumer Decision (CD) is the last-word mentality on a purchase or consumption experience. As for TikTok e-commerce, in particular, CD depends on PU, PEU, RA, and FI. Probing how these factors interact would ease tracing the decision-making processes of Gen-Z consumers. For example, a high PU and PEU may enhance the chances of positive CD. Likewise, high RA will likely obstruct CD unless tempered by high levels of assurance among consumers.

2.4.2. Research questions and hypothesis

Owing to the objectives of the current study, the researchers needed to address two research questions:
- What factors influence Gen-Z's shopping intentions on TikTok among tertiary-level students in Vietnam?
- How do those factors affect Gen-Z's purchasing decision at the tertiary level on TikTok?

Therefore, the hypothesis development based on TAM variables should be explored:
- H1: Perceived usefulness (PU) positively influences Gen-Z's shopping decision (CD) on TikTok.
- H2: Perceived ease of use (PEU) positively influences Gen-Z's shopping decision (CD) on TikTok.
- H3: Acceptance attitude (AA) positively influences Gen-Z's shopping decision (CD) on TikTok.
- H4: Consumer confidence (CC) positively influences Gen-Z's shopping decision (CD) on TikTok.
- H5: Subjective standards (SS) positively influence Gen-Z's shopping decision (CD) on TikTok.
- H6: Risk attitude (RA) positively influences Gen-Z's shopping decision (CD) on TikTok.
- H7: Future intention (FI) positively influences Gen-Z's shopping decision (CD) on TikTok.

3. METHODOLOGY

3.1. Participants

The current study involved 194 students from prominent universities: the University of Economics - Technology for Industries and Hanoi University of Science and Technology. Table 1 illustrates the demographic information of the participants in the research.

Table 1. Demographic information

		Frequency	**%**
Gender	Female	58	29.9
	Male	128	65.9
	Other	6	4.2
Academic year	Year 1	20	10.3
	Year 2	68	35.1
	Year 3	45	23.2
	Year 4	57	29.4
	Year 5	4	2.1
Majors	English language	82	42.3
	Business administration and marketing	69	35.6
	Engineering	6	3.1
	IT	1	0.5

	Computer sciences	1	0.5
	Automatic management technology	2	1
	Others	33	17
Monthly income	Below 1 million VND	78	40.2
	1-3 million VND	46	23.7
	3-5 million VND	50	25.8
	5-10 million VND	11	5.7
	10-20 million VND	2	1
	Over 20 million VND	7	3.6
Time period using TikTok	Under a year	28	14.4
	1-3 years	66	34
	3-5 years	21	31.4
	Over 5 years	39	20.2
Time using TikTok per day	Under 30 mins	149	76.8
	30 mins – 1 hour	6	3.1
	1-3 hours	13	6.7
	Over 3 hours	26	13.4
Purpose of using TikTok	Entertaining	149	76.8
	Shopping	27	13.9
	Searching information	3	1.5
	Connecting with other people	4	2.1
	Others	11	5.7

The sample consisted of 58 males, 128 females, and 6 individuals whose gender was unreported. According to the academic year, we studied participants with four different years, but many of them were Year 2 students (35.1%) and Year 4 students (29.4%). This implies a reasonable population of students which may comprise students who are halfway or towards the later part of their cycle of education completion, best to offer insight on proper conduct while shopping online. Regarding majors, most participants were in the English language (42.3%) and business administration and marketing (35.6%). This shows a considerable number of students are from the field of communication and commerce, which could affect how they use TikTok, a social media app. Furthermore, the participants' monthly income distribution was also diverse, with a substantial number (40.2%) receiving an income of less than 1 million VND.

Regarding the participants' experience with the TikTok app, a very few participants (8.8%) responded that they use it for shopping implication that it is still popular as a shopping site, but it is mostly used in other ways. In terms of usage duration, 34% of all the participants had been on the TikTok app for 1-3 years while 31.4% had been using the app for 3 to 5 years. Basically, this means that TikTok has already been in the current generation for a long time in users' digital lives; showing its appeal and timeliness. Daily usage patterns showed that most (76.8%) participants spend under 30 minutes daily on TikTok, which may suggest that users visit the app for short periods, not longer than an average of 30 minutes, probably due to the quick videos that are engaging in nature. Despite this pattern, a few spend longer on the app, which means some users find the app much more entertaining than the rest.

Regarding the purposes for using TikTok, for the overwhelming majority (76.8%), entertainment is the reason for using it. This proves TikTok's position as a source of fun and leisure. A smaller portion of participants (13.9%) use it for shopping. Other uses, like information seeking and social interaction, were relatively minor, focusing on the fact that this age group regards TikTok mainly as a consumption tool for entertainment.

3.2. Data collection instruments

In this study, the survey of students of TikTok usage was used and a quantitative method of data collection was adopted, having adopted a questionnaire developed from Nguyen and Nguyen (2022). The questionnaire was designed to elicit detailed demographic data and understanding of the participants TikTok use and impressions. These questions where included in the demographic section: gender, age range, marital status, average monthly income, academic year, significant other. These demographic data offered an initial insight into the potential participant base, which enabled the fine-grained assessment of these factors and how they could be related to the TikTok experience and attitudes.

The questionnaire measured social media experience of TikTok and it included questions like the frequency of use of TikTok, time spent on TikTok per day, purpose of using TikTok and the typical buying behavior observed on TikTok. These questions included the amount and types of engagement with TikTok relative to students which aided in squaring usage indicators to the idea about the application. It is thus important that these usage patterns are linked to their perception of TikTok since they can heavily impact students' perception of the usefulness and ease of use of TikTok for other aspects including shopping.

Also, the questionnaire provided the students with the guidelines on how to justify their views about TikTok based on constructs such as Perceived Usefulness (PU), Perceived Ease of Use (PEU), Acceptance Attitude (AA), Consumer Confidence (CC), and Subjective Standard (SS). This makes it possible to understand the behavioral intents and goals as pertains the use of the available TikTok technology.

There is also great nonsense that is deliberately difficult to understand concerning the combination of Consumer decision (CD), Future intention (FI), and Risk attitude (RA) approaches with one another in general when studying the factors that influence students' shopping behavior on TikTok. The purpose of CD Cognition factors is to assess the purchasing decisions made by students on TikTok. These items could include how much the product critics, the price, and how much TikTok followers will affect the purchase decisions made. Additionally, FI statements deal with students' possibility to shop through TikTok. These items test the endurance of the existing shopping habits and the prospect of Tikok's ability to enhance further constructs in its e-commerce features. This might be querying the students' intentions to place more or further orders, their readiness to promote TikTok shopping to other students, and how often they expect to make such purchases. Lastly, RA concerns relate to how students view the risk of shopping through TikTok. These questions could regard the issues of where the students offer their private information, the security of payments made, and genuine products. Within consumer behavior, such concerns are considered RA, which is very important since customers may decide not to purchase even if the offer is good or the shopping experience appealing due to the risks they associate with the offerings.

3.3. Data analysis

The principal instrument employed for data analysis was SPSS 27.0, which was used to determine the determinants of Gen-Z shopping attitudes on TikTok. The reliability of the questionnaire was verified, as Cronbach's alpha was calculated to be at 0.963. The analysis encompassed initial descriptive statistics to provide an overview of demographic variables and general trends in the specific domain, i.e., Gen-Z's engagement on TikTok for shopping. This stage was also critical for checking the characteristics of the sample population and the state of the data in relation to the advanced analyses to be performed.

Then, Pearson correlation analysis was used to test the hypothesis concerning relations between several factors and Gen-Z's intention to make purchases on TikTok. This method was selected because it is a quick, simple, and effective way of establishing how related the variables are in terms of their linear relationships. The focused analysis aimed at testing a hypothesis where some perceptions and attitudes, predetermined by the model itself, affect the user's intentions.

4. FINDINGS AND DISCUSSION

4.1. Gen-Z's perceptions of shopping on TikTok

The statistical analysis reveals Gen-Z's perceptions of purchasing things on TikTok, as shown in Table 2.

Table 2. Descriptive statistics of participants' perception of TikTok shopping

	N	Mean	Std. Deviation
PU1	194	3,80	1,130
PU2	194	3,68	1,014
PU3	194	3,94	0,917
PU4	194	3,75	1,008
PEU1	194	3,84	0,957
PEU2	194	3,85	0,964
PEU3	194	3,90	0,873
PEU4	194	3,97	0,830
RA1	194	3,85	0,951
RA2	194	4,01	0,902
RA3	194	3,69	1,022
RA4	194	3,73	1,028
RA5	194	3,70	1,009
AA1	194	3,78	0,996
AA2	194	3,78	0,954
AA3	194	3,70	0,918
AA4	194	3,77	0,927
AA5	194	3,73	0,846
AA6	194	3,61	0,916
CC1	194	3,49	0,923
CC2	194	3,49	0,877
CC3	194	3,31	0,920
SS1	194	3,40	1,009
SS2	194	3,71	0,917
SS3	194	3,64	0,929
FI1	194	3,73	0,853
FI2	194	3,76	0,830
FI3	194	3,61	0,939

Regarding PU, most participants agreed that TikTok was efficient for shopping, mainly since it is possible to shop anywhere and at any time (M=3.80). In addition, they perceived the variety of products available on the platform as appealing (M=3.94) and that shopping using TikTok saves more time than other methods (M=3.75). Therefore, the factors that stem from the accessibility and the nature of the diversity of TikTok's content were considered as positive. Speaking of PEU, the study highlighted that the significance of the level of usage for enhancing the overall shopping experience on TikTok. In terms of the assessors' easy of use, the majority responded that it was easy to find the items (M=3.85) and ordering freedom due to the direct (M=3.90) procedure. In addition, high clarity was given in using payments using various means (M=3.97), suggesting a well-laid-out structure in the user interface and payment features.

As for AA, the respondents had a favorable attitude toward the TikTok shopping experience. They reported low levels of meaning when comparing prices (M=3.78), and they believed that shopping on TikTok was a good decision (M=3.70). Also, the website was rated as entertaining (M = 3.73) and a wise decision (M = 3.61), showing a positive attitude toward the users. However, even with these positives, there remain substantial issues, which was illustrated by the level of RA. The most significant concern was related to the failure to meet the quality expectations of the products purchased (M=4.01), followed by uneasiness about the promised delivery time (M=3.69) and confidentiality of private data (M=3.85). Therefore, these aspects must be improved to enhance users' trust and satisfaction.

However, two key factors which dominated other factors affecting the shopping decisions were social factors. The information dissemination effect (Mean=3.71) and the perception of family and friends (Mean=3.40) seem to explain the users' purchasing behavior indicating that external factors are crucial for understanding the shopping behavior of users of TikTok.

Users witnessed readiness to proceed with shopping more in TikTok if it is possible (M=3.73). They were also likely to prescribe it to others (Mean=3.61), suggesting other uses until such a time when these problems will be solved. Other issues that influenced decision to buy through TikTok included; perceived ease of use (M=3.48) and perceived risk of buying on the platform (M=3.39).

The following section will analyze the relationship among those variables more clearly, which highlights the factors affecting Gen-Z's intention of shopping on TikTok.

4.2. Factors affecting Gen-Z's intention of shopping on TikTok

The analysis from Pearson correlations ascertains most of the hypothesis on how specific factors impacted Gen-Z's purchasing behavior on TikTok.

Table 3. Correlations between different factors and Gen-Z's shopping intention on TikTok

Correlations

	PU	PEU	RA	AA	CC	SS	FI	CD
PU		0,025	0,000	0,000	0,000	0,000	0,000	0,000
PEU			0,897	0,092	0,032	0,356	0,580	0,267
RA				0,000	0,000	0,000	0,000	0,002
AA					0,000	0,000	0,000	0,000
CC						0,000	0,000	0,000
SS							0,000	0,000
FI								0,000
CD								

The table reveals that PU has a statistical co-efficiency of 0.000 to CD and also has made a positive contribution towards the rise in the relationship coefficient. This means that opportunities exist whenever Gen-Z stumbles into TikTok in a way that causes them to consider approaches to acquire the product. This squares with the H1 hypothesis of the research and agrees with the assertion that perceived ease of use for TikTok should be enhanced if shopping decisions are to be promoted. Connecting these results with hypotheses in terms of PEU and CD, there is a 0.267, therefore there is a low direct positive encouragement. These indicate that, though ease of use is precious, the level of influence is also almost the same as that of the perceived usefulness. This is in line with the H2 hypothesis of the research, indicating that the user interface and user experience can be improved so that the appetite for shopping is encouraged. Also, regarding the CC construct our research has revealed low correlation between the CC construct and the CD construct which might suggest that the former does not influence shopping related decisions. This is partly in support of the H4 hypothesis of the study which posited that although confidence is necessary, other aspects may be more salient. The un-constitutional terms of SS show a correlation of 0.356 with CD. As such, Validation substantiates that acceptable assets are acquired by proving that other assets have a social effect. This is in line with the H5 hypothesis of the research and shows the effectiveness of e-commerce on TikTok. Moreover, RA and CD correlate positively by 0.002, meaning that risk-tolerant Gen-Z consumers are more engaged in shopping on TikTok. This supports H6 and shows that resolving perceived risks can enhance purchase intention.

The correlation analysis supports the hypotheses, explaining that PU, PEU, RA, AA, CC, and SS are important determinants of Gen-Z's online shopping behavior on TikTok, etc. Although PU and SS have higher influences, PEU and RA are also very significant. Understanding these relationship make efforts towards enhancing the user experience, reducing perceived risk, and smoothly leveraging social interaction to influence consumers' behaviour on TikTok possible for businesses. These results elucidate how the Gen-Z consumers in vietnam have impacted on intentions in tertiary education on tiktok platform. Having determined that PU and PEU are the two most significant factors that affect shopping choices of Gen Z on TikTok. In alignment with this, Davies (1989) views the technology acceptance model where these variables replace other components as central to the uptake and usage of any technology. The high level of PU in shopping decisions indicates that Gen-Z is satisfied with the products and services offered by TikTok. This agrees with Keller and Kotler (2016); consumer expectations are often limited to the platform's values, including convenience. Also, the impact of social shopping on the shopping intentions of Gen-Z strengthens the arguments by Nguyen and Nguyen (2022) who observed the critical role of social proof or peer endorsement in the customers' behavior. The social influence equation that links SS and purchasing actions applies the same to the factors involving influencers and social channels in e-commerce on TikTok. As Fromm and Read (2018) have it, Gen-Z wants authentic content: this means that they only trust influencers whose content covers similar topics as their own. Furthermore, the present study's findings on RA indicated that risk-taking Gen-Z consumers are likelier to carry out shopping behaviors in TikTok. This concurs with the studies of Nguyen and Nguyen (2022) where they highlighted the issues of trust and risk in e-commerce. As for CC, with regard to shopping decisions, it can be said that the impact is minimal; however, the ability to resolve the existing level of risks must be addressed to boost the consumers' confidence. Quite the opposite, this positions the 'confidence and shopping factors' – rationalization theory of consumers' shopping behavior as a necessity but has limits, with other factors, especially social and psychological aspects, taking over the lead role. The study emphasized the continuity of the use of TikTok with e-commerce features, while worries such as product quality and security remain. This is in agreement with Woods (2013), who reported that Generation Z indulges in shopping with concerns of service, fun, and personal needs being

met descriptively. In addition, the focus on creating a safe and easy-to-use environment speaks to the growing need to improve user satisfaction to encourage repeat purchases.

5. CONCLUSION

This research contains an in-depth examination of the factors affecting Gen-Z's shopping intentions on TikTok, focusing on tertiary students in Vietnam. Significant findings suggest that PU and SS are critical determinants of shopping choices, confirming the clout exerted by the utility and social factors toward e-commerce commitment. Likewise, PEU and RA are also very important, implying that simplifying interfaces and clearing risks are likely to boost users' willingness to buy. All these findings are based on the TAM by Davies (1989), which demonstrates its value in analyzing TikTok's social media shopping elements.

Nonetheless, the current research has several limitations. Despite its adequacy in representing the target population, the sample size is limited and consists of students from only two institutions, which may not cover all the possible types of Gen-Z in Vietnam. Furthermore, the study relies on self-reported data and this comes with the shock that we get biased report or even exaggerated claims as to what actually took place while shopping. The observational aspect of buying intentions is also limited because the study in this paper relied cross-sectional, so the researchers did not have a chance to track buying intentions over time, especially as the use of new features of TikTok in e-commerce is gaining momentum.

Future studies might address the limitations mentioned previously by increasing the scope of the population so that it captures a broader group in terms of geographical area and educational level. Longitudinal studies in the contextualization of the present work might be helpful in assessing how the intentions of Gen-Z shoppers on TikTok change over a period of time as new technological changes are brought in, or new trends emerge. In addition, qualitative research such as interviews or focus groups could help answer quantitative data on why Gen-Z shops on TikTok. By closing these gaps, future research can provide more specific and better-informed evidence on the development of social commerce among young consumers.

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Systematic Review Comprising Prior Research on the Impact of Transformational Leadership on Change and Potential Moderating or Mediating Factors

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Abstract

Leadership is indispensable in realizing organizational performance among automotive companies due to its pivotal role in driving strategic direction, fostering a positive work culture, and maximizing the potential of the workforce. The objective of the overall research is to evaluate the impact of leadership role on openness to change, change management and change implementation effectiveness in the German / European automotive sector. In that context the moderating effects and interactions of employee motivation, organizational culture and decision-making effectiveness with leadership roles will be evaluated and a comprehensive causal model will be derived. The paper is focusing on the aspect of theoretical analyze regarding status of research on Leadership impact in the context of organizational change and Status of research on moderating factors of change readiness, implementation and outcome

Keywords: Automotive, transformational Leadership, organizational change, Systematic literature review

1. RELEVANCE OF EFFECTIVE LEADERSHIP TO MANAGE THE CHALLENGES OF AUTOMOTIVE INDUSTRIES

Different leadership styles, such as autocratic, democratic, transformational, and servant leadership, offer unique approaches to managing teams and achieving organizational goals. Echols (2009), p. 85. The effectiveness of each style can vary depending on the organization's culture, goals, and the characteristics of the workforce. Mansaray (2019), p. 18. Effective leadership requires a diverse set of skills and competencies, such as communication, emotional intelligence, strategic thinking, and decision-making.

2. LEADERSHIP THEORY

It seems obvious that change management thus requires responsible leadership to succeed (Judge & Piccolo, 2004, p. 755).. Section 1.2 introduces recognized leadership definitions, full-range leadership theory and the Upper Echelons framework to develop a research model for the analysis of leadership impact in organizational change processes.

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3. LEADERSHIP CONCEPTS AND APPROACHES

"In essence, leadership is a dynamic and multifaceted phenomenon, best described as a 'process through which an individual exerts influence over a group of people to collectively pursue a shared objective' (Northouse, 2018, p. 3). This comprehensive definition contains three aspects of leadership:
- The goal-oriented perspective
- The trait-based perspective
- The behavior-based perspective

Facets detailed to extent in academic leadership literature:

Trait-based approaches to the leadership concept focus on inherent traits or characteristics that leaders possess, such as charisma, intelligence, or decisiveness (Zaccaro, 2007, p. 6). This view suggests that leaders are born with certain qualities that set them apart. Trait based leadership theories seek to identify specific qualities that are common among successful leaders, e.g. confidence, openness, emotional intelligence or communication skill (Kelloway & gilbert, 2017, p. 193). The trait-based approach has faced criticism for oversimplifying leadership and neglecting the situational and contextual factors that influence leadership effectiveness (Taylor, 2019, p. 26; Jalšenjak& Richards, 2023, p. 2).

4. CONCEPTUAL FRAMEWORK

The thesis uses a systematic literature review comprising prior research on the impact of transformational leadership on change and potential moderating or mediating factors in the automotive sector and related manufacturing industries to concretize the theory-based model concretizes the review design and evaluation process, provides a tabular overview on relevant studies. Chapter 6 summarizes the review results on the impact of transformational leadership on organizational development and change and chapter 7 summarizes the results on moderating or mediating factors in organizational contexts and change processes to derive research hypotheses. Chapter 8 summarizes the review results and concretizes the work model based on the review.

5. REVIEW DESIGN

A systematic review, as a methodological approach, involves searching for, gathering, and systematically analyzing past research to address specific queries. This process is applicable both as an autonomous research project and as a foundation for future empirical studies, as exemplified in this thesis. Such reviews yield insights into previously established relationships and pave the way for new research, typically by consolidating findings into hypotheses or theoretical propositions in qualitative research (Eisend, 2004, p. 6). However, biases may arise from the review process, mainly due to selective or skewed interpretation and selection of primary studies. Ensuring transparency and replicability in the literature search and analysis procedures is essential to mitigate these biases. Snyder (2019, p. 336) proposes a four-step method.

The initial stage, termed the review design, entails defining the goals and research questions, a task was completed above. The actual review in phase 2 (Snyder, 2019, p. 337) encompasses academic research related to transformational leadership and potential moderators and mediator related to change process and organizational context with a focus on the automotive or manufacturing sector. Eligible academic research is derived from five scholarly databases: Google Scholar, EbscoHost, WISO, ScienceDirect, and Web of Knowledge.

The following key work combination is applied to identify eligible studies "transformational leadership" AND "organizational change" AND [automotive OR manufacturing] AND empirical.

The analysis encompasses studies with an empirical focus preferably using a quantitative approach (quantitative surveys and meta-analyses) and also includes systematic reviews with a concrete outcome but allows no conceptual papers without concrete novel results. It is required that studies are academically structured, meaning they include replicable research findings.

The review considers publications in peer-reviewed academic journals only, to ensure an academic standard. The focus is on publications in the time range of 2013 to 2023 to ensure topicality and consider research reflecting on the increasing significance of leadership research in the recent decade, particularly due to the rapid advancements of internationalization and multicultural interchange. To ensure a systematic evaluation of empirical primary studies, only publications available in full text are included.

Content-wise the focus of empirical studies in the explaining factor of transformational leadership and impact on organizational change is preconditional. Studies not indicating this focus in the title are not considered for

downloading. Studies analyzing the impact of transformational leadership on organizational performance or employee well-being or satisfaction without relevance to organizational change or development are discarded.

Potentially relevant studies based on title are downloaded locally and checked for quality manually, considering the source (peer-reviewed journal) and results (concrete empirical results required). They are categorized based on the researched moderators and mediators in table form. Reviews are considered individually to differentiate the own research from similar studies and build on the foundations of earlier review-based research systematically. Each primary text is labeled with the first author's name and publication year for easy reference. This method aligns with the objectives of a systematic review, which is to conduct a guided, comprehensive analysis of previous findings to derive new conclusions (Eisend, 2004, p. 6).

The empirical study outcomes are then textually assessed according to Snyder's (2019) fourth research phase, evaluating the main effect of transformational leadership on organizational development and change first and then analyzing the found moderating or mediating factors each and in interaction.

To outline the review process graphically and reproducibly a so -called PRISMA statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) is used (Moher et al., 2011, p. e9). It is a widely recognized guideline designed to improve the reporting quality of systematic reviews and meta-analyses. It provides a structured framework for authors, ensuring comprehensive and transparent reporting of research findings. PRISMA consists of a flow diagram documenting study selection and a chart required for study classification (Moher et al, 2016, p. 1-2): The PRISMA flow diagram visually presents the flow of study selection through the different phases of a systematic review. It maps out the number of records identified, included, and excluded, and the reasons for exclusions. This diagram is crucial for understanding the search and selection process of studies in the review. It illustrates that from the texts retrieved for the key-word combination, 178 studies are filtered as eligible since published in 2013 or later and are available in full-text. These 138 studies are not relevant according to the title since they do not refer to change processes directly. The 40 remaining eligible studies are downloaded. A manual quality and content check eliminates five further studies, as documented in the overview-table (Aarons et al.,02015: no change context; Gathungu et al., 2015: Review too superficial results in pure review; Rafferty et al., 2013: document not readable; Shvindina, 2017: low depth of results in pure review; Usuman, 2020: no adequate depth in pure review). 35 studies remain for textual evaluation. From the retrieved 6 reviews four are discarded due to lacking depth, only two are retained (Oreg & Berson, 2019 and Appelbaum et al., 2015). They are rich in effect range and quality and support the structure of the following argumentation.

34 studies are empirical and 32 of these are quantitative (except Penava & Šehić, 2014: case study; Busari et al., 2019: mixed method). 22 empirical studies analyze the impact of transformational leadership and further moderating or mediating factors, 11 focus on the main effect of transformational leadership only.

The following graphical outline in the style of a PRISMA statement illustrates the research and evaluation process:

Table 1: PRISMA Flow diagram
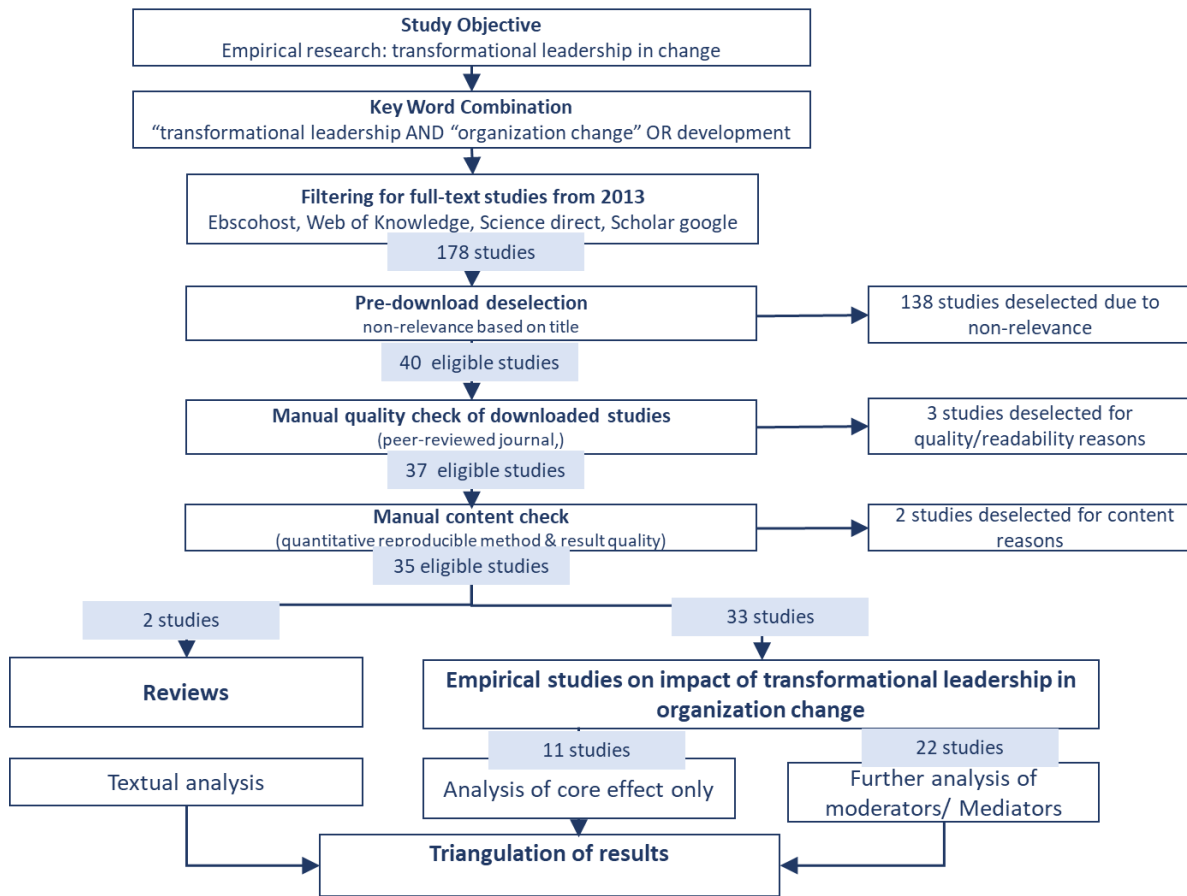
5.1 Tabular study overview

The PRISMA checklist includes items focusing on various aspects of a systematic review, here author/ publication year, sample/ origin, statistical methods, input factors, target factors, confirmed relationships, and limitations are included. The PRISMA checklist guides the verbal reporting process ensuring clarity, completeness, and transparency. The detail tabulary study is not part of the paper due to volume limitation.

6. STATUS OF RESEARCH ON LEADERSHIP IMPACT IN THE CONTEXT OF ORGANIZATIONAL CHANGE

To structure the textual evaluation on the impacts of transformational leadership the target effects are classified, based on a method suggested by Webster & Watson (2002). The observed target effects as listed in column four of the PRISMA check list are organized by categories and listed in a concept.

Table 2: concept table of target/ output effects of transformational leadership

Concept matrix of effects of transformational leadership in organizational change processes		
Employee level	Employee change acceptance/ readiness	Abbasi, 2017
		Chou, 2014
		Tayal et al., 2018
	Employees' attitude during/ to change	Faupel, 2019
		Onyeneke & Abe, 2021
		Penava & Šehić, 2014
	Resistance to change	Appelbaum et al., 2015

		Groves, 2020
	Willingness& support to change	Van der Voet, 2014
	Employee reactions to change	Peng et al., 2020
		Saleem & Saheryar, 2017
	Employee commitment to change	Santhdran, 2013
		Thuy & Van, 2020
		Van der Voet, 2015
	Employees behavioural support for change	Chou, 2015
	Trust and participation in organization change	Busari et al., 2019
		Yue et al., 2019
	Follower extra effort	Groves, 2020
	Championing behavior	Islam, 2020
	Work engagement	Islam et al., 2021
	Leadership transition support	Zhao, 2016
	Employee creativity	Teymournejad & Elgai, 2017
Organization level	Organizational change management	AlQura'an, 2016
	Organizational readiness to change	Potnuru et al., 2021
	Affective organizational commitment	Pradhan & Pradhan, 2015
		Rogiest et al, 2015
	Organizational change management capacity	Atasoy, 2020
		Yasir et al., 2016
	Error learning	Bligh et al., 2018
Performance level	Change implementation	Appelbaum et al., 2015
		Harb, 2019
	organization change	Bligh et al., 2018
	Organizational learning	Noruzy, 2013
		Rijal, 2016
	Organizational innovation	Noruzy, 2013
	Readiness to innovate	Tan, 2020
	Organizational response & Outcome	Oreg & berson, 2019
	Orgnaizational performance	Noruzy, 2013
	Contextual performance in change	Pradhan & Pradhan, 2015

Table 2 illustrates that the reviewed studies utilize a broad range of little homogenous target parameters to measure the impact of transformational leadership in organizational change processes. Roughly the retrieved categories fall into three groups: employee level, organization level and performance level measures of change process/ implementation.

More roughly but conceptually similarly, Oreg & Berson's (2016, p. 274) review classifies the effects leadership behavior in change process impacts, organizational change responses and organizational change outcomes. Their review also outlines that impacts at the three stages of the organizational change process build on each other:

Employee level acceptance of and support to change (level 1) is preconditional to organizational change readiness and implementation (level 2) which again is preconditional to change performance (level 3). This observation is comparable in Oreg & Berson's review (2016, p. 274), where the change process predetermines responses to change and organizational outcomes.

The impacts of transformational leadership in change processes are thus obvious at three interconnected levels of organizational change according to the review results and the concept matrix of impacts of transformational leadership in organizational change processes illustrates this review.

The retrieved previous empirical studies largely coincide concerning positive impact of transformational leadership in change situations. The following sections report the results by effect level

6.1 Employee level effect of transformational leadership

Abbasi (2017, p. 41), explores the relationship between transformational leadership and employee change readiness in government organizations, and finds a positive relationship. Chou (2014, p. 57) investigates how transformational leadership influences employees' support for organizational change in Taiwanese companies. Using data from 379 employees across nine companies, the study examines the direct and indirect effects of transformational leadership on behavioral support for change. Results indicate that transformational leadership directly enhances employees' behavioral support for change and boosts it indirectly by improving self-efficacy. Yayal et al. (2018, p. 569), examines the role of transformational leadership in influencing employee acceptance of change in Indian banks and confirms the core effect: transformational leadership positively impacts employee acceptance of change.

Faupel & Süß (2019, p. 138) differentiate this effect chain of transformational leadership on employees: Transformational leadership positively influences employee valence and work engagement, which in turn positively impacts championing behavior during change. A survey in the Federal Ministry of Education in Nigeria observes, that change leadership significantly affects employees' cognitive appraisal of change, but not their emotional response or behavioral intentions (Onyeneke & Abe, 2021, p. 12). Penava and Šehić (2014, p. 144) examine the impact of transformational leadership on employee attitudes during organizational changes in a Bosnian company. It analyzes three different organizational changes, assessing the influence of various leadership behaviors on employee attitudes and resistance to change. The study finds that the effectiveness of transformational leadership varies depending on the nature of the change, highlighting the complexity of leadership and employee dynamics during organizational transformations.

Resistance to change on the other hand is diminished by transformational leadership: Appelbaum et al. (2015, p. 141) suggest that leadership styles, including transformational leadership, can significantly impact employee attitudes towards change, either directly by shaping employee attitudes throughout the change or indirectly by influencing factors that predispose employees to change. Groves et al.'s (2020, p. 42-43) survey among different Californian businesses demonstrates that transformational leadership influence on employee attitudes and behaviors during change is mediated by employee values

Van der Voet (2014, p. 6) examines how transformational leadership and the bureaucratic structure of public organizations affect employee willingness to change and concludes that transformational leadership's impact varies with the change approach (planned or emergent) and organizational structure. Within the Army Public Schools and Colleges System in Pakistan, transformational leadership and leaders' openness to change negatively correlate with employees' intentions to resist change. Conversely, leaders' conservation values positively correlate with resistance intentions (Saleem & Naveed, 2017, p. 72). Peng et al. (2021, p. 369) conduct a meta-analysis to assess the impact of transformational leadership on employee reactions to organizational change. The research synthesizes data from multiple studies and concludes that transformational leadership is significantly related to positive employee reactions to change. This includes reduced resistance and increased commitment to change. The study underscores the effectiveness of transformational leadership in facilitating smoother transitions during organizational changes.

Transformational leadership strengthens employee commitment to organization change according to Thuy (2020, p. 10) who analyzes 381 employees from post-merger enterprises in the retail and pharmaceutical sectors, transformational leadership positively and significantly influences affective, normative, and continuance commitment to change. Santhidran et al. (2013, p. 355) investigates the relationship between transformational leadership, change readiness, and commitment to change. Conducted in a Malaysian energy organization, the study finds that leadership positively affects change readiness, but not directly commitment to change. Change readiness significantly influences commitment to change, acting as a mediator between leadership and commitment. Van der Voet (2016, p. 21) explores the influence of change leadership and organizational characteristics on employee commitment to change in the public sector and concludes that transformational leadership positively influences employee participation and commitment to change. Beyond that, employee behavioral support for change is strengthened by transformational leadership as Chou (2015, p. 118) observes for a sample of employees in multiple Taiwanese organizations.

This effect is brought forth by employee trust and participation on organization change, which is encouraged by transformational leadership according to Busari et al.'s (2019, p. 192) research in Pakistanian telecommunication companies and Yue's et al.'s (2019, p. 8) survey among 439 US Employees.

According to data from employees in Bangladesh's banking sector, transformational leadership significantly relates to championing behavior (Islam & Furuoka, 2020, p..9). A follow up study for the same sample reveals that transformational leadership significantly boosts employee trust in leadership, which in turn positively affects their championing behavior during organizational change (Islam et al., 2021, p. 100). Groves (2020, p. 44) investigate the relationship between transformational leadership, employee values, and their response to organizational change and

basically finds a positive impact of transformational leadership strategies on employees' readiness to cooperate in change processes.

Beyond, transformational leadership strengthens employee creativity according to a survey in Maskan Bank in Tehran. It highlights the importance of leadership characteristics like idealized influence, intellectual stimulation, individualized consideration, and inspirational motivation in fostering a creative work environment (Teymournejad & Elghaei, 2017). Zhao et al. (2016) find for a Chinese sample that in leadership transgression processes, new leader's transformational leadership on employees' resistance to, and support for, change is moderated by the former leader's leadership style. A new leader's transformational leadership is more effective in reducing resistance and increasing support for change among employees.

Condensing these results transformational leadership brings forth a positive reaction cycle in employees who are confronted with change situations (Abbasi, 2017; Chou, 2014; Tayal et al., 2018), which unfolds as follows: transformational leadership strengthens employee trust in leaders and organization, which increases employees positive attitude on and finally acceptance of change (Faupel & Süß, 2019; Onyeneke & Abe, 2021; Penava & Šehić, 2014) or respectively diminishes their resistance to change (Appelaum et al., 2015; Groves, 2020). Based on the acceptance of required changes employees development the willingness (Vander Voet, 2014) and even commitment to support the change (Peng et al., 2020, Saleem & Saheryar, 2017). They participate in the advancement of change processes (Busari et al., 2019; Yue et al., 2019) and finally even show extra effort and creativity to implement organizational change (Groves, 2020; Islam, 2020, Islam et al., 2021). Fig. 1 summarizes this cycle:

Fig. 1 Cycle of impact of transformational leadership on employee attitude and behavior in organizational change situations
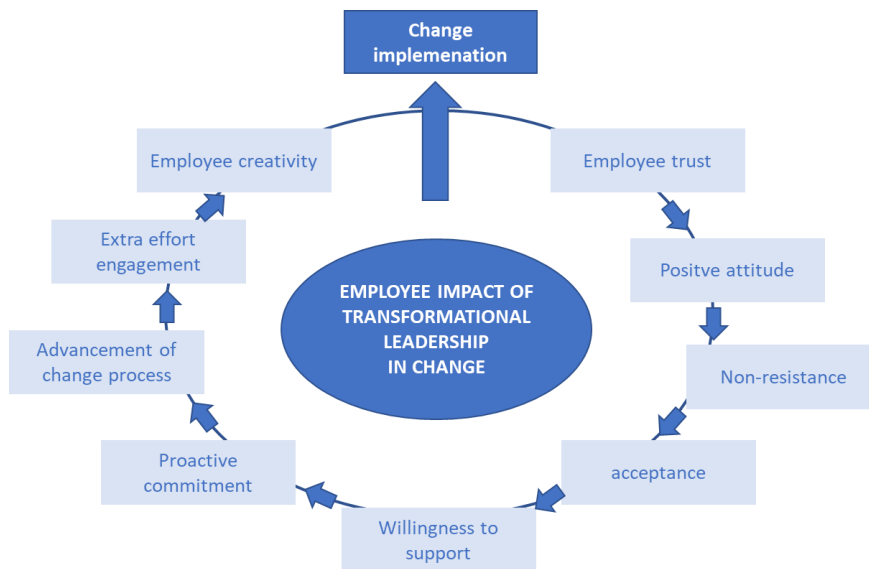
Based on this here derived effect chain an initial hypothesis is developed:
H1: Transformational leadership strengthens employee support for organizational change processes.

6.2 Organization level effect of transformational leadership

Transformational leadership prepares the whole organization to accept and manage the change process. Several studies confirm this empirically.

Focusing on Jordan Ahli Bank, AlQura'an (2015, p. 6) uses questionnaires completed by 44 branch managers of Ahli Bank in Iran to analyze the influence of transformational leadership on structural, technological, and people changes within the organization. The study concludes that the dimensions of transformational leadership—idealized influence, inspirational motivation, intellectual stimulation, individualized consideration, and empowerment—significantly affect change management in these areas. According to Rogiest et al. (2018, p. 26) employee orientation towards leadership affects their reaction to participative leadership during organizational change. The study finds that participative leadership can have varying effects on affective commitment to change, depending on the individual's leadership orientation. For those with a high dominance orientation, participative leadership reduces affective commitment to change, whereas for those with a high development orientation, it enhances commitment. This study underscores the importance of considering individual differences in leadership orientation when implementing participatory approaches in organizational change. A study in the Indian public sector confirms that transformational

leadership enhances the relationship between employee voice and commitment to change, supporting its role in facilitating change readiness in organizations (Potnuru et al., 2021, p. 8).

Transformational leadership enhances organizational change management capacity. Atasoy (2020, p. 265) investigates how transformational and transactional leadership styles of school principals affect school culture and organizational change and finds that transformational leadership is more effective in creating a positive school culture facilitating organizational change processes. Yasir et al. (2016, p. 7) confirm the superiority of transformational leadership for NGO managers in Malaysia: Transformational leadership positively correlates with both employees' trust and organizational change capacity, whereas laissez-faire leadership negatively impacts these aspects. Transactional leadership also shows a positive relationship with organizational change capacity but not with employees' trust. Bligh et al. (2018, p. 132) examines how leadership styles, particularly transformational, transactional, laissez-faire, and aversive leadership, influence employee error learning in different cultural contexts (Europe, China, and the US). Transformational leadership accordingly fosters positive attitudes towards error learning, while laissez-faire and aversive styles inhibit it.

Summing up the results of these earlier empirical studies on the impact of transformational leadership in organizational change a second hypothesis is formulated:
H2: Transformational leadership enhances organizational change capacity.

6.3 Performance level effect of transformational leadership

A further group of studies confirms that transformational leadership is effective to make change processes succeed, and the change establish and perform: Based on A review Appelbaum et al. (2015, p. 140) examine multifaceted role of leadership in shaping employee responses to organizational change and explain that transformational leadership can reduce resistance to change in organizations. Harb and Sidani (2019, p. 213) highlight the role of transformational leadership in facilitating organizational change within the public sector in Lebanon. Using qualitative methods, including interviews with public managers, the study documents the significant influence of transformational leadership behaviors, particularly idealized influence and inspirational motivation, on successful organizational change.

Pradhan (2015) explores the impact of transformational leadership on affective organizational commitment and contextual performance of employees in the Indian IT sector. The study utilizes a sample of 480 software professionals and employs statistical analysis to understand these relationships. The findings indicate a significant positive influence of transformational leadership on both affective organizational commitment and contextual performance, with affective organizational commitment also positively linked to contextual performance. Transformational leadership enhances employee commitment and performance in change processes beyond their formal role requirements.

Noruzy et al. (2013, p. 1081) explore the interplay between transformational leadership and various organizational factors in Iranian manufacturing companies. It finds that transformational leadership positively influences organizational learning and knowledge management, which in turn positively impacts organizational innovation and performance. The study underscores the pivotal role of transformational leadership in fostering a learning culture and knowledge management practices, leading to enhanced innovation and improved organizational performance.

A comparative analysis of the IT sector in Nepal and India examines the impact of transformational leadership and organizational culture on developing learning organizations transformational leadership significantly influence the evolution of learning organizations in different cultural contexts (Rijal, 2016, p. 126). Tan et al. (2020, p. 701) explores how transformational leadership influences innovative work behavior in Singapore and highlight the importance of transformational leadership in fostering an environment conducive to innovation, especially in a collectivist cultural context like Singapore.

Summarizing these results on transformational leadership impact on organizational change performance a third hypothesis is suggested:
H3: Transformational leadership enhances change implement organizational learning and innovation in change.

7. STATUS OF RESEARCH ON MODERATING FACTORS OF CHANGE READINESS, IMPLEMENTATION AND OUTCOME

22 empirical studies consider moderators and mediators codetermining the impact size of transformational leadership in organizational change processes. The considered mediators and moderators are classified in a concept matrix in the style of Webster & Watson (2002, p. xvii) to organize the textual evaluation first.

Table 3: Concept matrix of moderators and mediators of transformational leadership impact in organizational change processes according to earlier studies

Concept matrix of moderators and mediators of transformational leadership impact in organizational change processes		
Change related	Perceived Valence of change	Faupel & Süß, 2019
	Change magnitude	Groves, 2020
	Change readiness Commitment to change	Santhdran, 2013 Zhao, 2016
	Change communication	Van der Voet, 2015 Yue et al., 2019
Organization-related	Bureaucratic structure Bureaucratic/ non-bureaucratic structure	Abbasi, 2017 Van der Voet, 2014
	Red tape (burden of administrative rules)	Van der Voet, 2015
	Use of IT	Tayal et al., 2018
	Organizational culture	Atasoy, 2020 Oreg & Berson, 2019 Rijal, 2016
	Leaders' personal attributes	Saleem & Saheryar, 2017
Employee-related	Employee mindset (fixed/ growth)	Bligh et al., 2018
	Employee intentions	Onyeneke & Abe, 2021
	Follower values (openness, self-transcendence)	Groves, 2020 Oreg & Berson, 2019
	Innovative behaviour	Tayal et al., 2018
	Perceived self-efficacy	Chou, 2014
	Work engagement	Faupel & Süß, 2019 Islam, 2020
	Trust in leadership/ in change	Islam et al., 2021 Yasir et al., 2016
	Employee participation	Busari et al., 2019 Van der Voet, 2015
	Employee voice & involvement	Potnuru et al., 2021
	Employee job satisfaction	Thuy & Va, 2020

The concept matrix of moderators and mediators of the impact of transformational leadership in organizational change (

Table 3) identifies three categories of moderators/ mediators: change- related, organization-related and employee-related factors. These are discussed in the following sections:

7.1 Change-related moderators/ mediators

The perceived effect and communication of the organizational change itself moderates the impact of transformational leadership in change processes.

The perceived consequences of change (valence) mediate the impact of transformational leadership on employees' championing behavior in a multi-industry study: transformational leadership enhances work engagement and valence, leading to positive employee behavior in support of change (Faupel & Süß, 2019, p. 14). For a sample of leaders and followers in Californian enterprises, the magnitude of organizational change moderates these effects, offering a

nuanced understanding of how transformational leadership impacts employee behaviors and attitudes in varying contexts of organizational change (Groves, 2020, p. 43).

Van der Voet (2016, p. 42) explores how communication about change mediates the relationship between leadership styles (transformational and transactional) and employee acceptance of change in public organizations. It highlights the importance of effective change communication in enhancing employee acceptance of change initiatives, particularly under transformational leadership. Transformational leadership and effective change communication in organizations enhance employee trust which again encourages employee openness to change for a sample of US-employees (Yue et al., 2019, p. 8).

Based on these prior observations on the contextualization of change as a mediating factor the following fourth hypothesis is derived.

H4: Constructive communication (H4a) and high perceived valence of the change (H4b) positively moderate the impact of transformational leadership in organizational change processes.

7.2 Organization-related moderators/ mediators

Organizational practice and culture further codetermine the effectiveness of transformational leadership in change processes according to previous research:

Abbasi (2014) explores the impact of transformational leadership on change readiness in government organizations, considering the role of perceived bureaucratic structure. The study, involving 600 employees from three state organizations in Rasht, Iran, found that transformational leadership positively affects change readiness. However, the introduction of bureaucratic structure as a moderating variable negatively moderates this effect.

For a Dutch sample of employees in public organizations, the impact of transformational leadership on employee willingness to change varies depending on the type of change approach (planned or emergent) and the organizational structure, where emergent cultures are more effective in the mediation of change. Transformational leadership significantly contributes to emergent change processes in non-bureaucratic contexts but has limited impact on planned change processes (Van der Voet, 2014, p. 6). Transformational leadership positively influences employee participation in change. However, this effect can be moderated by the level of bureaucratic red tape within the organization, suggesting that organizational culture and environment play crucial roles in determining the effectiveness of transformational leadership in change processes (Van der Voet, 2016, p. 42).

Organizational culture is broadly recognized as an important mediator of transformational leadership in change. In the Indian banking sector, transformational leadership positively affects employee acceptance to change. This relationship is mediated by employee innovative behavior and moderated by the use of information technology (IT) (Tayal et al., 2018, p. 569).

Atasoy (2020, p. 264) investigates the mediating role of school culture in the relationship between transformational and transactional leadership styles and organizational change. The study, conducted among 382 teachers in North Cyprus, finds significant relationships between leadership styles, school culture, and organizational change. School culture is identified as a mediator between both leadership styles and various sub-dimensions of organizational change. Leaders' attributes play an important role in that context: Zhao et al. (2016, p. 14) investigate how the transformational leadership of both former and new leaders affects employees' responses to organizational change in a large Chinese hospitality organization, involving 203 employees from 22 teams. Here highly transformational former leaders can constrain the effectiveness of a new leader, while a low transformational former leader enhances the new leader's effectiveness. Saleem and Naveed's (2017, p. 73) study focuses on how transformational leadership and leaders' personal values influence employee reactions to organizational change. Conducted in the Army Public Schools and Colleges System in Pakistan, it found that leaders' personal attributes, including their openness to change and conservation values, are mirrored in employee resistance to change. For a sample from the IT sector in India and Nepal, transformational leadership and organizational culture influence the development of a learning organization. The research concludes that both transformational leadership and generative and adaptive cultures positively impact the development of learning organizations (Rijal, 2016, p. 126).

Based on these observations on the impact of organizational style and culture a fith hypothesis is suggested:
H5: An open (H5a) and non-bureaucratic (H5b) organizational culture positively mediates a transformational leadership style in change processes.

7.3 Employee-related moderators/ mediators

Finally, employee-related moderators and mediators are observed:

First, employee traits and character type are found relevant in several studies: Santhidran et al. (2013, p. 358) examines mediators in the relationship between transformational leadership and commitment to change. For a sample from a Malaysian energy company of 205 respondents change readiness positively mediates the core relationship. Follower openness to change and self-transcendence values mediate the relationship between transformational leadership and employee reactions to organizational change according to an employee survey (Groves, 2020, p. 43). Similar high perceived self-efficacy mediates the impact of transformational leadership on employee readiness to change in a mixed Taiwanese business sample (Chou, 2014).

Bligh et al. (2018, p. 132) explore the role of fixed versus growth mindsets as a mediator of different leadership styles for samples from Europe, China and the USA. The findings suggest that transformational leadership fosters positive attitudes towards error learning, while laissez-faire and aversive styles inhibit it. Employees' growth mindset significantly enhances their error learning orientation.

Leaders seem to have an influence on employee mindset and attitude in change: For a Nigerian Federal Ministry undergoing significant reform, change leadership behaviors significantly impact on employee cognitive appraisal of change, but not directly on behavioral intentions to support change. The relationship between change leadership and behavioral intentions is mediated by cognitive appraisal and emotional response (Onnyeneke & Abe, 2021, p. 403).

Transformational leadership positively affects employees' work engagement and strengthens employees' productive collaboration in change processes for a multi-industry sample (Faupel & Süß, 2019, p. 12). Employee innovative behavior mediates the relationship of Indian Bank Managers to change processes in their bank under transformational leadership (Tayal, 2018, p. 568). Employee work engagement mediates the relationship between transformational leadership and championing behavior in organizational change processes for a cross-sectional sample in Malaysia (Islam & Furuoka, 2020, p. 9).

The establishment of a productive collaboration between leaders and their followers is found an effective mediator of transformational leadership in change processes: Employee trust in leadership or in the change process as a whole reinforces the positive effect of a transformational leadership practice according to a study in the Bangladesh Banking sector (Islam et al., 2021, p. 99). Organizational change capacity of NGOs similarly benefits of the mediating effect of employee trust, which is further strengthened by transformational leadership (Yasir et al., 2016, p. 8).

Employee trust and support for change processes can be instilled by targeted measures of participation and involvement. Busnari et al. (2020, p. 193-194) finds a mediating effect of employee followership as an interaction term in a model explaining change frequency and change participation. Recipients' commitment to change is strengthened by intense and open change communication for a mixed Dutch sample (Vander Voet, 2016, p. 13). Potnuru et al. (2021, p. 11) confirm the positive mediating impact of employee voice and involvement in change processes for Indian public sector organizations. Further, employee job satisfaction is a positive mediator of transformational leadership to encourage change acceptance according to Thuy & Van's (2020, p. 9) analysis of employee commitment to organizational chance in the post-merger phase of retail and pharmaceutical enterprises in Vietnam.

Based on these observations a final sixth hypothesis is suggested.

H6: Employee self-efficacy, growth-mindset, leadership trust and change participation positively mediate the impact of transformational leadership in organizational change processes.

8. SUMMARY OF REVIEW RESULTS

The review results enrich and detail the initially suggested research model as illustrated in

Fig. 22 below. According to this refined work model, transformational leadership has a positive direct effect on employee support of organizational change (H1), organizational change capacity (H2) and organizational learning and innovation in change (H3). High perceives change valence and constructive change communication (H4a and H4b) moderate these relationships, a non-bureaucratic and open organizational culture (H5a and H5b) and high employee openness, growth mindset and trust in the process and leaders (H6a, H6b and H6c) mediate the impact of transformational leadership on the target effects.

The review conducted the range of studies on the impact of transformational leadership on change, comprises 40 per-reviewed studies, and has found a plethora of potentially relevant direct and indirect effects on three coherent target factors. However available empirical research on transformational leadership in change processes faces some important limitations.

Each of the reviewed studies focuses on specific aspects of organizational change, such as leadership or communication strategies, but neglects other critical areas like employee resistance or cultural aspects. The work

model suggested in figure 2 represents a synopsis of previously assessed categories but several interactions and cross effects never considered before may emerge in the process of further empirical research.

Fig. 2 Review-based, detailed research model
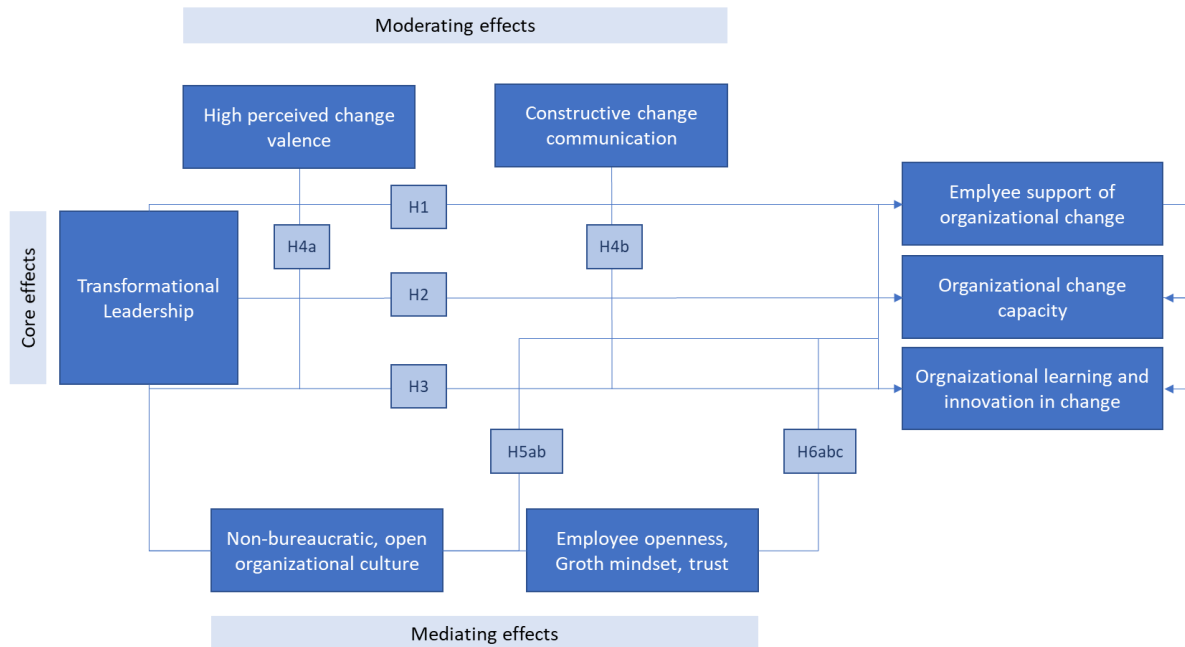
The evaluated studies are each conducted in specific organizational contexts or industries, making it challenging to apply the findings universally. Different organizational cultures, sizes, and industries may respond to change differently. So far, no study in the German / European automotive sector is available. Further research is required to explore the impacts of transformational leadership and potential moderators and mediators in change processes here, to design these effectively.

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The Moderatıng Role of Age and Tenure in the Relatıonshıp Between Dıstrıbutıve Justıce and Organızatıonal Cynıcısm

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Abstract

In the global dynamic business life where sustainable competition is constantly increasing its importance, every factor in the work life becomes important. Managing the factors in the work environment increases employee performance and becomes an important part of competitiveness. In this context, managing attitudes such as cynicism becomes a critical success factor. Considering that the most important resource for the organization is the human factor, balancing factors such as organizational cynicism, which is a result of negative attitudes towards the business, and increasing positive attitudes and behaviors within this framework has become an important factor for managers. In this study, the effect of distributive justice on organizational cynicism and the moderating role of age and tenure in this relationship were investigated with a study conducted in the health sector (n=350). The findings revealed that distributive justice (DJ) has a negative and significant effect on organizational cynicism (OC). Along with this expected finding, it was determined that age and tenure have no moderating role in the relationship between justice and cynicism. It is evaluated that the findings obtained will be useful for health sector managers.

Keywords: Distributive justice; organizational cynicism; age; tenure; health sector

1. INTRODUCTION

The health sector is an important sector that plays a critical role in meeting the health needs of societies. The performance of employees in this sector is an important factor affecting the health of individuals and society. Increasing job performance in a sustainable manner is indispensable to improve the quality and effectiveness of health services. There are many antecedent variables that are effective on performance. This study examines the relationships between Cynicism, Distributive Justice, age and experience.

The emergence of cynicism in working life can be expressed as organisational cynicism. The cognitive (belief) dimension of organisational cynicism is the belief that the organisation lacks honesty (Torun and Çetin, 2015: 139). Employees' distrust or disappointment as a result of the experiences against the workplace, society, colleagues and managers is the initial stage of negative belief. This negative perspective turns into negative attitudes. It manifests itself as disliking and being ashamed of the organisation, getting angry, doubting everything and criticising everything. This situation brings along many problems for both the organisation and its employees.

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In both social and organisational contexts, distributive justice is a concept that deals with the sharing of all kinds of gains such as tasks, goods, services, opportunities, punishments/rewards, roles, statuses, wages, promotions, etc. among individuals (Cohen, 1987). Employees who think that they are not treated fairly in the organisation may negatively affect the success of the organisation due to this perception.

In this study, the relationship between distributive justice and cynicism and the role of age and tenure in this relationship are examined through an empirical study conducted in the health sector with citations from the business literature.

2. METHODOLOGY

2.1. Sample

The population of the research consists of health sector employees in Antalya. The sample of the research consists of subjects selected by simple random method among the employees of health institutions operating in the centre of Antalya. Approximately 3500 people work in these institutions. Taking into account a 5% margin of error within 95% reliability limits from the main mass, the sample size was calculated as 350 people (Sekaran, 1992). In this context, a total of 500 people randomly selected by convenience sampling method were planned to be surveyed. Of the questionnaires sent, 355 were returned and 350 of them were found suitable for analysis. In the extreme value analysis, 5 data sets that violated the normal distribution of the variables were removed and the questionnaire filled by 350 participants was included in the analyses.

In order to measure the organisational justice levels of the employees, the three-dimensional (procedural justice, interaction justice, distributive justice) organisational justice scale developed by Moorman (1991) and validated by Niehoff and Moorman (1993) was used. The 5-item distributive justice scale of this scale was included in the analysis as an independent variable.

In order to determine the level of organisational cynicism of healthcare workers, the scale developed by Brandes in 1997 was used in its first version with 14 items. The scale was then revised by Brandes, Dhanwadkar and Dean (1999) and transformed into a 13-item scale by eliminating an item belonging to the behavioural dimension. The scale validated by Karacaoğlu and İnce (2012) was used in this study.

2.2. Findings

Hierarchical regression analyses were performed to reveal the predictive and moderating relationships between variables. The research model is presented in Figure 1 and CFA findings of the scales used in the research are presented in Table 1.

Since the organisational cynicism scale among the research scales did not confirm its 3-dimensional structure, it was included in the analysis by being confirmed as a single dimension.
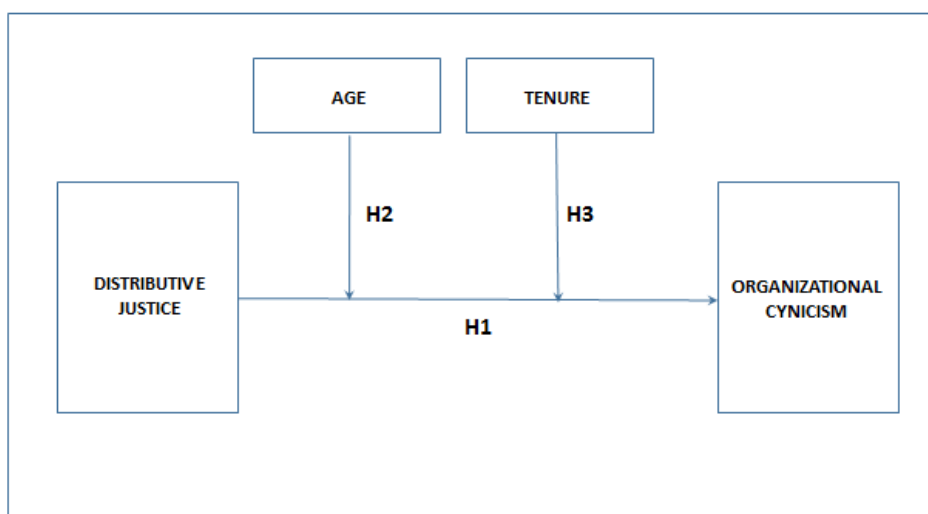
Figure 1: Research Model

Table 1. Goodness of Fit Values of the Scales at the End of Confirmatory Factor Analysis

Variables	X²	d f	CM IN/ DF ≤5	G FI ≥. 85	AG FI ≥.8 0	C FI ≥. 90	N FI ≥. 90	T LI ≥. 90	RMS EA ≤.08
1. Distributive justice	96,6	3 2	3,2	0, 93	0,9 0	0, 97	0, 94	0, 94	0,06
2.Organizational cyncism	66,8	2 5	2,6	0. 98	0.9 5	0. 98	0. 98	0. 99	0.07

Note: Goodness of fit value ranges are arranged according to ' *acceptable'* standards.

Pearson correlations were calculated in Table 2. The results of the analyses show that cynicism has significant relationships with some independent variables.

Table 2. Mean, Standard Deviation and Correlation Values

Variables	Mean	S. D.	1	2	3	4
1. Org. cnycism	2,75	0,98	-			
2. Age	38,3	10,7	-.04	-		
3. Tenure	14,7	9,7	-.04	,83***	-	
4. Distributive justice	2,85	1,20	-.41***	.01	.04	-

*p≤.05; ***p≤.001

In this study, which aims to determine the moderating role of age, hierarchical regression analyses were conducted to test the hypotheses.

In the analysis process, distributive justice (DJ) was included in the model as independent variable, organisational cynicism (OS) as dependent variable and age as moderator variable (Table 2). The independent variable and the moderator variable were centralised when they were added to the analysis (Cohen et al., 2003).

According to the results of Table 2, which includes the analyses conducted in the first stage, it is seen that the relationship between DJ and OC is negative and significant*(β =--.41; p≤001)*. Thus, **Hypothesis 1** was supported. According to these findings, DJ appears as a factor that decreases OC. As a result of these findings, the effect of age on OC was found to be insignificant (β=-*.03; p>05*). It was determined that age did not assume a moderating role in the OJ-OC relationship. According to these results **,Hypothesis 2 was not supported.**

Table 3. Hierarchical Regression Analysis Findings

	Org. Cnycism (OC)		
	Step 1	Step 2	Step 3
Variables	β	β	β
Dist. justice (DJ)	-.41***	-.41***	-.41***
Age		.-03	-.001
DJ x Age			-.09
R²	.17	.17	.18
Düz. R²	.16	.16	.17
F	71,3***	36,1***	25,8***

* p≤ .05, ** p≤ .01, ***p≤ .001

In the second stage, the moderating role of tenure in the DJ-OC relationship was analysed. According to the results of Table 4, which includes the analyses conducted, it was seen that the relationship between DJ and OC was positive and significant (β=.41; *p$\leq$001*) as before. As a result of these findings, the effect of tenure on OC was also found to be insignificant (β=-.*02; p>05*). As a result of the analyses, it was determined that tenure did not assume a moderating role in the DJ-OC relationship (β=-.*06; p>05*).

Table 4. Hierarchical Regression Analysis Findings

	Org. Cnycism		
	Step 1	Step 2	Step 3
Variables	β	β	β
Org. justice (OJ)	-.41***	-.41***	-.41***
Tenure		-.02	-.007
OJ x T			-.06
R^2	.17	.17	.17
Düz. R^2	.16	.16	.17
F	71,9***	36,03***	24,7***

* *p$\leq$ .05, ** p$\leq$ .01, ***p$\leq$ .001*

3. CONCLUSION

The results of the research conducted in private hospitals indicate that perceived distributive justice in the health sector reduces organisational cynicism in employees. This is an expected finding. As a matter of fact, it is a normal finding that distribution justice, which is a positive variable, reduces cynicism, which is a negative organisational variable. Since the decrease in cynicism is an important input for employee productivity, this finding is an important finding.

Another finding of the study is that low and high age in the sector does not create a significant change in the DJ-OC relationship. This finding is an unexpected finding. Because it is known that perception can change in certain periods of age. However, the endeavours of the employees in the health sector are not only related to work and compassion and humanitarian values should also be taken into consideration. It was evaluated that this finding may be caused by the sector. Unfortunately, it was not possible to support the finding since there is no similar research conducted with these variables.

Another finding of the study is that low and high level of experience in the sector does not create a significant change in the OJ-OC relationship. This finding is also unexpected. Because it is known that perceptions can change in certain periods of experience. It is also known that the efforts of the employees in the health sector are not only related to work and that compassion and humanitarian values should be taken into consideration. It has been evaluated that this finding may also be caused by the sector. It has been evaluated that this finding may be caused by the sector. Unfortunately, it was not possible to support the finding since there is no similar research conducted with these variables.

The study has various limitations. The most important of these limitations are that the study was conducted in a single sector and province and the study was not longitudinal. It is considered that longitudinal studies to be conducted in different sectors and different geographies may yield more objective results.

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Can Distance Education Centers Improve the Quality of Distance Education?

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Abstract

It is known that distance education applications are increasing with the widespread use and accessibility of the internet in the world. There are examples of countries providing basic education to their citizens and in relatively dispersed settlements, education is provided via radio, television or mail. The complete distance delivery of formal undergraduate education is associated with the physical distance between the instructor and the learner. The fact that everyone was exposed to this situation during the pandemic process, either prepared or unprepared, has been a situation that has been a challenge especially for higher education institutions. In this case, it was necessary to establish units within the institutions that organize the distance education process. Most universities in Turkey have tried to make these arrangements through Distance Education Centers (DEC) or Application Research Centers. However, there are various question marks about the functionality of these centers. These centers have turned into a body that has no sanctioning power and only provides technical support. This research was conducted to understand the changes that emerged as a result of DEC's practices at a state university. Thanks to the monitoring, reporting and stakeholder collaboration carried out in the spring semester of 2022-2023, when distance education was 100% due to the earthquake, numerical data on issues such as enrollment time, total amount of live courses and course content in distance courses were observed longitudinally. In the light of the data obtained, the importance of the effective work done by the units organizing distance education in increasing the quality even in a process that is difficult to control has emerged. The results emphasize the importance of the existence of DECs and the role of their more effective use in improving the quality of distance education.

Keywords: Distance education, educational quality, educational management

1. INTRODUCTION

With the developing technology and the global pandemic process, there have been changes and developments in the distance education system. Moore and Kearsly (2005) divide the historical development process of distance education into five periods: "learning by letter, radio and television broadcasts, open education institutions, teleconferencing, internet and web". All regions face similar challenges in delivering sustainable transport solutions to meet their current and future mobility requirements. Transport authorities are aware of the real needs specific to their region but often find it difficult to identify detailed information on targeted solutions that would deliver direct and tangible positive outcomes. Especially in the last two decades, the process of Internet-supported distance

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education has aims such as creating new educational opportunities, providing equal opportunities in education, ensuring lifelong learning, integrating educational technologies into the process, providing both individual and mass education opportunities, making education effective, efficient and cost-effective (Alkan, 1998; Cavanaugh, 2001).

Distance education methods are applied in two ways: synchronous and asynchronous (Burma, 2004). Synchronous communication is face-to-face communication that takes place at the same time but does not require people to be in the same place at that time. In the field of distance education, this type of communication is based on two or more computers connecting to each other over a computer network to share data and information. For example, communication can be through written text, audio tools, video and other techniques. In asynchronous applications, course content is presented to students one-way and interaction is extremely limited. In this application, TV broadcasting systems or materials such as books, CD ROMs, videotapes are used (Jonassen, 2000). Especially when compared to face-to-face education, distance education has significant advantages such as providing instant and easier access to information, reducing educational costs, and offering flexible and objective assessment and evaluation opportunities (Elitaş, 2017; İşman, 2008; Uşun, 2006).

Distance education is a system and has different dynamics in its structure. These dynamics are psychological structure, social structure, technological structure, instructional structure and organizational structure. Psychological structure refers to the motivation, beliefs and attitudes of individuals involved in the distance education process; social structure refers to the communication and responsibilities of individuals involved in the education process; technological structure refers to the software and hardware technology needed to create the flexibility and instructional ground of distance education; instructional structure refers to the teaching techniques and methods used during education; and organizational structure refers to the necessary institutional structure and coordination. The interaction of these five structures constitutes the distance education system (Brigham, 1992; Ehrman, 1990; Essary, 2014; Maguire, 2005; Menchaca and Bekele, 2008). It is also known that distance education within the organizational structure involves some difficulties in terms of supervision.

This research was conducted to understand the changes that emerged as a result of DEC's practices at a state university. In line with this purpose, the following questions were sought to be answered.
1. Is there a change in the total number of lessons as a result of DEC's feedback?
2. After DEC's feedbacks, has there been a change in the average lesson duration as desired?
3. Has there been a change in the total amount of synchronous video recordings as a result of DEC's suggestions?
4. Has there been a change in the average number of participants in synchronous lessons after DEC's suggestions?

2. METHODOLOGY

This study was conducted using a comparative study design (Creswell, 2014). The aim of the study is to examine the effects of interventions and improvements in the distance education process. In the first stage of the research process, the university's data on distance education were collected and an assessment of the current educational processes was made. Then, feedback was given to the instructors and administrators, and improvements were suggested in terms of educational processes and the quality of teaching. After these feedbacks, the same data were collected again and the effects of the changes were analyzed.

2.1. Data Collection Process

In the study, a pre-test post-test comparison was made and the changes between the data before and after the intervention were compared. Comparative analysis aims to understand the impact of developments and improvements in distance education (Creswell, 2014; Salkind, 2016). The data collection process consisted of two stages. In the first stage, existing data on distance education were collected. These data included the number of synchronous courses, course durations, the number of in-semester assessments (aternative assessment practices), and shared educational content. In the second stage, the same type of data was collected again after feedback to instructors and administrators. The data were re-analyzed to examine the improvements in education and the impact of the improvements.

During the implementation process of the research, various feedbacks and suggestions were given to the administrators of the educational units as DEC and directly to the faculty members based on various criteria. In line with the criteria determined by the university and in the literature on distance education, instructors who failed to meet the standards in criteria such as the number of contents, the number of synchronous courses and total course hours received feedback in this context.

2.2. Ethical Considerations

The research was conducted in accordance with university ethical rules and participant consent. Participants were informed about the research process and it was stated that participation was voluntary. Participants' identity information was anonymized and all data were kept confidential. In addition, no harm was caused to the participants during the research process (APA, 2020).

2.3. Data Analysis

Descriptive statistics were used in data analysis. First, the general distribution of the data, measures of central tendency (mean, median) and measures of dispersion (standard deviation) were calculated. In this way, the general trends of improvements in education and the magnitude of changes were observed (Thomas, 2017). In this context, the analysis consists of the course data of the faculties and departments of the courses that were made 100% online due to the major earthquake in Turkey. The data related to the courses were analyzed comparatively before and after the implementation.

3. FINDINGS

The findings of this study, which sought to understand the impact of DEC's audit work at a public university, include the variation of the average course data in the table below. These data were tracked for all courses during the semester, including data usage on all days.

Table 2. Semesterly change in the total number of synchronous classes on the days of the week
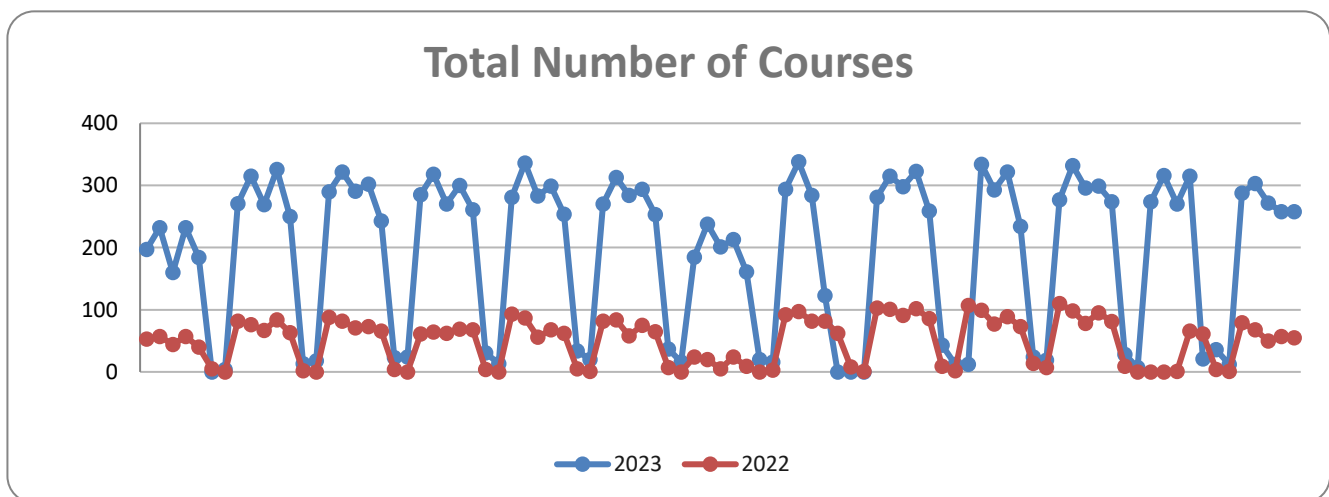
The table above shows the total number of synchronized lessons that were audited at the end of the first week compared to the previous year. The number of courses that were relatively lower in the first week increased slightly with the feedback in the first week. In general, there was a dramatic increase in all weeks compared to the period without supervision.

Table 3. Semesterly change in the Average Number of Students on the days of the week
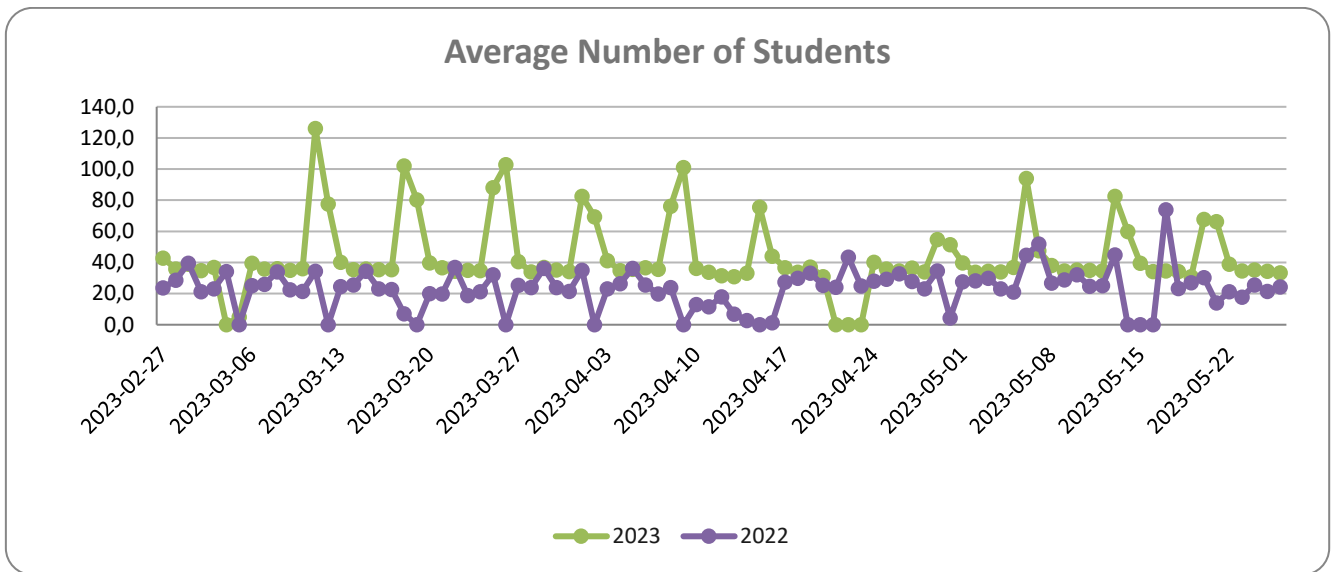
The table above shows the weekly change in the average number of users. As can be seen, the number of users was relatively similar in the first week, but after the first week of the audit, the average number of active users increased significantly.

Table 4. Semesterly change in the Total Video Recording (GB) on the days of the week
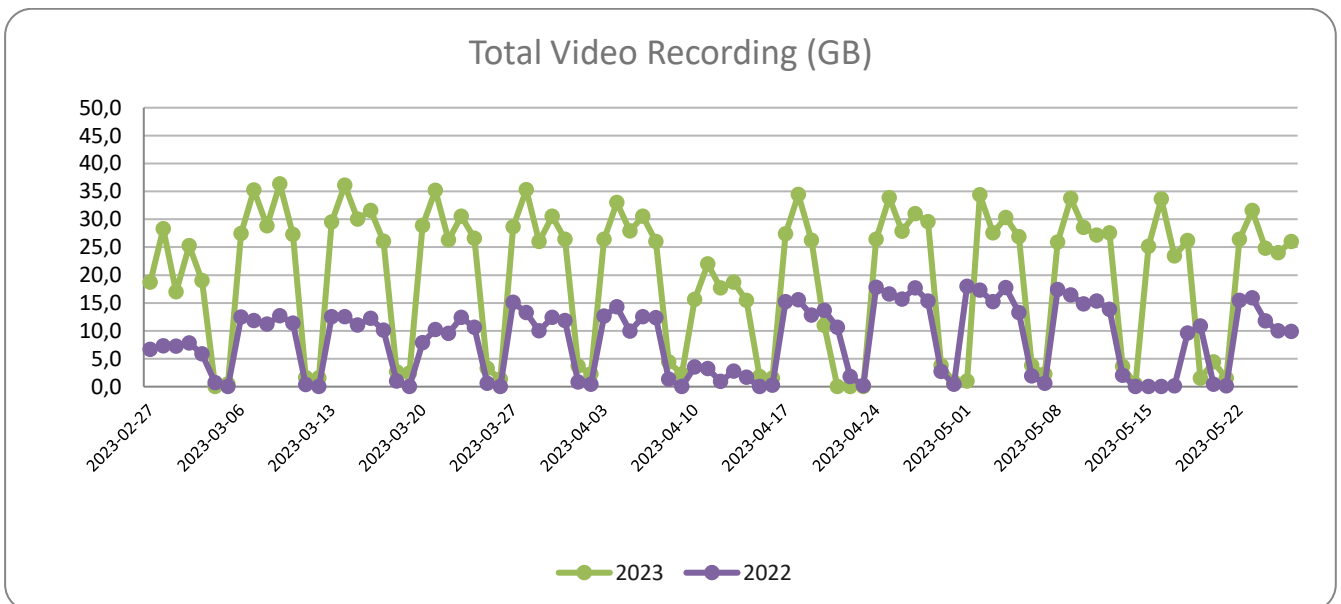
As can be seen in the table above, total video recordings changed significantly after the first week of the audit. After the second report given in the middle of the period, a significant decrease and increase can be observed in the graph. The difference with the previous year can also be clearly observed.

Table 5. Semesterly change in the Average Recording Time (Minutes) on the days of the week
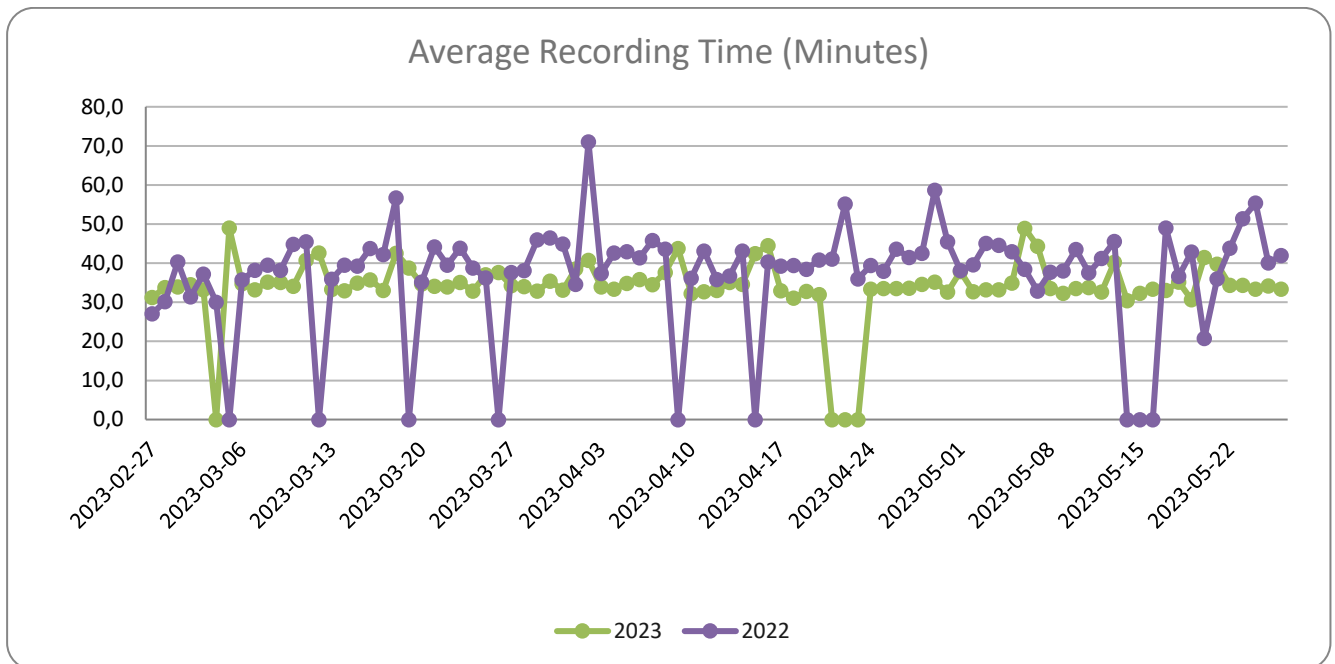
As can be seen in the table above, the average course enrollment minutes decreased relatively in 2023, the year of the audit. The purpose of this audit is to prevent lessons over 25-30 minutes as desired in distance education systems. The Blackboard learning management system used in the state university where the study was conducted keeps the records individually. This analysis also includes the records kept individually.

4. CONCLUSION AND DISCUSSION

The results of this study, which aims to discuss the results of the work of a unit established to audit the distance education process of a state university, are generally discussed in this section. In this context, positive changes were observed in data such as average course minutes, total number of courses, and total course area (GB).

The first issue examined within the scope of the research was the total number of courses of the faculty members reaching the desired criteria. As DEC, course records that did not meet the criteria were forwarded to the faculty member's unit. As a result of these feedbacks and suggestions, the course hours of the faculty members started to transform as desired. The second issue is the studies on the compliance of course hours with distance education standards in the distance education process. As a result of the work done to reduce the average duration of the courses to 25-30 minutes, the average duration has decreased to the desired levels. The literature suggests that the attention span should not exceed 25 minutes in the distance education process (Lemke, 2022). In this context, the university where the study was conducted has also published a distance education regulation. Another regulation made within the scope of the research is related to the content that faculty members share directly. The total size (GB) of the lecture was monitored by whether the lecturers posted informative or direct instructional content in the space reserved for the lecture. At the end of the study, it was concluded that shared content and total enrollments increased.

To summarize, it can be said that the unit assigned to regulate the distance education process has successfully fulfilled its duty in line with the criteria determined, limited to the university where this research was conducted. In this context, it can be said that the number of courses, average course minutes and the amount of content offered to students on a course basis have reached the desired level in a positive sense.

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Comparative Approaches to Natural Gas Price Calculation: Insights from Norway and Hungary with Implications for Romania

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Abstract

This paper examines the natural gas pricing and taxation mechanisms in Norway and Hungary to draw insights for Romania's energy market. Norway bases its taxation on actual sales prices, ensuring alignment with market conditions, promoting transparency, and encouraging investment. Conversely, Hungary relies on external benchmarks like the TTF Day-Ahead prices for calculating royalties, which may not reflect domestic realities and can discourage internal production. Romania currently uses the CEGH Day-Ahead prices for pricing, leading to debates over its suitability and over taxation. The study suggests that Romania could benefit from adopting a pricing and taxation framework based on actual domestic market prices, similar to Norway's approach. This shift could stimulate investment, improve energy security, and strengthen market integrity. With upcoming changes in Romania's energy policies and anticipated increases in production from offshore projects like Neptun Deep, reassessing its pricing and taxation methodologies is timely and crucial.

Keywords: Natural gas royalties, Energy security, Domestic production, Market competitiveness, Hub-based pricing

1. INTRODUCTION

Natural gas plays a vital role in the global energy landscape, serving as a cornerstone for economic development, energy security, and the transition to a low-carbon future. Its versatility and relative cleanliness compared to other fossil fuels have made it a critical energy source for industries, power generation, and residential use.

The determination of natural gas prices is not only a financial and market issue but also a foundational element of taxation and policy frameworks. These prices influence the fiscal revenues of producing countries, shape investment decisions, and affect affordability for consumers. As such, methodologies for calculating natural gas prices vary widely across nations, reflecting differences in market structures, resource endowments, and policy priorities.

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This paper explores the pricing mechanisms in Norway and Hungary, two European countries with contrasting approaches to natural gas pricing. Norway, as a net exporter, employs a transparent system where the price used for tax calculations reflects the actual sale price obtained by producers, while Hungary, a net importer, relies on the day ahead prices at the Title Transfer Facility (TTF) at Netherlands.

Romania's reliance on the Central European Gas Hub (CEGH) index for pricing has sparked debates about its suitability for the local market, especially given Romania's domestic production capabilities. By comparing Norway's and Hungary's practices, this paper seeks to draw valuable lessons for Romania and provide recommendations for optimizing its pricing framework to ensure economic stability, fairness, and market competitiveness.

2. LITERATURE REVIEW

The natural gas market is a highly researched field, reflecting its critical role in energy security, economic development, and the global transition toward sustainable energy systems. The literature surrounding natural gas can be broadly categorized into two main types: studies from specialized energy organizations, analyses by professional services firms and academic research. Each provides unique insights into market dynamics, pricing mechanisms, and policy implications.

2.1. Reports and Analyses by Energy Organizations and Professional Services Firms

Energy organizations and professional services firms play a pivotal role in shaping the discourse around natural gas markets by publishing comprehensive analyses on production, consumption, fiscal regimes, and pricing mechanisms. Reports such as the BP Energy Outlook (2024) provide valuable projections regarding the role of natural gas in the global energy transition. These reports often present multiple scenarios which explore potential pathways for natural gas consumption and production in the coming decades. Such scenarios highlight the evolving dynamics of energy markets and the increasing focus on sustainability. As highlighted by the IEA (June 2022) (September 2022) natural gas serves as a transitional fuel in efforts to reduce greenhouse gas emissions. However, its future viability is questioned considering the growing emphasis on renewable energy and hydrogen-based solutions. The contrasting strategies of countries like Norway, which leverage natural gas for economic stability, and Hungary, which prioritizes consumer affordability through regulated pricing, illustrate the varied roles natural gas plays across national contexts.

Reports from Deloitte (2014), (April 2018), (June 2018) have produced detailed assessments of natural gas markets in countries like Norway and Hungary. These reports underscore the critical differences in their approaches to taxation and pricing. Norway, a leading exporter of natural gas, employs a transparent taxation model based on the actual sale price, ensuring alignment with market realities. In contrast, Hungary relies on a formula tied to external benchmarks.

Similarly, in Romania, PwC (August 2021), (October 2022) provided critical evaluations of the country's reliance on CEGH for determining reference prices. Their studies reveal significant disconnects between the external hub-based pricing methodology and the realities of Romania's domestic market. These reports argue that the current methodology disregards local production costs, infrastructure constraints, and market characteristics, leading to increased volatility and discouraging the development of a robust internal trading market. Furthermore, the high effective tax rates in Romania's offshore gas sector, nearly four times higher than the European average, are seen as a major deterrent to investment.

2.2. Academic Research on Natural Gas Markets

The academic literature on natural gas markets is rich and diverse, encompassing studies on pricing mechanisms, market liberalization, and the role of natural gas in energy transitions. These studies often employ a range of econometric models to understand supply-demand dynamics, price elasticity, and market behavior across different regional and global contexts.

One significant area of research focuses on pricing mechanisms and their evolution over time. The global shift from regulated pricing to market-based mechanisms, as highlighted in Tatiana's Gutium paper (Gutium, 2021), is particularly relevant to Europe. Gas-on-gas competition pricing has become dominant in many European markets,

replacing oil price escalation as the primary mechanism. This shift reflects the increasing role of gas hubs, such as the TTF, which has become a benchmark for European gas prices.

Research by Heather (Heather, July 2022) illustrates the growing importance of hub-based pricing and its implications for market efficiency and price volatility. Moreover, the role of infrastructure in natural gas markets has been a key focus. Heather emphasizes the critical importance of transport and storage facilities in ensuring market stability and security of supply. Moreover, notes the role of new LNG terminals and floating storage regasification units in expanding Europe's import capacity and mitigating supply disruptions caused by geopolitical tensions.

In the context of Romania, studies on market liberalization highlight the challenges of transitioning from a regulated to a competitive market. Popp and Grasu (Ruxandra Madalina Popp, 2023) provide a detailed account of Romania's delayed liberalization process, which was completed only in 2021 for household consumers. Their findings underscore the vulnerability of Romania to a gas import crisis, risks of reduced stated budget revenues and challenges in developing domestic gas resources. Isaic-Maniu et al. (Isaic-Maniu, 2024) examine the structural limitations of Romania's natural gas market, including limited domestic competition.

In Hungary, another regional case, Szép and Kashour (Tekla Szép, 2024) explore the price elasticity of household energy demand, noting that Hungary's pricing policies have led to a reduction in utility costs but have also discouraged energy efficiency and market competitiveness. These findings emphasize the trade-offs between affordability and sustainability in regulated pricing models.

Academic research has also focused on the long-term dynamics of natural gas markets in light of energy transition goals. Ribeiro et al. (Vitor Miguel Ribeiro, 2023) highlight the role of natural gas as a transitional fuel in decarbonization efforts. Their study employs econometric models to analyze the interplay between liquefied natural gas (LNG) imports, renewable energy adoption, and natural gas pricing. The findings reveal significant short- and long-term dependencies, underscoring the importance of strategic diversification and integration of natural gas with renewable energy sources.

3. NATURAL GAS PRICING IN NORWAY

Norway's natural gas industry has played an important role of its economy and energy strategy since the discovery of substantial reserves in the North Sea during the 1960s. As the fourth-largest exporter of natural gas globally, after the United States, Russia, and Qatar, (Fig. 1a) Norway supplies nearly 30% of the European Union and United Kingdom's natural gas needs (Norskpetroleum, 2024). This remarkable contribution is facilitated by a highly developed infrastructure, including an extensive network of pipelines that transport natural gas directly to European markets.

3.1. Production and Economic Significance

Norway's domestic consumption of natural gas is minimal, with nearly all production dedicated to export. The government's careful management of its natural resources has enabled Norway to maintain high production levels, with forecasts indicating stability through the next decade. Production is expected to peak in 2025 (Fig. 1b), reflecting the nation's significant yet only partially exploited reserves, estimated to be around 40% tapped (Norskpetroleum, 2024).
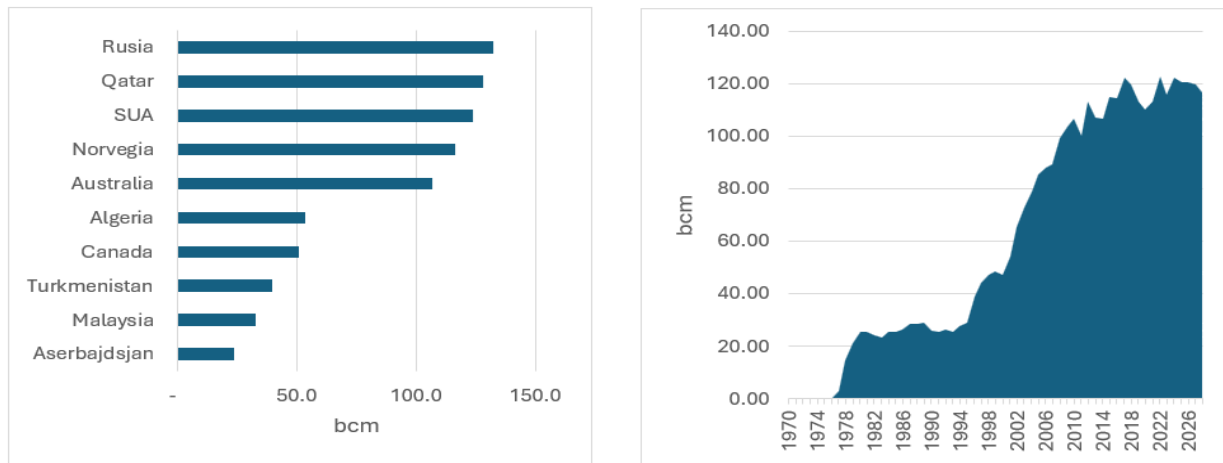
Fig. 1. (a) Norway's net gas exports in 2023 compared to other gas exporting countries; (b) Historical and projected production in Norway, 1970-2028 (Sources: Own analysis based on data retrieved from Energy Institute - Statistical Review of World Energy 2024; Norwegian Offshore Directorate

Revenues from the oil and gas sector form a vital part of Norway's economy, contributing an estimated 680 billion NOK (approximately €60 billion) to the government budget in 2024. These revenues include corporate taxes, the State's Direct Financial Interest in oil and gas fields, and dividends from Equinor, the state-owned energy company. Over the years, petroleum activities have added over 24 trillion NOK to Norway's GDP, underpinning the country's robust social welfare system (Norskpetroleum, 2024).

3.2. Taxation and Pricing Mechanisms

Norway's petroleum sector operates under a dual-tier taxation model governed by the Petroleum Taxation Act of 1975. Companies pay a standard corporate tax rate of 22%, coupled with a special tax of 71.8% on profits from petroleum activities. To avoid double taxation and ensure fiscal neutrality, the standard tax is deducted from the taxable base of the special tax. This structure results in a marginal combined tax rate of 78%, ensuring significant revenue generation for the state while maintaining industry profitability.

The pricing of petroleum for tax purposes is overseen by the Petroleum Price Board (PPB). The PPB sets quarterly "norm prices", which serve as the reference for taxable income. These "norm prices" reflect the hypothetical prices that would have been achieved in an arm's length transaction under market conditions. The determination of norm prices involves a rigorous process that incorporates market data, company-reported figures, and assessments by external consultants such as Argus and Platts. These prices are heavily influenced by the daily Brent crude oil quotations, which are averaged over a five-day period. The prices are then adjusted based on specific quality differentials and market conditions, reflecting factors such as gas composition and export destination.

For natural gas, taxation relies on actual sales prices, same as Denmark, Netherlands, Great Britain, etc., counties with a relevant share of consumption from domestic production. The transparency and alignment of Norway's pricing model with real market conditions exemplify a pragmatic approach that balances government revenue maximization with the industry's competitiveness.

4. NATURAL GAS PRICING IN HUNGARY

4.1. Production and Economic Significance

Hungary is the 38th largest natural gas producer globally, contributing approximately 0.03% to global production. Despite its modest output and a 0.18% decrease in production in 2023 compared to 2022, natural gas remains a critical energy source for Hungary. It is expected to maintain a significant share in the country's energy mix through 2030 and beyond, especially as Hungary transitions away from lignite-based power generation. For instance, the Mátra lignite power plant is slated to be replaced by a 500 MW gas-fired power plant, supplemented by solar and smaller generation units (IEA, August 2022).

Although Hungary has domestic reserves, they are insufficient to meet internal demand, resulting in significant reliance on imports, primarily from Russia. In 2023, Russia accounted for the majority of Hungary's natural gas imports, followed by Austria, Serbia, and Croatia (Table 1).

Table 1. Hungary Natural gas in gaseous state imports by country in 2023 (Sources: Own analysis based on data retrieved from World Integrated Trade Solution)

Exporting Country	Trade Value 1000, USD	Quantity, kg
Russia	3,655,525.68	463,705,000,000,000.00
Austria	651,809.86	89,098,700,000,000.00
Serbia, FR(Serbia/Montenegro)	62,697.20	11,624,200,000,000.00
Croatia	53,827.40	6,588,420,000,000.00
Romania	33,221.31	6,354,880,000,000.00
Ukraine	28,823.53	2,499,470,000,000.00
Bulgaria	392.66	642,651.00
France	27.58	57,185.90

Hungary's energy diversification efforts include access to LNG through Croatia's Krk terminal, which currently operates at an expanded capacity of 2.9 billion cubic meters per year and is expected to double to 6.1 billion cubic meters by 2025. Additionally, Hungary's state-owned MVM signed an agreement with Turkey's Botas to secure additional gas volumes via the TurkStream pipeline starting in 2024.

Recent domestic production developments include investments by MVM in the Berettyóújfalu and Nyékpuszta fields in eastern Hungary. The drilling of multiple wells in these fields is anticipated to significantly enhance production by 2024, potentially reducing Hungary's import dependency (Szőke, 2024). These initiatives, coupled with Hungary's strategic position as a natural gas transit hub with 5.8 billion cubic meters of underground storage capacity, underscore the country's efforts to strengthen its energy security and infrastructure.

4.2. Taxation and Pricing Mechanisms

Hungary's fiscal regime for natural gas production is characterized by one of the lowest corporate tax rates in Europe—9%—which aims to attract investment. However, the sector is also subject to a complex system of mining royalties, which vary significantly depending on factors such as the date when the mining rights were obtained and the amount of natural gas extracted. The mining royalties are regulated under Mining Act 48 of 1993, with subsequent amendments.

For natural gas fields in production before January 1, 1998, royalties are calculated using a complex formula that factors in the annual average gas price, the 2003 base price, and an annually increasing correction factor. The resulting percentage is tied to the price differential but cannot be less than the minimum rate of 12%. For fields brought into production before January 1, 2008, the royalty is 16% with some exceptions. And for fields brought into production after January 1, 2008, royalties range from 12% to 30%, depending on the annual extraction volume:

- Royalties are 12% for production below 300 million cubic meters annually,

- 20% for production between 300 million and 500 million cubic meters annually,

- 30% for production exceeding 500 million cubic meters annually.

The reference price based on which the royalties are calculated has the following formula:

$$E = p * d - K_2 * l \qquad (1)$$

where:
E: Reference price in HUF/MWh,
p: Arithmetic mean of daily TTF Day-Ahead closing prices (EUR/MWh) during the reporting period plus an average adjustment of 1.05 EUR/MWh,

d: Arithmetic mean of official HUF/EUR exchange rates by Hungary's National Bank during the reporting period,
K_2: Specific preparation cost, fixed at 260 HUF/MWh,
l: Inflation correction factor, adjusted annually.

In the context of rising energy prices and the need to balance the state budget, the Hungarian government introduced in 2022 a series of additional tax measures applicable to companies in the energy sector. One of them is the tax on additional profits (extra profit tax), which applies to companies that have recorded significantly higher profits because of the increase in energy prices. According to the legislation, the tax applies mainly to producers of petroleum products and traders of fuels, but not to producers of natural gas. In the case of natural gas, the government opted to increase mining royalties:

- for hydrocarbon fields put into operation before January 1, 1998 varies between (42-56) %

- for hydrocarbon fields put into operation before January 1, 2008 varies between (48-62) %

- for hydrocarbon fields put into operation after January 1, 2008 varies between (46-56) %

Hungary's natural gas pricing incorporates elements of market-based and regulated systems. For unregulated sales, the reference price is determined by the arithmetic mean of daily TTF Day-Ahead prices during the reporting period. This ensures alignment with European market trends, however, for regulated sales to universal service providers, the government establishes fixed prices.

5. COMPARATIVE ANALYSIS OF NORWAY AND HUNGARY

The methodologies for natural gas price calculation and taxation in Norway and Hungary present contrasting approaches that significantly impact their respective energy sectors.

Norway bases its taxation on the actual sales prices obtained by producers, reflecting real market conditions. The PPB sets norm prices for tax purposes, but for natural gas, the actual sales prices are used. This method ensures that taxation aligns with the revenues producers actually earn, avoiding discrepancies that could lead to over taxation or under taxation. Hungary, on the other hand, calculates mining royalties using a reference price linked to the arithmetic mean of daily TTF Day-Ahead prices. This approach introduces external market volatility into the domestic taxation system and may not accurately reflect the actual prices at which natural gas is sold within Hungary.

Norway's taxation and pricing mechanisms contribute positively to energy security by stimulating internal production. The alignment of taxation with actual market conditions encourages producers to invest in exploration and production, ensuring a steady supply of natural gas. Transparent pricing based on actual sales fosters trust and integrity in the market, supporting the development of a robust internal natural gas market. Hungary's complex taxation system and reliance on external price benchmarks may discourage internal production due to increased financial burdens and market uncertainties. Producers may find investments less attractive, potentially leading to reduced domestic output and greater reliance on imports. This scenario could negatively impact energy security by making the country more vulnerable to external supply disruptions.

Norway's taxation and pricing frameworks support market integrity by ensuring that all producers are subject to the same rules, and taxation is based on actual economic activity. This uniformity promotes fair competition and encourages efficiency and innovation within the sector. In Hungary, the variable royalties and adjustments based on external prices can create disparities among producers, potentially distorting competition. Smaller producers or those with higher production costs may be disproportionately affected by higher effective tax rates, undermining market integrity.

6. IMPLICATIONS FOR ROMANIA

Romania, as one of the largest natural gas producers Europe, has a significant role in the regional energy market. Recently, Romania surpassed even the Netherlands in natural gas production, becoming the biggest EU's gas producer (Petrescu, 2024). This notable position is due to Romania's substantial onshore reserves and the potential of offshore fields in the Black Sea. Despite this advantageous position, Romania faces challenges related to its

natural gas pricing and taxation policies, which have implications for investment, market development, and energy security.

Romania's royalty system for natural gas production is governed by a framework that calculates royalties based on a reference price. Since February 2018, the National Agency for Mineral Resources (ANRM) introduced a new methodology through Order no. 32/2018, which shifted from fixed prices to prices quoted on CEGH. The formula for calculating the reference price, *PR*, is as follows:

$$PR = PM * PCS_{ref} * RS \qquad\qquad (2)$$

where:

PM: average stock market index for natural gas trading displayed on the website of the hub chosen by ANRM, PEGAS CEGH Day Ahead Market Single Day Select, VWAP/CEGHIX CEGH, for the month prior to the period for which the reference price is calculated, expressed in EUR/MWh,

PCS_{ref}: reference superior calorific power, calculated based on data from producers, expressed in kWh/standard m^3

RS is the average exchange rate for EUR to RON.

This methodology effectively ties the calculation of royalties to the CEGH market prices, which recorded significantly higher values than the average prices achieved by natural gas producers in Romania. as can be seen in Figure 2. Moreover, discourages the development of the internal gas trading market, considering it practically irrelevant and undermining the functionality of local market mechanisms.

The adoption of Order no. 32/2018 sparked significant criticism from industry stakeholders, who argued that the methodology was unfair and did not consider Romania's market realities. In Romania, market practices are mainly based on long-term contracts, which are not subject to the same volatility as spot prices and which provide a higher degree of predictability. One of the most notable reactions came from OMV Petrom, Romania's largest oil and gas company. Following the approval of the methodology, OMV Petrom contested Order no. 32/2018, requesting its annulment and seeking damages. The Romanian courts ultimately rejected OMV Petrom's appeal, and the methodology remains in effect (Enea, 2023).

Norway bases its taxation on the actual sales prices obtained by producers, ensuring that taxes reflect real market conditions and revenues. Similar to Romania, Hungary uses external benchmarks for calculating royalties, which may not align with domestic prices, leading to potential over taxation. Romania could consider adjusting its methodology to base royalty calculations on actual domestic market prices rather than external hub prices. This change would align taxation with real revenues, promoting fairness and encouraging investment.

By aligning taxation with market conditions and maintaining a stable investment climate, Norway has successfully stimulated internal production, contributing to its energy security and economic prosperity. By adopting a fair and market-reflective taxation system, Romania can stimulate internal production, enhancing its energy security. Encouraging investment in domestic resources reduces dependence on imports and supports the development of the internal natural gas market.
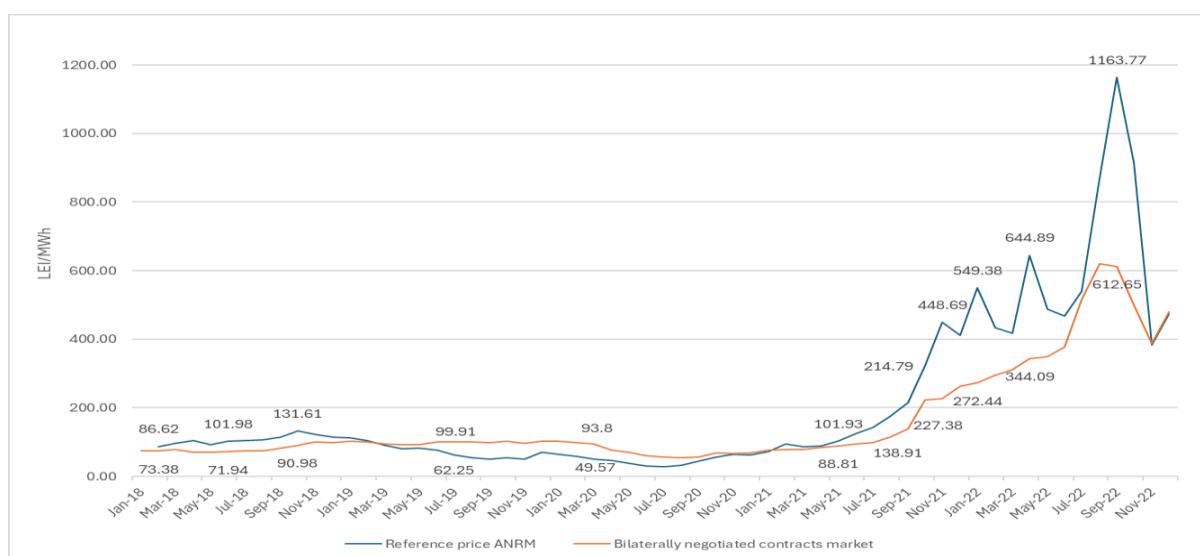

Fig. 2. ANRM reference price comparison VS market prices of bilaterally negotiated contracts, 2018-2022 (Sources: ANRE, CEGH)

Using actual sales prices for taxation promotes transparency and integrity in the market, fostering trust among stakeholders. Promoting transparent pricing and taxation practices can strengthen the integrity of Romania's natural gas market. This approach supports fair competition and can enhance the country's reputation among investors and trading partners.

7. CONCLUSION

In conclusion, the comparative analysis of Norway and Hungary's natural gas pricing and taxation methodologies provides valuable insights for Romania. Norway's approach of basing taxation on actual sales prices ensures alignment with market realities, promoting fairness, transparency, and investment attractiveness. Conversely, Hungary's reliance on external benchmarks can lead to misalignments with domestic market conditions, resulting in over taxation and discouragement of investment. These findings suggest that Romania could benefit from adopting a pricing and taxation framework that reflects its domestic market dynamics, fostering a more favorable environment for investment and sustainable growth in the natural gas sector.

This is a crucial moment for Romania, as the current emergency orders (27/2022, 119/2022, and 153/2022) are set to expire in April 2025, marking a return to a free market. With Romania now being the largest natural gas producer in the European Union and anticipating a significant production increase in 2027 due to the Neptun Deep offshore project, it is imperative to reassess existing pricing and taxation policies. With the Black Sea investments, a great part of the domestic production will cover the national demand and Romania will become a net exporter.

By aligning its methodology with actual domestic prices and ensuring a stable, transparent fiscal regime, Romania can capitalize on its robust production capabilities, enhance energy security, and strengthen its position in the regional energy market.

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**Engineering, Transport, IT and Artificial Intelligence
(IAC-ETITAI)**

Problematic Case Law of the Constitutional Court of the Czech Republic on the Legal Nature of the Price List for the Use of a Parking Zone Under Section 23(1) of the Roads Act No. 13/1997 Coll. Commentary to the Judgment no. Pl. ÚS 14/08 of 18 November 2010

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Abstract

The issue of parking is one of the most popular topics in Czech case law and legal literature. A highly debated issue is the price list as a price list. Municipalities may, for the purpose of organizing traffic on the territory of the municipality, by ordinance define areas of the municipality in which local roads or their designated sections may be used for parking a road motor vehicle in the municipality for a limited period, provided that such use does not endanger the safety and continuity of traffic on roads and other public interest. The method of payment of the agreed price and the method of proof of payment shall be laid down by the municipality in the ordinance designating the parking zones. The commentary rejects the legal opinion adopted in the judgment cited above, according to which the price list for the use of a parking zone defined in accordance with Section 23(1) of the Act No. 13/1997 Coll. on Roads is by its nature a legal regulation for which the Act No. 526/1990 Coll., on Prices provides in Section 10(1) for the form of an ordinance. At the same time, the Constitutional Court stated that an ordinance is not an ordinance and is in fact, from a material point of view, a measure of a general nature.

Keywords: price list; regulation; measures of a general nature; parking; road charging

1. INTRODUCTION

The general use or traffic on roads may be regulated in the case of specific sections of specific roads not only based on a decision on the placement of traffic signs, but also based on administrative acts[1] (Průcha, 2007), which are currently regulated by positive law in the form of legal regulations of local self-government units (Hendrych, 2009). Act No. 13/1997 Coll., on Roads, as amended (hereinafter: the Roads Act) expressly and unambiguously provides for the form of a regulation as a normative (i.e. not mixed) administrative act.

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[1] Throughout the text, the term "administrative act" means a public power act largo sensu, not just an individual administrative act.

This discrepancy between the statutory form of the traffic regulation and its conceptual features (and thus its substantive nature) is then closely related to the relationship between them and the (necessarily related) decisions. A clear determination of the nature of the traffic regulation and its position in relation to the (subsequent) decisions is essential, in particular, in order to establish the legal form of the two administrative acts in question, which is decisive, above all, for the definition and delimitation of the powers of the competent administrative authorities and the scope of the rights of the persons affected by the traffic regulation in question, both in the process of its determination and in the context of any (particularly judicial) review (Hejč, 2013).

The main sources used for the preparation of the paper are the legislative sources of law of the Czech Republic. The main legislative sources of law are the Roads Act and the Act on Prices. The materials used also include available domestic literature on the subject. Finally, the materials used for the preparation of the paper include relevant case law. In terms of methodology, the paper uses both traditional and excerpted methods of legal science research - general scientific methods and special methods of legal science. The general scientific methods used in the paper are mainly logical methods, namely the methods of analysis and synthesis. The special methods of legal science used mainly include methods belonging to the group of interpretive methods, namely, the teleological and systematic methods.

The aim of this paper is to clarify the most important practical issues related to the subject. Although this topic seems to be simple, it is not and many questions related to this issue arise in practice, e.g. whether a parking space price list can be issued pursuant to Section 10(1) of Act No. 526/1990 Coll., on Prices, as amended (hereinafter: the Prices Act)? (I)f a price list can be issued with reference to Section 10(1) of the Prices Act, under what statutory authority is this done? Could Section 23(1) of the Roads Act itself, which refers to the Prices Act without reference to any specific provision, be sufficient statutory authority? In what capacity is the price list issued? If the Constitutional Court in its Judgment no. Pl. ÚS 14/08 of 18 November 2010, concluded that the price list is a legal regulation, it can be "assigned" the form of a regulation, or will it be an "unnamed legal regulation"? If the price list is issued only as a resolution (of the Council), does it have the nature of a legal regulation? Is it appropriate to publish it in the Collection of Legal Regulations of Local Government Units and Certain Administrative Authorities? In particular, the case law cited here is crucial for the practical answer to the above questions.

2. INITIAL STATE

On 18 November 2010, the Plenum of the Constitutional Court issued a decision in the no. Pl. ÚS 14/08 on the issue of the regulation of the Capital City of Prague No. 11/2007 Coll. of the City of Prague, defining the areas of the City of Prague in which local roads or their designated sections may be used for a price agreed in accordance with the price regulations. In the resolution in question, the Constitutional Court stated that the regulation issued pursuant to Section 23(1)(a) of the Roads Act is materially a measure of a general nature and the price list for the use of a parking zone defined in accordance with Section 23(1) of the ZPK is by its nature a legal regulation for which the Act on Prices in Section 10(1) provides for the form of a regulation. But is this interpretation supported by the Prices Act?

3. PROPOSAL FOR THE REPEAL OF THE PRAGUE CITY HALL REGULATION NO. 11/2007 COLL. OF THE CITY OF PRAGUE

In 2008, a group of 41 members of the Chamber of Deputies of the Parliament of the Czech Republic (hereinafter: the petitioners) submitted a proper motion (cf. Article 87(1)(b) of the Constitution of the Czech Republic (hereinafter: the Constitution) and Section 64(2)(b) of Act No. 182/1993 Coll, on the Constitutional Court, as amended (hereinafter: the Constitutional Court Act), delivered to the Constitutional Court on 28 March 2008, sought the annulment of Prague City Ordinance No. 11/2007 Coll. Prague City Council, defining the areas of the City of Prague in which local roads or their designated sections may be used for a price agreed in accordance with the price regulations (hereinafter: the Regulation). According to the appellants, the Regulation in question was in breach of Article 23(1)(a) and (c) of the Roads Act on the ground that it was too expansive, since the law allows only areas of a municipality to be defined by charging for parking, but, for example, the Municipal District of Prague 2 regulated and charged for its entire territory in this way. The price list in that case was issued by resolution No. 564 of the Prague City Council of 5 May 2009, which was not challenged by the appellant. By their submission to the Constitutional Court on 11 January 2010, the appellants clarified the petition by considering the subsequent amendments to the contested Ordinance and proposed its annulment "as amended".

4. A REGULATION IS NOT A REGULATION

Unfortunately, neither the petitioners nor the public were able to obtain a substantive assessment of the compliance of the Prague ordinance with the law. Instead, the Constitutional Court presented another of its considerations on the topic of what is and what is not a legal regulation? As part of this reflection, it then concluded that, despite the clear indication in Section 23(1) of the Roads Act, the "regulation" defining the parking zones and their regimes is not a municipal regulation within the meaning of Section 11(1) of Act No. 128/2000 Coll. on Municipalities (establishment of municipalities), as amended [i.e. a legal regulation as contemplated by Articles 79(3) and 87(1)(b) of the Constitution].

The Constitutional Court, in its resolution of 18 November 2010, no. Pl. 14/08, the Constitutional Court rejected the above-mentioned petition, but in its reasoning it also stated that in fact it is in fact a measure of a general nature [see Part Six of the Act No. 150/2002 Coll., the Code of Administrative Justice (hereinafter: the CAJ)] and the Supreme Administrative Court is competent to review such a measure [Section 4(2)(c) of the CAJ]. The subject-matter of the case thus falls within the sphere of administrative law and not constitutional law. The Constitutional Court compares a municipal ordinance defining spatially specific places in a municipality where one can stand only under the charging regime to a collective decision on the placement of traffic signs, whereas the establishment of traffic signs is, as we know, done by a measure of a general nature (see the judgment of the Supreme Administrative Court of 7 January 2009, no. 2 Ao 3/2008-100 and of 29 May 2009, no. 4 Ao 1/2009-58). These conclusions were subsequently also reflected in the judgment of the Supreme Administrative Court of 30 January 2012, no. 9 Ao 8/2011-68, and in the resolution of the Constitutional Court of 3 May 2012, no. III ÚS 1328/12. The Supreme Administrative Court also dealt with the nature of the regulation in its judgment of 9 October 2020, no. 5 As 80/2019-36, in which, with reference to the above-mentioned plenary resolution of the Constitutional Court of 18 November 2010, no. Pl. 14/08, held that the contested regulation materially meets the definition of a measure of a general nature.

The Supreme Administrative Court defined what is to be understood by a measure of a general nature in its judgment of 27 September 2005, no. 1 Ao 1/2005-98, published under no. 740/2006 Coll. of the Supreme Administrative Court, where it stated that "a measure of a general nature is an administrative act with a specifically defined subject matter (i.e., it relates to a specific situation) and with a generally defined range of addressees." According to Section 171(1) of Act No. 500/2004 Coll., on administrative proceedings, as amended (hereinafter: the Administrative Procedure Code), a binding measure of a general nature is not a legal regulation or a decision. The specifically defined subject matter distinguishes a measure of a general nature from a legal norm, the material feature of which is, on the contrary, generality as regards the subject matter (in addition to generality in the subjects of the legal norm and its other features, which also include regulatory character, legal bindingness and enforceability by the state power). The algorithm for the review of a measure of a general nature consists of five steps, namely an examination of whether, firstly, the administrative authority has the power to issue a measure of a general nature; secondly, whether the administrative authority has exceeded the limits of its statutory competence in issuing the measure of a general nature (ultra vires action); thirdly, whether the general nature measure was issued in accordance with the procedure laid down by law; fourthly, whether the general nature measure is contrary to the law in terms of its content (substantive criterion); and fifthly, an examination of the content of the general nature measure issued in terms of its proportionality (criterion of proportionality of the regulation). In the fifth step of the algorithm described above, the administrative courts are obliged to examine whether the interference has a constitutionally legitimate reason based on legal objectives, whether the interference is carried out to the extent strictly necessary, whether the interference is carried out in the most benign manner still reasonably leading to the intended objective, whether the interference is carried out in a non-discriminatory manner and whether the interference is carried out with the exclusion of arbitrariness (see the resolution of the Extended Chamber of the Supreme Administrative Court of 21. July 2009, no. 1 Ao 1/2009-120, published under no. 1910/2009 Coll. of the Supreme Administrative Court, or the judgment of the Supreme Court of 16 February 2016, no. 3 As 195/2015 55).

The Constitutional Court stated that in the present case, the enabling norm [Section 23(1) of the Roads Act] presupposes the existence of two legal regulations. The first is an ordinance defining the areas of the municipality, or local roads or designated sections thereof, the general use of which is restricted to persons referred to in Section 23(1)(a) to (c) of the Roads Act and is subject to charging and setting out the method of payment of the agreed price and the method of proof of payment (the ordinance). The second is the price list, for which the Prices Act provides for the form of an ordinance [see Section 10(1)], and by which the municipality sets the price for the use of these local roads for these persons (Price List). According to the Constitutional Court, the Price List imposes on an indefinite group of persons, defined by definitional features [e.g. The Ordinance specifically defines for this group

of persons the area of the municipality (local roads) to be charged by the Price List and specifies in the local conditions the individual zones of reserved parking (on the nature of price lists as legal regulations, see also the resolution of the Supreme Administrative Court of 6 August 2010, no. 2 Ao 3/2010-55 and the case law cited therein].

5. PRICE LIST AS PRICE LIST

This reasoning, in itself, would not be legally challengeable, if the Constitutional Court in the commented ruling had not proceeded from the strange construction that, on the contrary, the price list of the owner of the local road (which is always the municipality) is a price assessment, and therefore it is this price list (and not the above-described regulation) that is the legal regulation of the municipality issued pursuant to Section 10(1) of the Prices Act and Section 11(1) of the Municipalities Act.

The Constitutional Court explains in the reasons for its ruling that while the municipal regulation itself (according to the court, a measure of a general nature) defining the municipality's areas with paid parking cannot be challenged before the Constitutional Court for contradiction with the law, another municipal regulation, the price list, which is related to it, could be challenged before the Constitutional Court, which the appellants did not do.

However, it is clear from the case-law that the appellants did not do so because they never considered the parking fee schedule to be a price schedule (a legal regulation), and it never occurred to them to consider the document setting the parking fee in that way. Nor did I, and I suspect many city and town lawyers.

Following the ruling of the Constitutional Court, some municipalities have now started to issue a price list for paid parking pursuant to Section 23(1) of the Roads Act as an ordinance pursuant to Section 10(1) of the Prices Act, but the other part of the municipalities continues to approve the price list by a resolution of the municipal council under Section 102(2)(d) of the Municipalities Act. The legal nature of the price list in question has thus remained an open question for more than 10 years. It is therefore not even clear whether the price list in question is subject to the supervision of the Ministry of the interior of the Czech Republic pursuant to Section 124 of the Municipalities Act or to the supervision of the superior regional authority pursuant to Section 125 of that Act.[2] Administrative courts review parking zone regulations as measures of a general nature, but they refuse to review "price lists" (they are not competent to review legal regulations, cf. e.g. the judgment of the Supreme Administrative Court of 4 March 2022, no. 5 As 345/2019-43). The answer to the question whether it is necessary to publish it in the Collection of Legal Regulations of Territorial Self-Government Units and Certain Administrative Authorities pursuant to Act No. 35/2021 Coll.

6. CRITICAL EVALUATION OF THE CONSTITUTIONAL COURT'S DECISIONS

Pursuant to Section 23(1) of the Roads Act, a municipality may, in a municipal ordinance, designate areas of the municipality in which local roads or designated sections thereof may be used for a "price agreed in accordance with the pricing regulations". k:
   a) parking a road motor vehicle in the municipality for a limited period, but not exceeding 24 hours,
   b) the parking of a lorry or combination of vehicles in the municipality for the time necessary to carry out customs clearance,
   c) the parking of a road motor vehicle operated by a legal or natural person for the purpose of doing business under a special legal regulation, which has its registered office or place of business in the defined area of the municipality, or for the parking of a road motor vehicle of a natural person who has a permanent residence or is the owner of real property in the defined area of the municipality, or for the parking of road motor vehicles as specified in a municipal ordinance,

provided that the safety and smooth flow of traffic on the roads and other public interest will not be endangered by such use. The municipality shall establish in the municipal ordinance the method of payment of the agreed price and the method of proof of payment thereof.

The provision of Section 23 of the Roads Act violates the general principle of gratuitous use of local roads set out in Section 19(1) of the Roads Act. For these reasons, at the beginning of the law's effectiveness it was

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[2] According to the opinion of the Ministry of Transport of the Czech Republic, the administrative review is to be carried out under the regime of Section 174(2) in conjunction with Section 94 of the Administrative Code (no. MD-34658/2022-930/2 of 1 November 2022, or opinion of 9 February 2024, no. MD-5204/2024-940/2).

established that this could only be done by a municipal regulation, which in 1997 was a generally binding municipal ordinance. In connection with the amendment of the Municipalities Act, the Act was amended in 2006 and the generally binding municipal ordinance was replaced by a municipal regulation. The municipal ordinance is issued solely because of the need to organize traffic within the municipality and is certainly not intended to be a financial gain for the owner of the local roads. It is intended to ensure a rapid turnover of parked motor vehicles in areas of the municipality which, due to the location of e.g. offices, cultural or medical facilities, are to be accessible to a larger number of persons interested in parking a motor vehicle [Section 23(1)(a) of the Roads Act]. A further objective of the Regulation is also to provide parking spaces for road motor vehicles of persons who have a legal relationship to the defined area of the municipality as defined in the Roads Act [Section 23(1)(c) Roads Act].

The municipality's regulation may not go beyond the scope of section 23(1) and (2) of the Roads Act. The ordinance shall contain only the delimitation of the areas of the municipality and the exact designation of local roads or sections thereof on which motor vehicles may stand. It must also include the purpose of parking road motor vehicles as determined pursuant to Section 23(1)(a) to (c) of the Roads Act, the method of payment of the agreed price and the method of proof of payment (Černínová, et al., 2015).

To ensure that road users are properly and functionally informed that a special (paid) parking system operates in certain areas of the municipality, the law stipulates that designated local roads or sections thereof must be marked with an appropriate traffic sign (with reference to the Road Traffic Act). It then follows that, in addition to the regulation on the designation of areas with a different regime, the local roads concerned must be marked on the ground with traffic signs. It should be added that traffic signs which alter the rights and obligations of road users will have to be approved in the form of a measure of a general nature (cf. judgment of the Supreme Administrative Court of 7 January 2009, no. 2 Ao 3/2008-100).

The question is what the nature of the parking zone regulation in these cases is. There can obviously be no doubt that the content of that regulation is identical to the decision on the establishment of the traffic signs which serve to implement it, since it is the parking zone regulation which determines the type and location of the restriction. However, in the case of a regulation on a parking zone, the key question as to whether it already imposes an obligation on the addressees to whom it is addressed, or whether that obligation is imposed only by the traffic sign which defines the content of that regulation in the relevant area, is whether the regulation fulfils the conceptual characteristics of a measure of a general nature. The regulation on the parking zone and the decision on the establishment of its traffic signs are de lege lata two separate administrative acts (Kněžínek, 2007).

In the reasoning of the resolution of the Plenary of the Constitutional Court, no. Pl. 14/08 of 18 November 2010, which dealt with the interpretation of Section 23(1) of the Roads Act, the Constitutional Court stated, without further details, that the price for the use of a parking zone under Section 23(1) of the Roads Act is determined by a price list, for which the Law on Prices provides in Section 10(1) for the form of a regulation.

However, in my view, for the pricing area, such an interpretation of section 10(1) of the Prices Act has no support in the Prices Act, primarily for the following reasons:

The Roads Act entered into force on 21 February 1997 and became effective on 1 April 1997. In its original wording, Section 23(1) of the Act already stated that local roads or sections thereof defined by a generally binding municipal ordinance may be used in specified cases at a price negotiated in accordance with the price regulations, without, however, the explanatory memorandum to the Act explaining in detail what the legislator intended by using the phrase "price negotiated in accordance with the price regulations" in the quoted provision. It is clear, however, that this provision could not, at the time of the adoption of the Act, be linked to Section 10(1) of the Prices Act, as amended.

According to the quoted provision, "the price authorities shall determine by a price decision pursuant to Section 3(2), regions and municipalities by their ordinance, the goods subject to price regulation pursuant to Sections 5, 6 and 8, the method and conditions of price regulation applied, the prices officially set, the rules and procedures for setting such prices and their changes." This provision has been part of the Act on Prices as amended only since 1 June 2006, when the Act on Prices was amended by Act No. 230/2006 Coll., amending Act No. 89/1995 Coll., on the State Statistical Service, as amended, and other related acts. At the time of the adoption of the Roads Act, Section 10 of the Prices Act read: "Goods subject to price regulation pursuant to Sections 5 and 6 shall be included by decision of the price authorities in a list of goods with regulated prices (hereinafter: the list). The list and the prices set therein and goods subject to price regulation pursuant to Section 8 shall be published by the price authorities in the Price Bulletin."

At the time of the adoption of the Roads Act, Section 10 of the Prices Act, to which the Constitutional Court referred in its above-mentioned plenary order, did not refer to municipal regulation at all. From this fact alone, there

was no connection between Section 23(1) of the Roads Act and Section 10(1) of the Prices Act (as amended) as intended by the legislature.

Section 10(1) of the Prices Act is part of Part II of the Prices Act, entitled "Price Regulation". The interpretation of the Constitutional Court according to which the price list for the use of a parking zone pursuant to Section 23(1) of the Roads Act is to be issued by individual municipalities as a regulation based on Section 10(1) of the Prices Act completely contradicts the principles underlying the Prices Act in relation to the issue of price regulation.

In the case of price regulation, there is always a price regulator that has the authority to regulate the market for a particular commodity. The subject matter jurisdiction of the price regulator is established here based on Act No 265/1991 Coll., on the Competences of the Bodies of the Czech Republic in the Pricing Area, as amended (hereinafter: the Act on the competence of administrative authorities in the field of prices).

The price regulator here does not primarily regulate itself, but other entities. The regulator sets the prices, or the price ceilings within which the individual entities on the market for regulated goods can move when negotiating prices. According to Section 5(5) of the Price Act, regulation in the form of a maximum, fixed or minimum price applies to all sellers and buyers of the specified type of goods. In the case of price regulation in kind, this method of price regulation applies to all sellers of the specified type of goods [Section 6(2) of the Price Act].

However, if the municipality were to set the price for the use of a local road based on Section 23(1) of the Roads Act, the municipality would primarily regulate the price for itself as the seller, since in accordance with Section 9 of the Roads Act, the municipality on whose territory the local roads are located is the owner of the local roads. In order to constitute a price regulation within the meaning of the Prices Act, the price regulator in the present case would have to be the superior region or, better still, the Ministry of Finance of the Czech Republic, which would have to set out in its price assessment what price individual municipalities can charge for parking pursuant to Section 23(1) of the Roads Act and the municipalities would have to respect this when drawing up their individual price lists.

A price decision under the Prices Act [Section 3(2) in conjunction with section 10(1)] can therefore not be understood as a price list, but as a legal regulation that limits the free pricing power of individual sellers of regulated goods. They are obliged to comply with the rules laid down in the relevant price decision or regulation issued by the relevant price regulator when drawing up their individual price lists. For illustrative purposes, reference may be made to Regulation No. 20/2006 Coll. Prague, on maximum prices for passenger taxi services. This regulation does not contain a price list, but rules that must be respected by individual taxi operators in the territory of the Capital City of Prague when creating their price lists, which are displayed on individual taxi vehicles. Prague.

According to the applicable legislation, municipalities may act as price regulator within the meaning of the Prices Act only in the cases provided for in Section 4a of the Act on the competence of administrative authorities in the field of prices

Pursuant to Section 4a of the Act on the competence of administrative authorities in the field of prices, a municipality may, to the extent and under the conditions set out in a decision of the Ministry, determine by municipal ordinance:
  a)   maximum prices, unless they are set by the Ministry,
  b)   maximum prices lower than the maximum prices set by the Ministry,
  c)   maximum prices higher than the maximum prices set by the Ministry or determine cases to which the maximum prices set by the Ministry do not apply.

Thus, a municipality may issue a regulation on price regulation pursuant to Section 10(1) of the Prices Act arbitrarily, but only in the case of goods defined in the relevant price decision of the Ministry of Finance of the Czech Republic. According to the current MF Decree no. 01/2024 of 14 December 2023, which issues the list of goods with regulated prices (for 2024), a total of 11 items are set out under Section B that can be regulated by individual regions and municipalities by setting a maximum price. These include, for example, passenger taxi services, funeral services and cemetery services. In no other case can municipalities (and regions) issue regulations under Section 10(1) of the Prices Act, which is confirmed by the opinion of the Ministry of Finance of the Czech Republic.[3]

For example, the Ministry of Finance of the Czech Republic, as the competent price regulator, regulates the price of a single travel document issued under the so-called uniform tariff in the form of officially set fixed prices.[4, 5] In

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[3] See MF Opinion no. MF-31943/2022/1601-2, Department 16 - Pricing Policy.
[4] Partition C of MF Circular no. 01/2024 of 14 December 2023 issuing the list of goods with regulated prices.
[5] See Section 7a of Act No. 194/2010 Coll., on Public Services in Passenger Transport and Amending, as amended.

this case, the price decision of the Ministry of Finance of the Czech Republic cannot be called a price list either, since the Ministry of Finance is not acting as a seller but as a price regulator. The price lists are subsequently issued by the individual railway undertakings as sellers based on the price decision in question.

Thus, price regulation within the meaning of Section 23(1) of the Roads Act could only be price regulation if the price for these goods were regulated directly by the Ministry of Finance of the Czech Republic as the competent price regulator. The municipality as the seller (as well as the buyer) would then have to respect the rules set by the price regulator when negotiating the price, otherwise they would be guilty of an offence.

Another argument that shows that the municipality's setting of the price pursuant to Section 23(1) of the Roads Act does not constitute price regulation within the meaning of the Prices Act is that in the event of non-payment of the price set by the municipality for the use of a parking space by the purchaser, this action is not punishable as an offence under the Prices Act, but as an offence under Act No. 361/2000 Coll. Act on Road Traffic and on Amendments to Certain Acts (Road Traffic Act), as amended.

In addition to the above, I note that the legislator uses the phrase "price negotiated in accordance with the price regulations" in the case of Section 23(1) of the Roads Act to make it unambiguously clear that the case in question does not involve a fee, unlike other cases of charging for the general use of roads (time charge, toll). The consequence of the fact that the payment for the use of a parking space is set as a price under the Prices Act is that the use of a parking space under section 23(1) of the Roads Act must be regarded as a commodity within the meaning of section 1(1) of the Prices Act. This means that, if one of the statutory conditions is met (section 1(6) of the Prices Act), these goods could, as a last resort, be subject to price regulation by the relevant price regulator, which in this case would be the Ministry of Finance of the Czech Republic in accordance with section 2(1) of the Prices Act. At present, however, the use of a parking zone pursuant to Section 23(1) of the Roads Act is not subject to price regulation by the Ministry of Finance of the Czech Republic, which does not mean that municipalities can set the price for the use of a parking zone pursuant to Section 23(1) of the Roads Act in a completely arbitrary manner. Here, municipalities (like any other seller) are bound by the general rule against abuse of an advantageous economic position, which is enshrined in Section 2(3) of the Prices Act. The price set by the municipality should therefore not significantly deviate from the usual price for the use of the parking zone in comparable municipalities.

7. CONCLUSION

To briefly recapitulate the theses outlined above, I can summarize that whether it is parking meters or resident parking cards, the price of parking is negotiated by agreement and there are no price assessments in terms of binding legislation. In this respect, I cannot but agree with the conclusions of the Constitutional Court in its judgment no. Pl. 14/08 of 18 November 2010, according to which the price list for the use of a parking zone pursuant to Section 23(1) of the Roads Act should be issued as a regulation pursuant to Section 10(1) of the Prices Act. The content of a regulation issued under section 10(1) of the Prices Act must be exclusively the price regulation of a particular commodity. However, in the case of the setting of a price for the use of a parking zone pursuant to section 23(1) of the Roads Act, it is not a price regulation within the meaning of the Prices Act. Here, the municipality is not setting the price as a price regulator, but as a seller.

In this context, it is disputable whether, despite the (possible) fulfilment of all the conceptual features of a measure of a general nature, including the imposition of an obligation on the (generally defined) addressees, an administrative act, which is explicitly named by law as a regulation, can be considered a measure of a general nature.

The Administrative Procedure Code, in which the general regulation of measures of a general nature is found, does not provide a positive definition of this form of administrative act, as is generally well known, but merely defines a measure of a general nature negatively as a (binding) administrative act which is neither a legal regulation nor a decision. Moreover, the above, in conjunction with the provision requiring administrative authorities to follow the general rules governing measures of a general nature in cases where a specific law requires them to issue a binding measure of a general nature, has opened a debate on the identification of an administrative act as a measure of a general nature. The gradual development, the fundamental direction of which was determined only by the Constitutional Court in its judgment of 19 November 2008, no. Pl. 14/07, it has concluded that a measure of a general nature can be any act - even if not explicitly marked as such in the law - which fulfils the conceptual features of not being a legal regulation or a decision.

In accordance with the above-mentioned ruling of the Constitutional Court, which expresses the primacy of the material concept of a measure of a general nature over the formal one, i.e. the possibility of a material approach to the assessment of administrative acts as measures of a general nature, it is possible to consider the decision on the

establishment of traffic signs as a typical example of a measure of a general nature, despite the fact that Act No. 361/2000 Coll., Act on Road Traffic and on Amendments to Certain Acts (Road Traffic Act), as amended, does not explicitly designate the establishment of traffic signs as a measure of a general nature.

However, the situation is different in the case of the parking zone regulation, since the Act already directly provides for one of the forms of administrative action, which is a regulation as a municipal regulation, the general legal regulation of which is found in the Municipalities Act.

In my opinion, this reflects an inconsistency in the Constitutional Court's understanding of the regulation under review as a measure of a general nature. If the regulation is to be regarded as a measure of a general nature, then the procedure for adopting a measure of a general nature laid down in the Administrative Procedure Code should be followed at the same time. However, the procedural procedure applied by the respondent in the present case corresponds to the statutory form contained in Article 23(1) of the Roads Act, i.e. the adoption of a legal regulation by a local authority. I find this fact when considering the judgment of the Constitutional Court in no. Pl. 14/08 of 18 November 2010, as essential, since it is not acceptable that, in terms of its material content, the administrative act under review is a measure of a general nature, but at the same time, in terms of the procedural procedure for its adoption, the procedural procedure relating to the adoption of a legal regulation has been applied.

The Constitutional Court found the valid wording of Section 23(1) of the Roads Act to be a measure of a general nature because of the specific definition of the subject matter of the legislation. The form chosen by the legislator for this administrative act in the form of a legal regulation, the characteristic feature of which is the generality of the definition of the subject matter of the legislation, does not correspond to this. The legislator cannot treat the forms of law arbitrarily, regardless of their content. Applying the principles of proportionality and subsidiarity, when comparing a legal regulation and a measure of a general nature, the form of the measure of a general nature is less restrictive in relation to the preservation of the fundamental right referred to in Article 36(2) of the CHARTER OF FUNDAMENTAL RIGHTS AND FREEDOMS as a part of the constitutional order of the Czech Republic. Conversely, the form of the legislative provision precludes judicial review in the administrative courts. In other words, the cited reasoning of the Constitutional Court's judgment (no. Pl. ÚS 19/11, of 31 January 2012) does not indicate the criteria for review at the stage of issuing legislation which is materially a measure of a general nature (Bahýlová, 2010).

Thus, the material breakthrough, when a statutory regulation of a municipality was designated as a measure of a general nature, occurred in rather specific circumstances. Therefore, in my opinion, the above-mentioned judgment of no. Pl. ÚS 14/08, of 18 November 2010, can be applied without further consideration to the case of the parking zone ordinance or to other municipal regulations regulating land transport, which are expressly provided for by law in the form of a municipal ordinance. In the case of this regulation, this is not a situation where a double interpretation is possible.

The Supreme Administrative Court seems to have given an answer to the question whether there can be measures of a general nature which are measures of a general nature subject to review within the meaning of the relevant provisions of the Administrative Procedure Code, but which are not measures of a general nature under the Administrative Procedure Code, or more precisely, the Administrative Procedure Code does not apply to their issuance. The parking zone regulation is therefore an administrative act which is a measure of a general nature in material terms (and subject to appropriate judicial review), but the procedure for its adoption cannot be brought within the scope of the Administrative Procedure Code (Vedral, 2012).

Based on the current case-law, the regulation in question can probably be regarded as a measure of a general nature from a material point of view. However, since the legal regulation provides for a specific form for these administrative acts, which is linked to a certain process of their creation in the legal order, it is possible to judicially review them as measures of a general nature, but when issuing them, the local self-government unit or its competent authority does not have to (or even cannot) follow the general legal regulation on the issuance of measures of a general nature in the Administrative Procedure Code, but issues them as an ordinance under the Municipalities Act.

In conclusion, the decision on the establishment of traffic signs, which serve to implement traffic regulation, is also a measure of a general nature. Such a situation, where two administrative acts are issued for a single traffic regulation, both of which are, moreover, materially (but not formally) measures of a general nature, is not suitable from the point of view of the systematics and efficiency of public administration, which is why I believe that the issue of judicial review of municipal regulations defining areas with paid parking is not definitively closed.

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International Comparison of Chatbots: Analysis of ChatGPT and ERNIE in Germany and China

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Abstract

This study explores the development and usage of modern chatbot technologies, specifically Chat GPT and ERNIE, and compares their application and acceptance in Germany and China. The technical advancements of both models are examined, including innovative approaches and improvements that enhance their performance. Additionally, the current state of research on chatbots is presented, and the methodological approaches of this study are explained. A central part of the investigation focuses on the application areas of chat-bots in both Germany and China. Specific use cases in various sectors, such as e-commerce and healthcare, are analyzed. The acceptance of these technologies in the two countries is also examined in detail, taking into account cultural and societal differences. Furthermore, the study analyzes customer communication via chatbots in both countries to assess the effectiveness and challenges of these technologies in practice. Another key aspect is a comprehensive comparison between Germany and China regarding ethical challenges, cultural frameworks, infra-structure, and practical considerations. The findings, based on interviews with experts and companies, provide valuable insights into perceptions, experiences, and strategies in dealing with chatbots. The study concludes with a discussion of the main findings in the context of theoretical foundations and literature, and out-lines implications for research and practice. Finally, the conclusion summarizes the key results of the study and provides an outlook on further research questions and opportunities

Keywords: Artificial Intelligence, Chatbots, Customer Communication

1. INTRODUCTION

The advancing digitalization and technological progress have fundamentally changed the way companies communicate with their customers. One of these technological innovations is the introduction of AI-based chatbots, which are now used in many industries and countries.

AI-based chatbots are programs that rely on artificial intelligence to enable human-like interactions. They are increasingly being deployed in customer communication to answer inquiries, solve problems, and improve customer service. By automating routine tasks, chatbots can enhance company efficiency while providing round-the-clock support. The ability of chatbots to handle large volumes of inquiries simultaneously and quickly makes them a valuable tool for businesses of all sizes.

Germany and China are two countries with significant differences in terms of technological development, culture, and economic environments. While Ger-many is known as a highly developed industrial nation with a strong focus

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on traditional industries and technologies, China has experienced unprecedented economic growth and rapid digitalization in recent decades. These contrasts offer a unique opportunity to compare the usage of chatbots in different con-texts, yielding valuable insights.

In Germany, chatbots are increasingly found in various sectors such as banking, insurance, retail, and public administration. Companies appreciate the efficiency gains and the ability to handle standardized customer inquiries around the clock. In China, on the other hand, where digital innovations and technologies are adopted more rapidly, chatbots are found in even broader ap-plication areas, including e-commerce, healthcare, and education.

2. THEORETICAL BACKGROUND

2.1. Fundamental Concepts of Chatbots

Chatbots are software applications that simulate human-like conversations with users through textual or verbal interfaces. They utilize a variety of technologies from the fields of Artificial Intelligence (AI), Machine Learning (ML), and Natural Language Processing (NLP) to understand user interactions and respond appropriately. The development of chatbots has made significant strides over the past few decades, and they are now widely used in various industries, including customer service, healthcare, and e-commerce.

Modern chatbots are based on a combination of various technologies. A crucial foundation is Natural Language Processing (NLP), a subfield of Artificial Intelligence (AI) that enables the interaction between computers and human language. Through NLP techniques, chatbots are capable of understanding the meaning and context of user inputs. Additionally, Machine Learning (ML) and Deep Learning play a central. These techniques allow chatbots to learn from large datasets and continually improve their performance. Particularly, neural networks, including recurrent neural networks (RNNs) and transformer models, have significantly enhanced the ability of chatbots to generate coherent and human-like responses. Another key element is the dialogue management system, which determines how a chatbot responds to user inputs. It considers the conversational context and previous interactions to formulate appropriate responses [1][2].

In general, chatbots can be divided into two main categories:

Firstly, there are rule-based chatbots that rely on predefined rules and scripts. These are particularly suitable for answering simple, frequently asked questions but exhibit weaknesses in handling complex conversations.

Secondly, there are AI-driven chatbots that use advanced AI techniques such as NLP and ML to deliver intelligent, context-aware, and personalized responses. These are capable of conducting sophisticated and dynamic conversations and learning from past interactions, significantly enhancing their flexibility and efficiency [1].

2.2. Development of Chat GPT

The development of ChatGPT, one of the most advanced language models, has been spearheaded by OpenAI. ChatGPT is based on the GPT-3 architecture (Generative Pre-trained Transformer-3), which is notable for its enormous size and the sheer number of parameters. GPT-3 employs 175 billion parameters, making it one of the largest and most powerful language models in the world [3].

A key component in the development of ChatGPT was the use of transformer architectures, first introduced by Vaswani et al. [4]. This architectural foundation allows the model to capture contextual information over long text se-quences and understand relevant relationships.

The training process of ChatGPT consisted of two main phases: pre-training and fine-tuning. During the pre-training phase, the model was trained on a vast amount of unstructured text data to learn basic language patterns and grammatical structures. Once the pre-training was completed, the fine-tuning phase began, where the model was trained with specific data and instructions to better prepare it for particular tasks and conversations [3].

A crucial aspect of the further development of ChatGPT is the method of Reinforcement Learning from Human Feedback (RLHF). This method was applied to improve the quality of responses and train the model to provide meaningful and helpful answers. By soliciting human feedback on the generated responses, the model was iteratively optimized [5].

The applications of ChatGPT range from everyday conversations and customer support to educational assistance. Thanks to its ability to understand and generate natural language, ChatGPT offers human-like interaction that is useful in various fields.

2.3. Development of ERNIE

The development of ERNIE (Enhanced Representation through kNowledge Integration) by Baidu represents a significant advancement in the field of Natural Language Processing (NLP) and Artificial Intelligence (AI). ERNIE, first released in 2019, is a language model that utilizes the transformer architecture and aims to produce better-contextualized text representations than its predecessors, including Google's widely adopted BERT models [6].

ERNIE employs a range of advanced technologies to enhance the semantic interpretation and understanding of texts. Its foundation is based on the trans-former architecture [4], but it has been extended through several innovative approaches. In contrast to models like BERT, ERNIE explicitly integrates structured knowledge from knowledge graphs during the pre-training phase. This allows the model to learn not only linguistic patterns but also facts and logical relationships [7]. Another important approach is continuous pre-training, which enables ERNIE to constantly incorporate new data and information, continually improving its capabilities. This ensures that the model re-mains up-to-date with the latest information. Additionally, ERNIE is trained for various tasks such as text classification, sentiment analysis, and question answering, contributing to the model's versatility and performance [6].

3. UTILIZATION OF CHATBOTS

3.1. Application Areas in Germany

In Germany, there are numerous applications for ChatGPT. One key area is customer service. Here, ChatGPT is used to answer queries around the clock, provide general information, and offer personalized support. For instance, companies like Deutsche Telekom and E.ON are already experimenting with AI-powered chat-bots to increase customer satisfaction and reduce service costs [8].

The potential of ChatGPT is also evident in the educational sector. ChatGPT and similar systems support teachers and students by offering individualized tutoring, answering questions, and providing learning resources. Additionally, these systems are used to create educational content and automate administrative tasks [9].

Furthermore, ChatGPT finds broad application in the creative industry. Authors, journalists, and content creators benefit from the technology, as it offers writing prompts, generates texts, and supports creative processes. Publishers and media companies use ChatGPT to produce content more efficiently and enhance creative output [10].

These diverse applications demonstrate that ChatGPT is gaining increasing importance not only in industry but also in education and creative professions in Germany. In some sectors, such as healthcare, customer service, and education, the use of ChatGPT receives positive feedback. The efficiency and quality of services are improved by implementing this technology. For example, AI-powered systems in hospital groups help manage patient inquiries and support medical professionals.

However, despite this positive acceptance, there is also significant resistance to the use of AI chatbots. These concerns are primarily related to data protection. The sceptical attitude of society towards the widespread collection and analysis of data leads to demands for strict controls and regulations. These da-ta protection and privacy concerns dominate the debate over the use of such technologies [2].

3.2. Application Areas in China

In China, ERNIE is applied in a variety of areas to enhance the efficiency and effectiveness of processes and provide innovative solutions. For example, Baidu, the largest internet service provider in China, uses ERNIE to improve its search algorithms. By integrating the language model into the search engine, more relevant and context-aware search results can be delivered [6].

In the e-commerce sector, ERNIE is used to personalize product recommendations and interact with customers in natural language. Platforms like JD.com and Alibaba utilize this technology to improve customer experience and streamline sales processes [6].

ERNIE is also utilized in the healthcare sector, particularly in supporting clinical decision-making and patient interaction. By analyzing medical literature and patient data, the model helps doctors make accurate diagnoses and develop treatment plans [6].

4. ACCEPTANCE OF CHATBOTS

4.1. Acceptance in German Society

The reception and integration of ChatGPT and similar AI technologies in German society are multifaceted, demonstrating both an increase in acceptance and discrepancies between enthusiasm and concerns regarding the impact of such technologies [11].

The fears extend beyond data protection and include questions of job security and the ethical use of AI. Some workers and unions fear that the automation of tasks by ChatGPT could lead to job losses. Simultaneously, there are ethical discussions about how to ensure the avoidance of bias in AI systems to achieve fair and balanced outcomes [12].

The discourse on the societal integration of ChatGPT thus reflects a field of tension between technological optimism and critical caution. While the efficiency gains and improvements in various application areas are undeniable, continuous reflection on the ethical and data protection implications is essential. Only in this way can the technology be used responsibly and to the benefit of the whole society.

Overall, it is evident that the acceptance of ChatGPT in Germany is growing, especially in areas that directly benefit from the improvements. At the same time, the technology is being closely and critically monitored to ensure that its implementation and usage align with societal values and legal frameworks.

In Germany, the general acceptance of AI technologies is positive, but there is scepticism regarding data protection. Consumers and companies are open to new technologies as long as they are deemed secure and data protection-friendly. Studies show that Germans are sometimes hesitant to adopt new technologies until their safety and benefits are comprehensively demonstrated [11].

4.2. Acceptance in Chinese Society

The acceptance of ERNIE and similar technologies in Chinese society is generally high. This is partly due to the general tech affinity and the rapid digitalization of the country. Many citizens and businesses recognize the benefits of AI technologies and actively use them, leading to increased efficiency and improved user experience.

However, there is also scepticism and concern regarding privacy and the potential negative impacts of surveillance. While the technology is perceived as positive and progressive by many, a critical stance remains towards data usage and ethical responsibility. These concerns lead to an ongoing debate about balancing technological advances with the protection of individual freedoms.

The development of ERNIE by Baidu represents a significant milestone in NLP. Through the integration of knowledge graphs, continuous pre-training, and multi-task learning, Baidu has created a model that supports diverse applications across various sectors. Despite the technological advancements, ethical challenges and data protection concerns remain, requiring careful consideration and continuous oversight. The acceptance in Chinese society shows that the benefits of the technology are widely recognized; however, a critical discourse on the ethical implications and potential negative impacts remains necessary.

In China, the acceptance of AI technologies is very high. This is largely due to the strategic promotion by the government, which provides long-term plans and subsidies to foster technological progress. The population's willingness to embrace technological innovations is also high, partly due to a culture that values technological convenience and efficiency [13].

5. COMPARISON OF GERMANY AND CHINA

The comparison of the frameworks for the development and use of language models in Germany and China reveals significant differences in cultural contexts, infrastructure, acceptance, and usage. These differences range from cultural attitudes towards technology to regulatory frameworks and practical considerations in daily use.

5.1. Ethical Challenges in Germany

Avoiding bias is a central challenge in the development and implementation of ChatGPT models. As these models learn from extensive training data, they often inherit the imbalances and prejudices present in the data. This can lead to biased or inappropriate responses, affecting the performance and reliability of artificial intelligence. Therefore, it is

crucial to develop systems for detecting and mitigating bias to ensure that the generated responses are fair and balanced [12].

Additionally, data protection is a significant challenge, particularly in a country like Germany, where strict data protection laws like the General Data Protection Regulation (GDPR) are followed. The development and implementation of ChatGPT must comply with data protection guidelines to ensure that users' personal data is protected. This requires not only technically sophisticated solutions but also transparent and understandable processes to gain users' trust and meet legal requirements [14].

Germany shows a nuanced stance towards the use of AI technologies like ChatGPT. While numerous companies and institutions recognize and utilize the benefits of these technologies, there are also fears and concerns regarding data protection, job security, and ethical implications.

5.2. Ethical Challenges in China

The implementation of ERNIE in China brings unique challenges and ethical considerations, particularly in the area of state surveillance and data protection. In China, state surveillance is a widespread and accepted phenomenon. The use of AI technologies like ERNIE could further intensify these surveillance practices. This raises ethical questions regarding citizens' privacy and the potential misuse of surveillance data [15].

Another central issue is data protection. Although China passed the Personal Information Protection Law (PIPL) in 2021, which is designed similarly to the GDPR of the EU, there are ongoing concerns about the enforcement and actual implementation of this law. The use of technologies like ERNIE must therefore be carefully monitored to ensure that users' data is safe and protected [16][17].

In China, the ethical challenge of gender bias in natural language processing (NLP) is a significant interdisciplinary issue. Many of the commonly used da-ta-driven techniques, such as large-scale language models, suffer from data scarcity and biased text collection. This is particularly problematic for low-resource languages like Chinese.

To address this challenge, the Chinese Corpus for Gender Bias Probing and Mitigation (CORGI-PM) was developed. This corpus contains 32,900 sentences with high-quality labels created using an annotation schema specifically de-signed for the Chinese context to identify gender bias. Additionally, the three central challenges of automatically mitigating gender bias in texts are ad-dressed: models must be able to detect, classify, and mitigate textual gender bias [18].

5.3. Cultural Frameworks

In Germany, the attitude towards new technologies is generally characterized by caution and security. Data protection and guarding privacy are deeply embedded in the culture, reinforced by the strict rules of the GDPR. These regulations im-pose stringent requirements on companies regarding the collection and pro-cessing of personal data, leading to careful consideration when introducing new AI technologies, especially in areas involving personal data.

In contrast, the acceptance of new technologies in China is widespread, sup-ported by policies that actively promote technological innovation. The Chinese government has introduced comprehensive plans like 'Made in China 2025' and the 'New Generation Artificial Intelligence Development Plan' to position the country as a global leader in technology and innovation. Consumers are highly willing to adopt technological advancements, even at the expense of privacy [19].

5.4. Infrastructure

Germany has a well-developed technological infrastructure, but there are still deficiencies in some rural areas, particularly in broadband connectivity. Initiatives like the Digital Pact and subsequent investments have aimed to close these gaps, although the expansion lags behind other European countries (Haefner & Sternberg, 2020). Nonetheless, Germany provides a stable foundation for AI re-search and development, supported by strong universities and research institutes like the Fraunhofer Institute.

China has massively invested in digital infrastructure in recent years, resulting in a state-of-the-art network of data centers and fiber optic connections. Chinese technology giants like Baidu, Alibaba, and Tencent have developed advanced infrastructure that supports the rapid and extensive deployment of AI technologies [13].

5.5. Practical Considerations

For the implementation of language models in Germany, data protection and security concerns play a central. Compliance with the GDPR is essential for companies that wish to apply AI technologies. Additionally, integration into existing systems is often complex and requires extensive legal and technical preparations.

In China, practical considerations are more influenced by regulatory requirements and the necessity to align with state control mechanisms. Companies must ensure that their technologies comply with Chinese government guidelines, which may necessitate adjustments in data processing and content.

In summary, a comparison between Germany and China in the context of AI and language models highlights clear differences in cultural, infrastructural, and regulatory frameworks. Germany places a strong focus on data protection and privacy, leading to a more cautious introduction of new technologies. In contrast, China emphasizes rapid technological development and extensive state support, resulting in swift and comprehensive AI technology implementation. These differences are crucial for shaping the form and function that language models like ChatGPT and ERNIE take in their respective countries.

6. CONCLUSION

The comparison of the frameworks for the development and use of language models like ChatGPT and ERNIE in Germany and China reveals striking differences in cultural contexts, infrastructure, acceptance, and usage. These distinctions shape the form and function that these AI technologies take in their respective countries, reflecting varying societal values, regulatory requirements, and technological environments. In Germany, the cautious integration of AI technologies is driven by a strong focus on data protection and privacy, deeply embedded in the cultural and regulatory frameworks. The adherence to the GDPR and a thorough reflection on ethical implications ensure that the deployment of systems like ChatGPT is carried out responsibly. This approach, although sometimes slowing down technological adoption, aims to balance the benefits of AI advancements with the protection of individual rights and societal values. Conversely, China's rapid technological growth and government support foster a more aggressive adoption of AI technologies like ERNIE. The strategic promotion of technological innovations and extensive investments in digital infrastructure facilitate a swift and broad implementation of these systems. However, this comes with its own set of challenges, particularly in terms of privacy and ethical considerations, as the state's surveillance practices and the enforcement of data protection laws raise concerns about potential misuse and the safeguarding of individual freedoms. Ultimately, while both countries recognize the transformative potential of AI and language models, their approaches are shaped by differing priorities and concerns. Germany prioritizes careful and ethical integration, ensuring that technological advancements align with societal values and legal constraints. In contrast, China leverages state support to drive rapid innovation and adoption, focusing on efficiency and technological leadership, albeit with ongoing debates about the balance between progress and privacy. The findings from this comparative analysis offer valuable insights into the multifaceted nature of AI acceptance and integration in different cultural and regulatory environments. They underscore the importance of context-specific strategies in deploying AI technologies and highlight the need for continuous dialogue on the ethical and societal implications of AI advancements. Future research should continue to explore these dynamics, providing deeper understanding and guidance for the responsible development and use of AI worldwide.

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Computer-Aided Diagnosis of Acute Appendicitis in Pediatric Patients Using Deep Learning Models on Abdominal Ultrasound Images

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Abstract

Appendicitis is a common diagnosis in the emergency abdominal disease of adolescence. Suppose the appendix is perforated, morbidity and mortality increase. Therefore, the budget for surgery is to diagnose as early as possible. This is not always possible in children. Especially in young children and infants, the stories seen may not be obtained correctly or be confused with other complaints. The clinical picture may appear in a very different way from the classical information. In this case, in addition to clinical recommendations, it helps us significantly in finalizing the diagnosis. To address this issue, the use of computer-aided diagnostic systems, particularly those employing deep learning, has gained prominence. This study explores applying various deep learning models—Xception, DenseNet-201, InceptionV4, EfficientNetV2, and ResNet-152—to classify abdominal ultrasound images of suspected appendicitis in pediatric patients. A dataset comprising 1709 ultrasound images was utilized, with 579 images specifically focused on appendicitis cases. A thorough preprocessing pipeline was employed, including image grayscale conversion, Gaussian blurring, Canny edge detection, and inpainting techniques, to enhance feature extraction and improve classification performance. Experimental results indicate that EfficientNetV2 achieved the highest classification accuracy (96%), followed closely by InceptionV4 (94.3%). These results demonstrate the potential of deep learning-based models to improve the accuracy and speed of appendicitis diagnosis in children, thereby reducing the reliance on traditional methods and minimizing the risk of complications. Future work will aim to expand this approach by incorporating clinical scoring systems such as the Alvarado Score and Pediatric Appendicitis Score to further enhance diagnostic precision.

Keywords: Pediatric appendicitis, Deep learning, Ultrasound imaging, Computer-aided diagnosis

1. INTRODUCTION

Acute appendicitis is one of the most common diseases in children. The most common causes of abdominal pain were evaluated in emergency departments and emergency surgical interventions performed worldwide [1-2]. Intratubular obstruction, fecalith accumulation, lymphoid hyperplasia, foreign bodies, parasites, and tumors may cause

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appendicitis. Appendicitis is less common in children than in adults but is more often complicated. The probability of acute appendicitis perforation is reported to be 20-70% [3-4]. Acute appendicitis, a common disease in children, is potentially morbid. [5-6]. Each year, in the United States, 80,000 children are diagnosed with appendicitis, the incidence of this disease in children under the age of 14 is reported to be 4/1000, reaching a peak in the age range of 12-18 years [7]. Acute appendicitis has the potential to progress rapidly and may become more complex with complications including perforation, early and accurate diagnosis is extremely important. In patients who are not diagnosed correctly promptly, peritonitis and intra-abdominal abscess may develop complications such as necrosis or rupture of the appendix [8]. The diagnosis of acute appendicitis is mostly based on clinical findings and some nonspecific laboratory tests. Symptoms range from a wide spectrum of classic symptoms to atypical symptoms (8,9). Disease-specific symptoms such as abdominal pain, nausea, vomiting, and loss of appetite are less frequently observed in more than 50% of patients. Therefore, most patients present with atypical symptoms. Anatomical differences in appendicitis in children, problems of compliance with pediatric physical examination, and patients presenting with atypical symptoms make the diagnosis of acute appendicitis more difficult Compared with adults [9]. Diagnosis is based on abdominal pain starting around the umbilicus and radiating to the right iliac fossa and is seen in 50-60% of patients and is defined as the classic course and physical examination findings. Despite all, advances in imaging technology, the differentiation of acute appendicitis from other diseases is largely based on the clinical and careful physical examination of the patient. However, imaging studies performed in addition to clinical evaluation are extremely helpful in increasing the size, and accuracy of diagnosis, decreasing the negative rate of appendicitis surgery and disease progression [10]. In some studies, USG, computed tomography (CT), and magnetic resonance imaging (MRI) examinations were used jointly to increase the accuracy of the diagnosis and were reported to have a positive effect on the prognosis of the disease. In addition, ultrasonography is the first and most used imaging method in the diagnosis of acute appendicitis. Although USG is the most widely used diagnostic imaging method in the medical field, image quality can be affected by many factors, it is difficult to overlap the images with each other and to be comparable with different cross-sectional methods and it becomes difficult to interpret USG. In recent years, the rapid use of processors in computers and the development of artificial intelligence neural network algorithms have enabled promising research to overcome this problem.

2. MATERIALS AND METHODS

2.1. General Framework

   Determining whether a suspicious appendix has turned into appendicitis by examining ultrasound abdominal images can be defined as a classification problem in terms of artificial intelligence, where two-dimensional images feed deep learning models. In this context, to obtain more effective results, the data has been pre-processed. Then, deep learning models are trained with training data by separating the samples for training and testing. Afterward, the trained models are given test data that they have never encountered before, and the label of the relevant data is predicted. The general structure's operation diagram is given in Fig. 1.
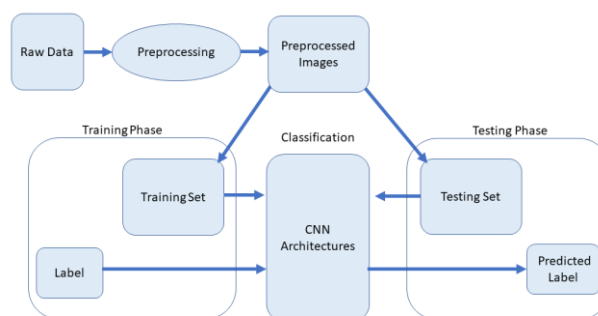
Fig. 1. The general overview

2.2. Dataset

   The dataset used in this study was created using data from 579 children and adolescents admitted to St. Hedwig Hospital for Children in Regensburg, Germany between 2016 and 2021 with suspected appendicitis. A total of 1,709

abdominal ultrasound images were retrospectively collected with clinical course and laboratory tests of each patient and, the corresponding data set was introduced with the literature by Marcinkevics et al. [11]. Images were acquired using Toshiba Xario and Aplio XG machines and included relevant anatomical regions such as appendicitis, intestines, and lymph nodes. In this study, only appendicitis images were used as subjects; in this context, a total of 579 images were used, 383 appendicitis, and 196 control. Patients were classified into three labeled categories: diagnosis (appendicitis present/absent), treatment (surgical/conservative), and severity (complicated/uncomplicated). In surgical patients, the diagnosis was confirmed histologically, whereas in those treated conservatively, appendicitis was determined according to ultrasound findings and clinical scores. In addition, clinical data were collected and evaluated with Alvarado and Pediatric Appendicitis Scores (AS and PAS). Examples of suspected appendicitis are given in Fig. 2.
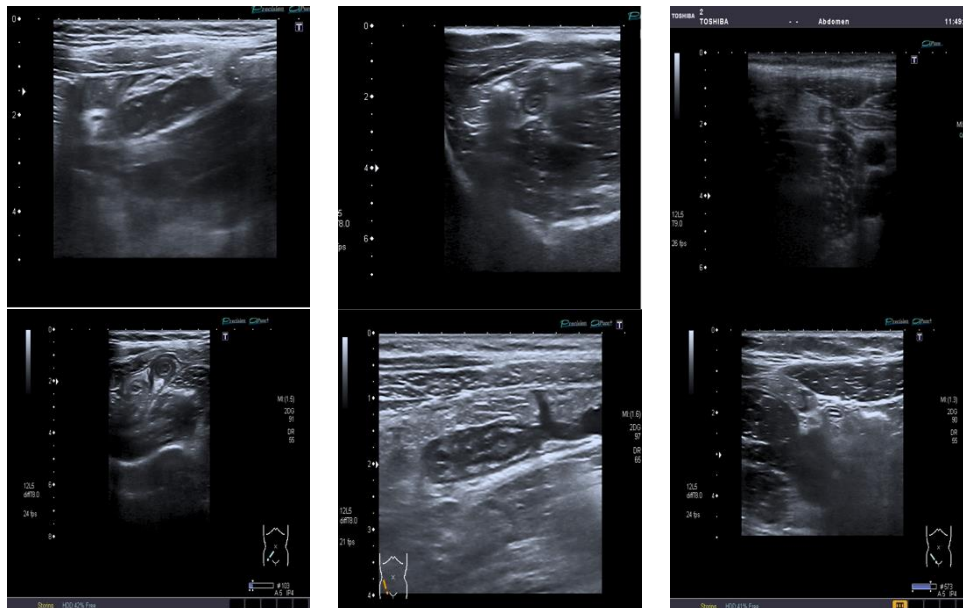
Fig. 2. The examples of suspected appendicitis

2.3. Preprocessing

The process begins with an RGB image initially converted into grayscale in order to facilitate analysis and reduce computational complexity. Then, a Gaussian blur is applied to the image to smooth it and reduce noise, thus facilitating the detection of important features [12]. After that, Canny edge detection [13] is used to identify the edges of the image, thus highlighting prominent structures such as text or logos. Then, the contours of the above-mentioned edges are identified, with contours exceeding an area of 20 pixels being selected to make sure that only the most prominent features are considered. To expand, the contours defined with precision, a dilation [14] is used to expand the mask and ensure the coverage of the targeted regions. Inpainting [15] is then used to remove unnecessary logos or similar elements of text, by populating the detected areas with relevant content from the surrounding regions. Finally, Contrast Limited Adaptive Histogram Equalization (CLAHE) [16] is applied to increase the contrast of the image, thus rendering the remaining features more distinguishable and drawn for further analysis. In Fig. 3., all the mentioned preprocessing steps are illustrated in an example.
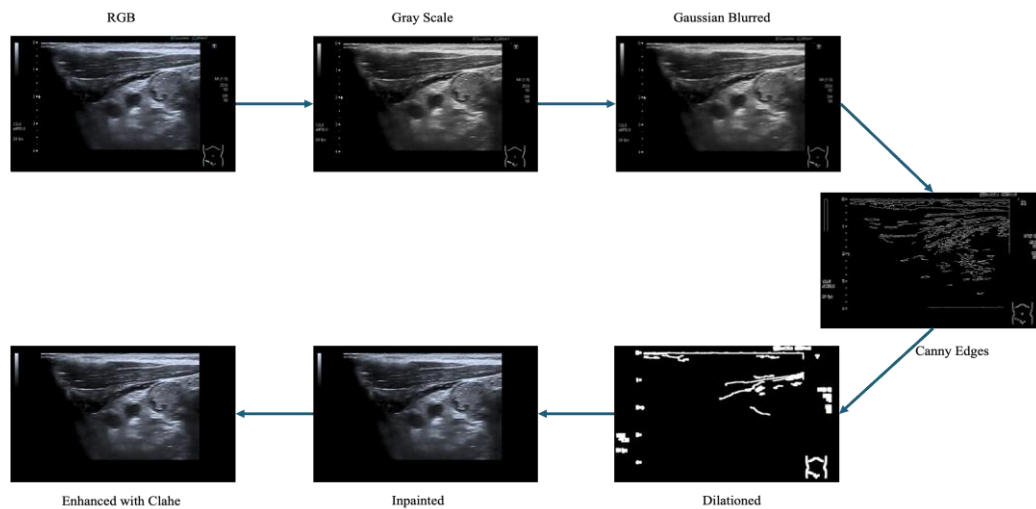
Fig. 3. The preprocessing steps

2.4. Models

The Xception algorithm is a network structure built on Inception networks. It has 36 convolutional layers that form the feature extraction base of the network. These 36 convolutional layers are structured into 14 modules with residual connections except for the first and last modules [17].

The DenseNet model was introduced by Huang et al. in 2016. It is a type of convolutional neural network whose all layers are directly connected via dense blocks [17]. DenseNet-201, consisting of 201 blocks, was used in this study.

The Inception-V4 architecture is the fourth version of the Deep Learning Convolutional Architectures series [18]. Inception-V4 is one of the most advanced architectures used in the field of image classification. This architecture proposes an initial model that combines multiple convolutional filters of different sizes into a new filter. Such a design reduces the number of parameters to be trained and thus reduces the computational complexity. The model consists of symmetric and asymmetric building blocks including convolution, average pooling, max pooling, and fully connected layers.

The EfficientNetV2 model was introduced in 2021. It aims to achieve higher accuracy by scaling the depth, width, and resolution of the neural network equally while using minimal computational resources [19].

The ResNet architecture is created by combining residual blocks layer by layer. The basic ResNet block prevents vanishing gradients by increasing the depth of the network and learning the difference between the input and output dimensions. This architecture is an important feature that distinguishes ResNet models from other deep networks. In this study, the ResNet-152 architecture consisting of 152 blocks was used [20].

2.5. Experimental Setup and Performance Evaluation

Within the scope of all experiments conducted during the research of the relevant study, the batch size was selected as 32, while the learning rate and epoch metrics were determined as 0.01 and 50.

The k-fold cross-validation technique was used in all experiments performed for the relevant study. In this technique, the dataset was divided into k randomly selected parts. Each part was allocated for testing, while the remaining parts were used in the training phase. This process is repeated k times [21]. With the order of measurement, the classification performance of the models, and evaluation metrics such as Accuracy, Sensitivity, Precision, F1 Score, and Matthews Correlation Coefficient were used [22].

The percentage of accuracy the model makes for the categorization task is known as accuracy. The formula Equation (1) is used to calculate it.

$$\text{Accuracy} = (TP+TN)/(P+N) \tag{1}$$

Sensitivity evaluates the classifier's ability to identify each positive example, whereas Precision is the amount of the classifier's ability to classify negative examples as positive. Equations (2) and (3) are used to calculate Sensitivity and Precision respectively.

$$\text{Sensitivity} = (TP)/(TP+FN) \tag{2}$$

$$\text{Precision} = (TP)/(TP+FP) \tag{3}$$

F1 score is a harmonic of Precision and Sensitivity, a single metric that balances both. This metric measures the overall performance of the model in a balanced way, considering both FP and FN. The formula for F1 score is shown in Equation (4).

$$\text{F1 Score} = TP/(TP+ (1/2 * (FP+FN))) \tag{4}$$

Matthews Correlation Coefficient (MCC) is a balanced evaluation metric used to measure the performance of a classification model. It provides more reliable results, especially for imbalanced datasets, because it takes into account the balance between positive and negative classes. The MCC formula is presented in Equation (5).

$$\text{MCC} = (TP * TN - FP * FN)/ \sqrt{((TP+FP) * (TP+FN) * (TN+FP) * (TN+FN))} \tag{5}$$

Where, TP, TN, P, and N are the true positives, true negatives, total positives, and total negatives, in this order.

3. RESULTS

The relevant hypothesis was tested using deep learning models Xception, DenseNet-201, InceptionV4, EfficientNetV2, and ResNet-152 in classification experiments following the preprocessing stage. In this context, when the results in Table I are examined, the best classification performance was achieved by the EfficientNetV2 model, which reached the values of 0.9603, 0.9661, 0.9737, 0.9699, 0.9153 for Accuracy, Sensitivity, Precision, F1 Score, MCC metrics, respectively. Again, the InceptionV4 model, which reached the values of 0.9429, 0.9529, 0.9605, 0.9567, and 0.8867 for the same metrics, achieved results close to the best performance but remained in second place. While the Xception and ResNet-152 models showed a moderate performance, DenseNet-201 showed sub-par performance with the values of 0.8221, 0.8355, 0.8889, 0.8614, and 0.6558, and its performance did not reach the desired level.

Table 1. The classification results of models

	Accuracy	Sensitivity	Precision	F1 Score	MCC
Xception	0.9085	0.9138	0.9459	0.9296	0.7998
DenseNet-201	0.8221	0.8355	0.8889	0.8614	0.6558
InceptionV4	0.9429	0.9529	0.9605	0.9567	0.8867
EfficientNetV2	0.9603	0.9661	0.9737	0.9699	0.9153
ResNet-152	0.8912	0.9008	0.9324	0.9163	0.7722

4. DISCUSSION AND CONCLUSION

Appendicitis is a 5 to 10 cm-long appendix located at the beginning of the large intestine and is usually associated with appendicitis. Appendicitis is half a centimeter wide and contains an extension called the lumen. Appendicitis usually occurs when this lumen is blocked. The appendix expands because the lumen's connection to the intestine is blocked and may burst due to impaired circulation. The appendix or appendicitis is located on the lower right side of the body, and it is not known exactly what it does or what its function is. Although appendicitis usually occurs in adolescence, it is also among the health problems frequently encountered in childhood and adulthood. Appendicitis symptoms can often be confused with gastroenteritis (intestinal infection) or urinary tract infection. For this reason, pediatric patients are usually treated incorrectly and given antibiotics or medications used in the treatment of gastroenteritis or urinary tract infections. Since the drug treatment applied will not be effective on appendicitis, it may burst after a while. Since appendicitis is difficult to diagnose in children, it is one of the most urgent situations that requires intervention in childhood. As the classification performances of the experiments conducted for this purpose

show, a computer-aided diagnostic system will both reduce the workload of clinicians and prevent the aforementioned erroneous diagnoses. In the experiments mentioned, appendicitis could be detected without any problems at rates of up to 96%. In future studies, in addition to disease detection, labels such as Severity, Disease type, Alvarado Score, and Pediatric Appendicitis Score will be used to estimate the relevant targets.

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Analysis of Power System Oscillations

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Abstract

New electrical energy sources, advancements in storage facilities, and the development of power electronics devices have significantly impacted power systems. These innovations, along with complex control strategies, economical operational practices, and cost-efficient equipment construction, have introduced challenges to power system stability, particularly affecting local mode oscillations. Currently, there is a notable absence of comprehensive analyses of local oscillations in the contemporary power systems. The scope of this investigation is to analyse local oscillations and their underlying causes to mitigate their adverse effects. Initially, the paper outlines mathematical models suited for studying local oscillations. A significant contribution of this paper lies in the formulation of practical guidelines to assist power plant operators in mitigating stability issues. Additionally, the paper estimates eigenvalue boundaries associated with local modes. To validate these findings, experiments were conducted using laboratory-scale synchronous generators to confirm the conclusions derived from numerical analyses.

Keywords: Synchronous generators, power system stability, eigenvalues

1. INTRODUCTION

Power system stability refers to the ability of an electric power system, under initial operating conditions, to return to a state of equilibrium after enduring a physical disturbance, with most system variables limited so that the system remains largely intact [1].

Synchronous generators are fundamental components of power systems. In recent decades, stability issues have notably increased among synchronous generators in power systems. This rise can be attributed to three main factors:

- Changes in generator construction: These changes, driven by cost optimization in production and transport, have reduced oscillations' damping [2].

- Implementation of auxiliary open- and closed loop systems: Additional control systems have been integrated into power systems to accommodate altered operational modes, such as peak performance operation, stringent transmission operator requirements, open access to transmission, environmental constraints, and heightened competition. While these systems enhance operation under specific conditions, they can diminish damping and potentially induce instability in other scenarios [2].

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- High demand and system loading: Modern power systems operate near their maximum transmission capabilities to meet escalating energy demands, increasing the likelihood of critical conditions [3].

Consequently, modern generators have become susceptible, leading to instability in natural oscillations.

The consequences of heightened stability issues are evident in the growing power outages worldwide. These outages, extensively reviewed in the literature [3], often stem from difficult weather, as well as issues like tree falls on transmission lines, accounting for approximately 50% of global outages from 2011 to 2019. Equipment faults and human errors follow as the second leading causes, accounting for about 31.8% of outages during the same period [3]. In 2011 alone, there were approximately 2,050 outages lasting an average of 4 hours, underscoring their severe societal and economic impact. Notable examples include the India blackout of July 30th and 31st, 2012, affecting over 1 billion people due to transmission line overload, and the Bangladesh blackout of November 1st, 2014, affecting 150 million people due to HVDC station outage [3].

According to [3], stability issues can be categorized in different classes. In the paper we investigated the small-signal stability which is a subcategory of rotor angle stability. The primary cause of this stability problems lies in oscillations involving synchronous generators and other components of the power system. These oscillations are classified into five categories based on the interacting elements: local mode oscillations, inter-machine or inter-plant mode oscillations, torsional mode oscillations (between synchronous generators and turbines), control mode oscillations (within power plant parts due to control system interactions), and inter-area oscillations (between groups of generators in different areas). Local mode oscillations are the most prevalent small-signal stability issues [4].

This study concentrates on an in-depth examination of local mode oscillations within the Slovenian power system. Covering an area of 20,271 km², the Slovenian system features robust 400 kV transmissions with neighbouring countries and comprises 74 synchronous generators exceeding 1 MVA in nominal power. Most generators are small-scale, with only two large units.

The purpose of the obtained findings will be:

- Forecast local mode oscillations without the need for direct measurements.

- Classify measured oscillations into local mode oscillations (distinct from torsional, control, and inter-area oscillations) when data are available.

- Prevent activities that could lead to stability issues related to local mode eigenvalues.

The discusses topic present significant challenges and has garnered substantial attention in scientific literature. Successful analysis and prediction of oscillatory characteristics hinge on accurate mathematical modelling. The 3rd order model (designated as the HP model, authors Heffron and Phillips), initially introduced in [5], serves as a foundational framework for local oscillation analyses. Although modified over time [6, 7], the HP model remains a cornerstone in current research [4, 8]. Detailed parameter determination and model identification techniques are extensively documented [9, 10].

Quantitative assessments of oscillation frequencies in synchronous generators date back more than two decades. Publications such as [11] and [12] estimate frequency ranges for various oscillation types, which continue to serve as benchmarks. A comprehensive overview of natural oscillatory behaviours in power systems, including inter-area modes, is provided in [13].

Despite advancements in generator construction, control strategies, and network integration, recent literature lacks comprehensive analyses estimating local mode oscillation frequencies across a broad spectrum of synchronous generators. Furthermore, detailed evaluations of expected damping for these oscillations remain scarce. Damping significantly influences stability, particularly in light of new technologies and equipment affecting synchronous generators [13]. Recent publications explore damping aspects, including studies on photovoltaic virtual synchronous generators [14], wind farm synchronous generators [15], storage systems for oscillation damping [16], and motor-generator pair [17].

The paper is structured into seven sections. The 2nd section introduces the HP model. In the 3rd section, an analysis based on eigenvalues is conducted. In the 4th section the consequences of the working conditions on dynamics are described. The 5th section describes the limits of eigenvalues. The 6th section presents significant measurement results. In conclusion, the article summarizes the most crucial findings.

2. MODELLING OF A SYNCHRONOUS MACHINE CONNECTED TO AN INFINITE BUS (SMIB)

There is a significant emphasis on developing robust dynamic models for synchronous generators operated connected to the infinite bus [8]. Various models of differing complexities are available. Among these, Non-Linear 7th order d-q Model (NLM) is fundamental, incorporating magnetic coupling of stator and rotor windings that vary with rotor position and saturation. However, due to the extensive number of required parameters, many of which are challenging to measure and often unknown, this model may not be suitable for precise quantitative analyses of real synchronous generators.

In the context of small-signal stability analysis, linearized models prove satisfactory. These models outline generator's behaviour near chosen equilibrium points and are characterized by parameter dependence on their respective equilibrium points. Linearized models facilitate straightforward eigenvalue analyses, providing valuable insights into oscillation frequencies and damping characteristics. A range of linearized models of varying complexities are utilized, with the HP model being particularly popular.

The HP model employs two inputs: mechanical (turbine) torque $T_{m\Delta}(t)$ and field excitation voltage $E_{fd\Delta}(t)$; and features three state-space variables: rotor angle $\delta_\Delta(t)$, rotor speed $\omega_\Delta(t)$, and transient reactance voltage $E'_{q\Delta}(t)$. Variables are represented as deviations (denoted by subscript Δ from equilibrium. Table I lists the parameters required for calculating the HP model parameters, showcasing a reduction compared to the NLM [8].

Table 1
LIST OF PARAMETERS THAT ARE NEEDED FOR DETERMINATION OF HP MODEL

parameters of synchronous generator	L_d (H), L_q (H), L_d' (H), H (s), R_e (Ω), L_e (H), D (pu), T_{d0}' (s)

The meaning of parameters: L_d and L_q, denote the d- and q-axis inductances respectively, L_d' represents the d-axis transient inductance; H is the inertia constant; R_e and L_e are the transmission line parameters; D is a damping coefficient; and T'_{d0}, is the open circuit time constant. Table I highlights a reduction in parameter requirements for the HP model [8], eliminating the need for knowledge of many NLM parameters.

Equations (1) and (2) [8] present the HP model:

$$\begin{bmatrix} \dot{\delta}_\Delta(t) \\ \dot{\omega}_\Delta(t) \\ \dot{E}'_{q\Delta}(t) \end{bmatrix} = \begin{bmatrix} 0 & \omega_s & 0 \\ -\dfrac{K_1}{2H} & -\dfrac{D}{2H} & -\dfrac{K_2}{2H} \\ -\dfrac{K_4}{T'_{d0}} & 0 & -\dfrac{1}{K_3 T'_{d0}} \end{bmatrix} \begin{bmatrix} \delta_\Delta(t) \\ \omega_\Delta(t) \\ E'_{q\Delta}(t) \end{bmatrix} + \begin{bmatrix} 0 & 0 \\ \dfrac{1}{2H} & 0 \\ 0 & \dfrac{1}{T'_{d0}} \end{bmatrix} \begin{bmatrix} T_{m\Delta}(t) \\ E_{fd\Delta}(t) \end{bmatrix} \tag{1}$$

$$\begin{bmatrix} T_{e\Delta}(t) \\ V_{t\Delta}(t) \end{bmatrix} = \begin{bmatrix} K_1 & 0 & K_2 \\ K_5 & 0 & K_6 \end{bmatrix} \begin{bmatrix} \delta_\Delta(t) \\ \omega_\Delta(t) \\ E'_{q\Delta}(t) \end{bmatrix} + \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} T_{m\Delta}(t) \\ E_{fd\Delta}(t) \end{bmatrix} \tag{2}$$

Linearization parameters K_1 to K_6 of are computed using values from Table 1 [8].

The advantages of the HP model were shown thoroughly in [8]. Calculations were conducted using the NLM and HP model, comparing results against experimental data. These analyses covered various operational points across the generator's entire operating range, examining different dynamic inputs such as mechanical torque and excitation voltage. Results consistently demonstrated strong agreement in amplitude, frequency, and damping characteristics of transient responses. As concluded in [8], the HP model effectively shows electromechanical phenomena in power systems throughout their operational ranges under minor input perturbations, making it suitable for analysis.

3. SYNCHRONOUS GENERATOR'S EIGENVALUES

The evaluation of local mode oscillations relied on analyzing the eigenvalues derived from the HP model. It yields 3 eigenvalues: 2 complex and 1 real. The complex eigenvalues are particularly critical as they specifically characterize local modes. The real part of the complex eigenvalues is directly linked to the frequency and the imaginary component

is related to damping of the local mode oscillation. To examine the oscillatory behavior, the eigenvalues λ_1, λ_2 and λ_3 were determined using (3), where **A** denotes model's system matrix (1):

$$\det(\lambda \mathbf{I} - \mathbf{A}) = 0 \rightarrow$$
$$2K_3HT'_{d0}\lambda^3 + \left(K_3DT'_{d0} + 2H\right)\lambda^2 + \left(K_1K_3T'_{d0}\omega_s + D\right)\lambda +$$
$$+\left(K_1\omega_s - K_2K_3K_4\omega_s\right) = 0$$

(3)

The response corresponding to the eigenvalues $\lambda_{1,2} = \sigma \pm \mathrm{j}\,\omega$ manifests as $\mathrm{e}^{\sigma t} \sin(\omega t + \theta)$. Here, σ dictates the time constant for the decay of oscillation amplitude. ω defines the damped frequency in radians per second. The natural frequency ω_0 describes the natural frequency and ζ defines the damping ratio:

$$\omega_0 = \sqrt{\sigma^2 + \omega^2}, \qquad \varsigma = \frac{-\sigma}{\sqrt{\sigma^2 + \omega^2}}$$

(4)

Due to the complexity and lack of transparency in analytical treatments and expressions, numerical methods were employed for eigenvalue analysis.

4. CORRELATION BETWEEN WORKING CONDITIONS AND OSCILLATIONS

4.1. Hydro Generators

The impact of the working conditions on generators' oscillations was assessed through eigenvalues. Initially, hydro generators with powers ranging from 9 MVA to 615 MVA, detailed in [1], were analyzed. Dominant conjugate complex eigenvalues of the HP model's system matrix were computed for various working conditions. Figs. 1 and 2 depict the eigenvalue loci of local mode oscillations as a function of working conditions for 9 MVA hydro generator and 615 MVA hydro generator. Separate contours relate to constant reactive power levels. Active power was varied between 0.0 pu and 1.2 pu at constant reactive power. Computations were conducted for reactive power values from 0.0 pu to 1.2 pu. Individual curves correspond to constant reactive power levels.
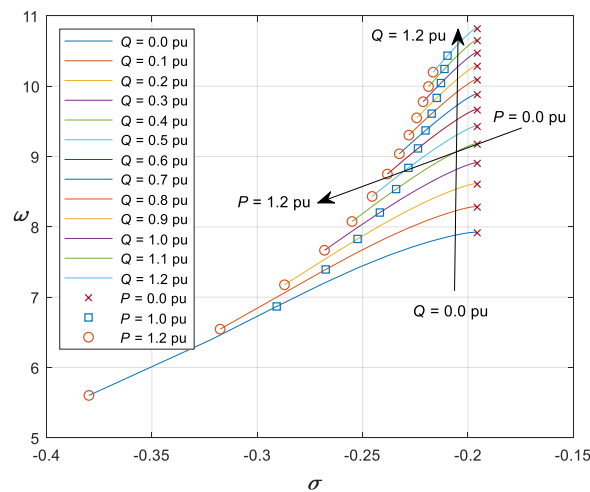
Fig. 1.   Curves of constant reactive power and changeable active power for hydro generator of 9 MVA.
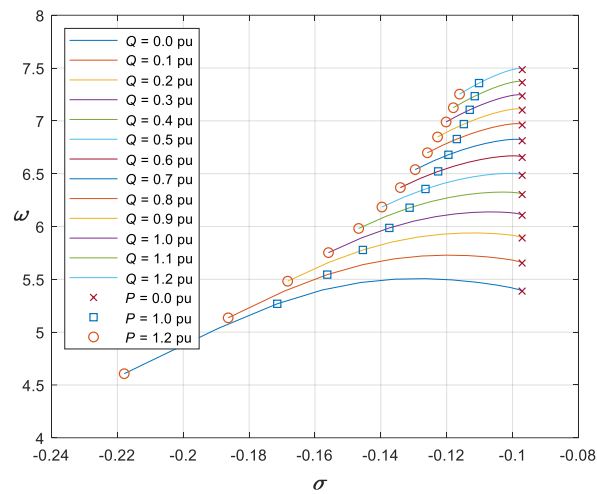
Fig. 2.   Curves of constant reactive power and changeable active power for hydro generator of 9 MVA.

Analysis was conducted for all Slovenian hydro generators (in Figs. 1 and 2 are presented only 2). An interesting finding was that all set of curves exhibited similarity. Based on all obtained results 4 key rules were drawn:

- Increasing active power enhances damping (reduction of σ),

- Increasing reactive power boosts damped frequency (increase of ω),

- Operation with high reactive power and low active power can pose stability challenges due to nonsufficient damping,

- Operation with low reactive power and high active power is well damped and stable due to maximal damping.

4.2. Turbo Generators

Turbo generators with nominal powers ranging between 10 and 1000 MVA, as detailed in [1], underwent similar eigenvalue analysis as hydro generators. Figs. 3 and 4 illustrate curves of eigenvalues depending on working conditions for two turbo generators.
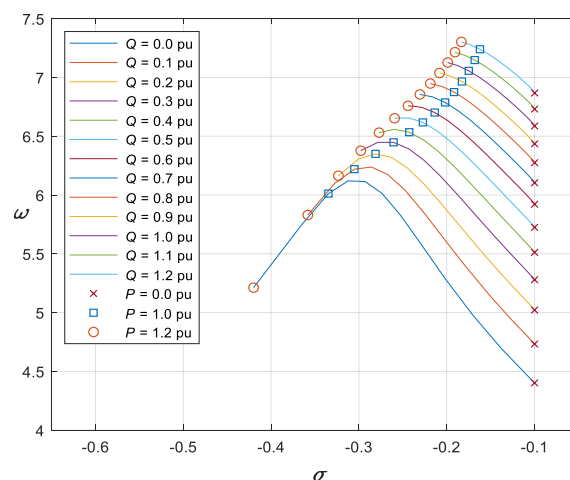
Fig. 3.   Curves of constant reactive power and changeable active power for turbo generator of 25 MVA.

Eigenvalues were computed for almost 50 generators. Comparable functions were observed for all generators, as depicted in Figs. 3 and 4. Unlike hydro generators, the calculated curves exhibit complexities, particularly noticeable in curves with lower reactive power values where convexity near nominal active power values is evident. Nevertheless, the fundamental conclusions remain unchanged: an increase in active power decreases σ, while an increase in reactive power increases ω. Furthermore, oscillations exhibit better damping by high values of P and low values of Q power, whereas damping is less effective at high Q and low P settings.
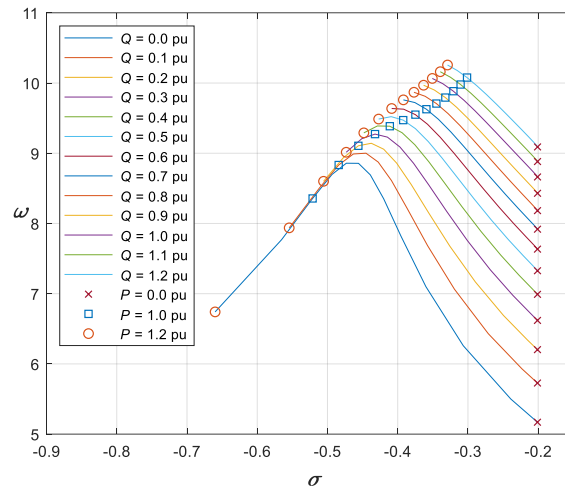
Fig. 4.   Curves of constant reactive power and changeable active power for turbo generator of 911 MVA.

5. REGIONS OF EIGENVALUES AND THEIR BORDERS

For the computation of the margin values of damped frequencies ω and decay time constants, the eigenvalues were calculated for all generators in Slovenian power system. The generators' working conditions in range from 0 to 120 % in active and reactive power were considered. The obtained margin values are shown in Table 3.

TABLE 3
THE BOUNDARIES OF EIGENVALUES

	σ_{min}	σ_{max}	$\omega_{min}(s^{-1})$	$\omega_{max}(s^{-1})$
hydro type	-0.4558	-0.0399	2.8554	10.8259
turbo type	-0.8871	-0.0807	3.6418	10.5455

6. EXPERIMENTAL CONFIRMATION

To validate the accuracy of obtained computations and conclusions, we conducted a series of experiments on a laboratory-sized synchronous generator. Unfortunately, direct confirmation on power plant units was not feasible. The tests aimed to measure oscillations' frequencies and damping in entire working conditions of a salient-pole generator rated at P_n = 12 kW. Manufacturer-provided data are detailed in Table 4,

TABLE 4
LABORATORY SALIENT-POLE GENERATOR

P_n = 12 kW	U_n = 400 V	I_n = 21.7 A	$\cos \varphi_n$ = 0.8
U_{Fn} = 400 V	I_{Fn} = 21.7 A	f_n = 50 Hz	n_n = 1500 min^{-1}

where P_n is nominal active power, U_n, I_n, U_{Fn}, I_{Fn} represent voltages and currents of stator- and rotor winding at rated conditions, and f_n and n_n denote frequency and speed, respectively.

Linearization coefficients were calculated and are detailed in Table 5 [18].

TABLE 5
HP MODEL PARAMETERS

$P_n = 0.8$ [pu]	$K_1 = 2.1555$	$K_2 = 2.0815$	$K_3 = 0.1285$
$Q_n = 0.6$ [pu]	$K_4 = 3.5155$	$K_5 = 0.0228$	$K_6 = 0.0998$

The experimental setup for parameter calculation and testing is depicted in Figure 5. A solid-state power amplifier provided rotor voltage, while an induction machine with a frequency converter generated mechanical torque. Dewetron data acquisition system recorded responses, with control by a dSpace controller board. Data analysis utilized Mathworks/Matlab.

Local modes were determined comprehensively in the entire working area. By utilizing an excitation system and a mechanical torque generator, steady-state operating points were established, and torque step changes provoked oscillations. Three-phase power was measured, revealing clear local mode oscillations in computed instantaneous power. Transfer functions of second-order lags were identified using Matlab/Identification Toolbox, and poles determined from these functions corresponded to local mode eigenvalues.

Figs. 6 and 7 depict the measured dynamics of the laboratory generator near two distinct operating points. From the measured responses the second order transfer functions were identified. On the basis of the step responses of the identified transfer functions the eigenvalues which corresponds the generator's dynamics were calculated. Step responses of the identified transfer function are shown in Figs. 6 and 7. In Fig. 6, the local mode oscillation is observed around the $P = 12$ kW, $Q = 0$ kVAr, demonstrating sufficient-damped oscillations. Fig. 7 presents corresponding functions in weakly damped working area, at $P = 0$ kW, $Q = 12$ kVAr.

Experiments, identification and computations of σ and ω were carried out for different operating points: $P = 0.00$ pu, $P = 0.40$ pu, $P = 0.80$ pu, $P = 1.00$ pu, and $P = 1.20$ pu, each at reactive power values $Q = 0.00$ pu, $Q = 0.50$ pu, and $Q = 1.00$ pu. The results are shown in Table VI. Fig. 8 graphically illustrates the identified local mode eigenvalues presented in Table VI. active power values $P = 0.0$ pu, $P = 0.4$ pu, $P = 0.8$ pu, $P = 1.0$ pu, and $P = 1.2$ pu, each at reactive power values $Q = 0.0$ pu, $Q = 0.5$ pu, and $Q = 1.0$ pu.
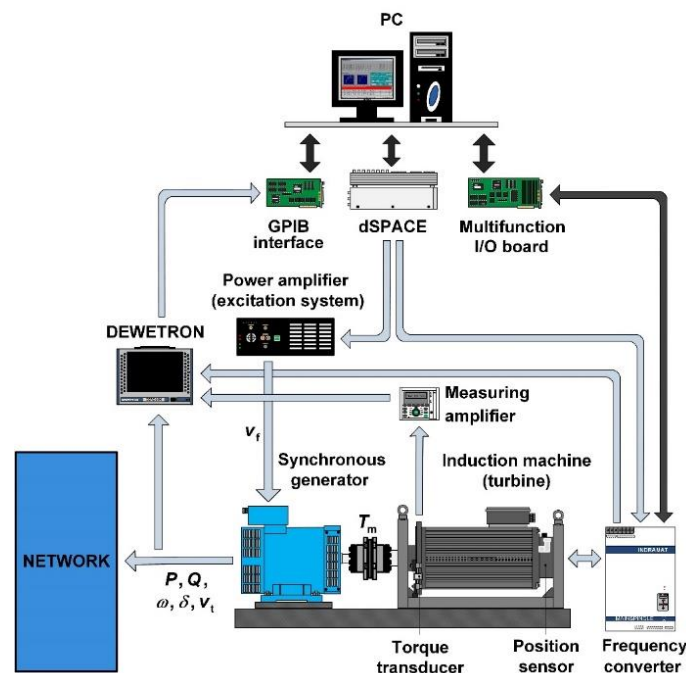
Fig. 5. Laboratory experimental system.
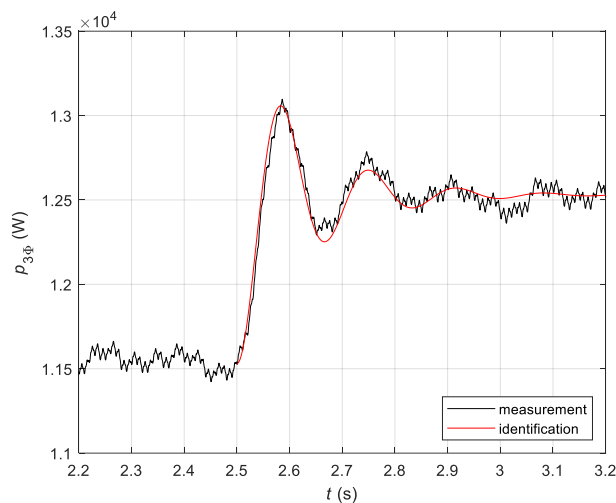
Fig. 6.　Measured and simulated instantaneous power of the laboratory synchronous generator in the sufficient damped working conditions, at P = 12 kW, Q = 0 kVAr.
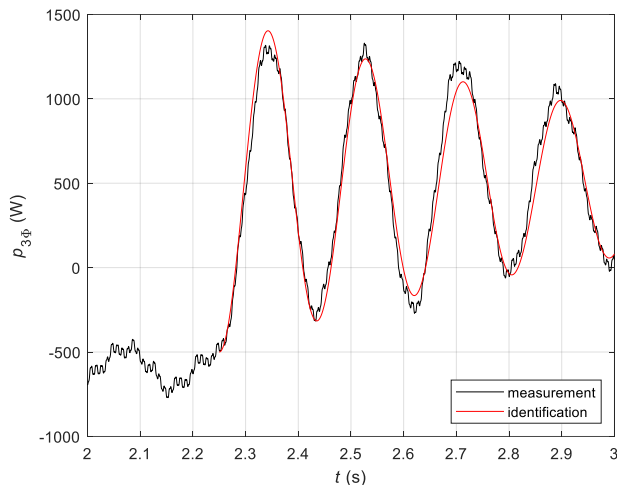
Fig. 7.　Measured and simulated instantaneous power of the laboratory synchronous generator in weakly damped working conditions, at $P = 0$ kW, $Q = 12$ kVAr.

Table 6
DAMPING AND FREQUENCIES OF LABORATORY GENERATOR IN DIFFERENT WORKING CONDITIONS

	$Q = 0.00$ pu	$Q = 0.50$ pu	$Q = 1.00$ pu
$P = 0.00$ pu	$\sigma = -1.75$	$\sigma = -1.63$	$\sigma = -1.10$
	$\omega = 22.85$	$\omega = 29.22$	$\omega = 34.25$
	$\omega_0 = 22.92$	$\omega_0 = 29.26$	$\omega_0 = 34.27$
	$\zeta = 0.0764$	$\zeta = 0.0558$	$\zeta = 0.0321$
$P = 0.40$ pu	$\sigma = -4.50$	$\sigma = -2.51$	$\sigma = -2.39$
	$\omega = 27.33$	$\omega = 31.22$	$\omega = 36.83$
	$\omega_0 = 27.70$	$\omega_0 = 31.32$	$\omega_0 = 36.91$
	$\zeta = 0.1625$	$\zeta = 0.0801$	$\zeta = 0.0649$
$P = 0.80$ pu	$\sigma = -7.16$	$\sigma = -4.18$	$\sigma = -2.89$
	$\omega = 34.15$	$\omega = 33.47$	$\omega = 37.16$
	$\omega_0 = 34.89$	$\omega_0 = 33.73$	$\omega_0 = 37.27$
	$\zeta = 0.2053$	$\zeta = 0.1241$	$\zeta = 0.0776$

$P = 1.00$ pu	$\sigma = -7.70$	$\sigma = -5.15$	$\sigma = -3.32$
	$\omega = 37.80$	$\omega = 36.43$	$\omega = 37.69$
	$\omega_0 = 38.57$	$\omega_0 = 36.79$	$\omega_0 = 37.84$
	$\zeta = 0.1996$	$\zeta = 0.1400$	$\zeta = 0.0877$
$P = 1.20$ pu	$\sigma = -8.06$	$\sigma = -5.93$	$\sigma = -3.91$
	$\omega = 41.34$	$\omega = 40.06$	$\omega = 39.12$
	$\omega_0 = 42.12$	$\omega_0 = 40.49$	$\omega_0 = 39.32$
	$\zeta = 0.1915$	$\zeta = 0.1465$	$\zeta = 0.0996$
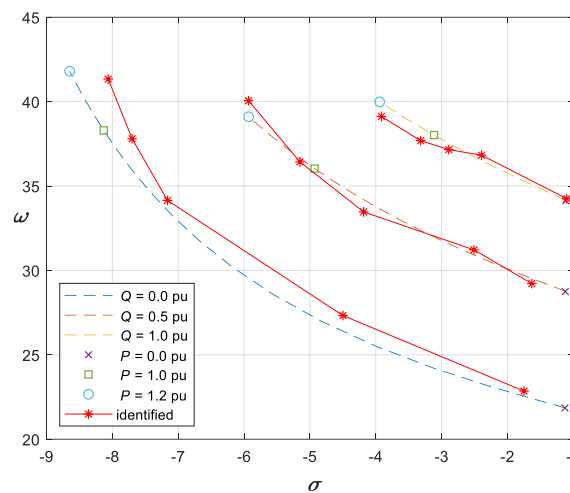
Fig. 8. Measured (dashed line) and identified (solid line) contours of eigenvalues for tested generator $P_\text{n} = 12$ kW (from Table 6)

7. CONCLUSIONS

Stability is the fundamental challenge in power systems. Stability is caused by oscillations, which can lead to rotor shaft fatigue, reduced rotor lifespan, power quality issues, undesired tripping of generation units, etc. Understanding local mode oscillations in is essential for analysis of stability problems. Key conclusions drawn from this study include:

- The working conditions have a significant consequence on oscillation frequency and damping.

- A general rule has been established that the generator is well-damped under high active and small reactive loads, but poorly damped under high reactive and low active loads.

- Local mode oscillation frequencies of present power plant synchronous generators are estimated to range from 0.45 Hz to 1.75 Hz, with damping ratios from 0.004 to 0.17.

- Experimental results obtained with the laboratory size generator confirmed the observed correlation between operating points and oscillation characteristics.

These findings facilitate the estimation of expected oscillation characteristics. It is our hope that engineers and scientists engaged in local mode oscillation measurements will compare their findings with the conclusions of this study, thereby validating or refining them.

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Probabilistic Modelling of the Conceptual Design Phase in Automotive Engineering

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Abstract

The multidisciplinary nature of the vehicle design process and the increasing demand for developing environmentally sustainable transport systems present a challenge to the automotive industry. These challenges are associated with uncertainties that are often neglected in the conceptual design phase of road vehicles. To address such uncertainties, a probabilistic approach can be adopted. More precisely, one can make use of the so called Sobol' indices. These are used within the context of variance-based global sensitivity analysis to quantify the uncertainties of a system's outputs caused by the uncertainties of its inputs. For this purpose, this paper aims to achieve the following goals:

1. Quantification of output uncertainties in the conceptual design phase based on the Sobol' indices. Within this context, the research plug-in hybrid electric vehicle "Interurban Vehicle" (IUV), designed at the German Aerospace Centre (DLR[1]), is considered.

2. Probabilistic, digital and parametric modelling of the IUV based on multidisciplinary design analysis (MDA).

Overall, this paper concludes that probabilistic modelling does not only enable the quantification of uncertainties, but also helps to understand the underlying complex mechanisms of the considered system and support the decision-making process in the conceptual design phase of road vehicles.

Keywords: uncertainty quantification, Sobol' indices, plug-in hybrid electric vehicle, conceptual design phase, automation, digitization, multidisciplinary design analysis (MDA)

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1. INTRODUCTION

1.1. Problem setting

Nowadays, the world is witnessing an exponential growth in technological advances that are revolutionizing almost every major industry. As a result, the complexity of products is increasing to a large extent. Road vehicles serve as a good example of this transformation. During the last couple of decades, vehicles evolved from being mainly a mechanical product to an increasingly interconnected system involving heterogeneous stakeholders as well as multidisciplinary requirements and constraints. In addition to this increasing complexity of the vehicle architectures, the pursuit of developing environmentally and economically sustainable transport systems as well as the resulting regulatory changes present a common challenge to the automotive industry. To address these challenges, important decisions should be made in the early phase of the vehicle design, also known as the concept phase or conceptual design phase. This phase is crucial, as it establishes the core design, performance criteria and the majority of the costs during the later stages. Therefore, it is essential to pinpoint the design factors, such as material parameters, operational conditions, etc., that have the greatest impact on the final design [18]. However, such factors are subjected to uncertainties that are often neglected in the conceptual design phase. In general, there are two distinct types of uncertainties, namely aleatory and epistemic [9]. On one hand, aleatory uncertainties arise from the intrinsic randomness of the system or process considered, like, for instance, the variability of material properties in manufacturing processes. Such uncertainties cannot be reduced by acquiring additional information or improving models. On the other hand, epistemic uncertainties stem from a lack of information or data and can be reduced by obtaining additional information or improving models [13]. Moreover, Kennedy and O'Hagan, 2001 [16] classified uncertainties in a more precise manner. They identified six types of uncertainties [15]: 1) parametric variability, 2) parameter uncertainty, 3) model inadequacy, 4) interpolation uncertainty, 5) numerical uncertainty and 6) experimental variability. Within the scope of this publication, emphasis is placed on uncertainties of the vehicle design parameters, i.e., parametric variability[2] and parametric uncertainty[3]. Efficiency of vehicle components and gravimetric energy densities serve as good examples for such vehicle design parameters. Accounting for such uncertainties in the conceptual design phase requires a shift from deterministic designing to a probabilistic one. In contrast to deterministic approaches, probabilistic ones can be utilized to analyze various design scenarios. Consequently, this enhances the robustness of the design concept by ensuring that it fulfills the requirements under a variety of conditions [22]. Furthermore, by analyzing different scenarios vehicle designers can extrapolate from current technological trends to create designs that incorporate possible future advancements. However, the interdisciplinary nature of the conceptual design phase, as well as the complex interconnections between the various engineering disciplines involved, render the integration of a probabilistic framework challenging.

1.2. State of the art and research gap

Within this context, sensitivity analysis (SA) can play a crucial role in accounting for uncertainties of the vehicle design parameters and thus establish a probabilistic framework for the conceptual design phase. In general, SA is referred to as the study that examines how the outputs of a system are connected to, and affected by the inputs of that system [25]. I.e., SA techniques quantify the impact of the input parameters on the outputs of the considered system. There are various ways how to conduct SA. Broadly speaking, methods of SA can be categorized into two main groups [33]:

1. **Local SA** (LSA) examines the local impact of a single input parameter on the system's output by varying the considered input parameter and fixing the remaining input parameters at a specific operating or design point. Such methods do not assign probability distributions to the input parameters [28]. The "one-factor-at-a-time" technique serves as a good example for such local approaches.

2. **Global SA** (GSA) asses the sensitivity of the system's output with respect to the variation of the entire input parameter space, rather than taking only a single design point into consideration as was the case using LSA.

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[2] Parametric variability points to the variation in the design variables and/or noise variables [15].
[3] Parameter uncertainty is related to fixed and non-measurable parameters of a simulation model (e.g. fracture coefficient) [15].

To clarify the difference between LSA and GSA, the simulation of a vehicle's energy consumption is considered. The energy consumption depends on some input parameters, such as a specific driving cycle, vehicle's mass, aerodynamic drag coefficient, etc. Conducting an LSA, one might examine how small variations in, for instance the vehicle's mass affect the vehicle's energy consumption, while holding the remaining inputs constant. On the other hand, a GSA involves varying each input parameter across its entire plausible range and measuring how much each parameter impacts the vehicle's energy consumption. Therefore, GSA plays an important role in determining which parameters have the greatest impact and which ones should remain unchanged. For this reason, GSA techniques are suitable for the initial design phase, since in the early design phases, it is often challenging to determine which parameters exert the greatest influence and which should remain constant [18]. However, there is not a unique way to conduct GSA. Razavi et al., 2021 [25] categorize GSA into five main groups: 1) derivative-based approach, 2) distribution-based approach, 3) variogram-based approach, 4) regression-based approach and 5) response surface-assisted GSA.

Within the scope of this paper only the distribution-based approach is considered. Distribution-based GSA examines the distributional properties of the output. Most commonly, distribution-based GSA involves partitioning the variance of the output into portions which are then attributed to the corresponding inputs [12, 18]. This assumes that the variance is a reliable measure of uncertainty. Such approaches are also known as "variance-based GSA". One of their key characteristics is their independence from the considered model or system. That is, conducting the analysis does not depend on the model's characteristics (linear, nonlinear, stationary, etc.) [28]. Typical representative of distribution-based GSA or variance-based GSA is the Sobol' method [31]. For a more comprehensive literature review regarding SA, it is referred to Razavi et al., 2021 [25].

To address the challenging task of incorporating uncertainties in the vehicle design process, several attempts were made, especially within the context of vehicle dynamics simulations.

In the work of Song et al., 2023 [32], SA was conducted on the input parameters of a nonlinear five-degree-of-freedom seated human model [2]. The main objective was to quantify the output uncertainties of the ride comfort with respect to the input uncertainties of the model's stiffness parameters. Here, the input uncertainties were quantified by assigning probability density functions (PDFs) to the input stiffness parameters. Within this context, Song et al., adopted a local approach for the SA. Each uncertain input parameter was varied separately, while keeping the other uncertain inputs constant. Subsequently, polynomial chaos expansion (PCE) [36] was used as a surrogate model to efficiently compute the output of the human model, i.e., the ride comfort, and characterize its uncertainties.

Brandt et al., 2022 [6] analyzed the crosswind stability of a vehicle by examining various crosswind gust profiles. For this purpose, Brandt et al., integrated vehicle dynamics models, such as the single-track model [30], with aerodynamic ones following a one-way-coupling approach. Here, uncertainties of input parameters from both disciplines (vehicle dynamics and aerodynamics), such as wheel-base, vehicle mass and lift coefficients were considered. Within this context, the input uncertainties were quantified using parameter intervals chosen based on existing vehicle specifications as well as vehicle types. To quantify the output uncertainties of the vehicle's crosswind stability, the main effect of the inputs on the crosswind stability was computed, i.e., how each input affects the output. Moreover, the effect of the inputs' interactions on the output was also studied based on response surface methodology (RSM) [5], which aims at developing a mathematical model based on statistical techniques.

Danquah et al., 2021 [8] examined the uncertainties of the energy consumption of an electric vehicle based on the Worldwide Harmonized Light Vehicle Test Procedure (WLTP). In order to compute the energy consumption, an open-source vehicle dynamics simulation was used, which can be found in [7]. PDFs as well as intervals were assigned to the input parameters, such as the vehicle mass, aerodynamic drag coefficient, tire pressure, etc., to quantify their uncertainties. Based on these intervals and PDFs, the simulation was performed repeatedly to quantify the uncertainties of the energy consumption stemming from the input uncertainties. Moreover, the simulated energy consumption was validated by experimental measurements, in which a prototype vehicle was placed on a chassis dynamometer. Subsequently, the error between the simulated and experimental energy consumption was computed, with the objective of quantifying the uncertainties of the simulation model used.

Schmeiler et al., 2016 [28] made use of various techniques to conduct SA on input parameters of vehicle dynamics simulations. More precisely, three simulations were considered. Two of them are based on the single-track model, which examines the lateral dynamics of a road vehicle. The third simulation is based on a commercial high-fidelity black-box model. The sensitivity of the yaw rate, roll angle and rollover risk were analyzed with respect to simulation input parameters such as mass, inertia, position of center of gravity, cornering stiffness, etc. For this purpose, distribution-based GSA, represented by the Sobol' method [31] as well as surface-assisted GSA, represented by PCE were used. Moreover, regionalized SA (RSA) was applied, which can be linked to GSA approaches. The main objective of RSA is to set a condition on the output space (for instance, an upper limit) and categorize the outputs that satisfy this condition as behavioral, otherwise as non-behavioral [24].

Wu et al., 2015 [37], analyzed the uncertainties of simulation input parameters within the context of vehicle vertical dynamics. To be more precise, a four-degree-of-freedom vehicle roll dynamics model was considered. Here, Wu et

al. quantified input uncertainties by assigning PDFs to the suspension's stiffness parameters. Moreover, an approach was proposed to also considered parameter intervals, as it is sometimes challenging to determine the PDF of certain input parameters, such as the vehicle's payload capacity. Within this context, surface-assisted GSA, represented by PCE combined with interval analysis [21] were implemented to characterize the output uncertainty of the suspension's deformation.

Within the context of road vehicles, SA techniques are well-established and have been extensively studied. However, to the author's knowledge, their usage is limited to specific vehicle dynamics models, rather than considering the whole conceptual phase of road vehicles. For this reason, this paper aims on answering the following research questions:

- *How can a probabilistic approach be adopted with the objective of quantifying uncertainties in the multidisciplinary conceptual design phase of road vehicles?*

- *How can the collaboration regarding computational tools across the engineering teams involved in the multidisciplinary conceptual design phase of road vehicles be enhanced?*

1.3. Contribution and outline

With the objective of answering the research questions stated above, this paper aims at providing a framework that incorporates a probabilistic approach in the conceptual design phase of road vehicles. Specifically, it employs the so called Sobol' indices (see Chapter 2) used within the context of variance-based GSA in order to:

- quantify the uncertainties of the outputs of interest, which are caused by the uncertainties of the considered design parameters reflecting possible technological improvements,

- identify the most influential design factors on the final vehicle concept and

- help in understanding the underlying mechanisms and interactions between the design factors governing the behavior of the vehicle concept.

As a result, the decision-making process in the conceptual phase is enhanced. With aim of digitizing and automating the conceptual design phase and improving the exchange of computational tools across the distinct engineering teams involved, a digital design workflow is built using the **m**ultidisciplinary **d**esign **a**nalysis and **o**ptimization (MDAO) workflow design accelerator (MDAx) and is then executed in the process integrating open-source software RCE, short for **r**emote **c**omponent **e**nvironment (see Chapter 3). In order to show that this approach is applicable to the state-of-the-art vehicle concepts, the conceptual design phase of the research vehicle "Interurban Vehicle" (IUV) is considered (see Chapter 4). The IUV is a plug-in fuel cell electric vehicle conceptualized at the German Aerospace Centre (DLR[4]) in Stuttgart, Germany. To reduce the complexity of the problem at hand, the IUV's design workflow was reduced to include the following disciplines: vehicle performance, engine, fuel cell, energy storage, mission, mass, operating costs and well-to-wheel processes. Finally, the results of the IUV's probabilistic conceptual design phase with regard to the Sobol' indices are discussed and the impact of the design factors on the vehicle concept as well as their interactions are analyzed (see Chapter 5).

2. FUNDAMENTALS OF GSA

In contrast to deterministic approaches, in a probabilistic framework, inputs and outputs are regarded as random variables [10]. Let $f: \mathbb{R}^d \mapsto \mathbb{R}$ be a computational model such that:

$$Y = f(\boldsymbol{X}). \tag{1}$$

Here, $Y \in \mathbb{R}$ represents a scalar uncertain output with an unknown PDF and $\boldsymbol{X} = [X_1, X_2, \cdots, X_d]^{\mathrm{T}} \in \mathbb{R}^d$ denotes the random vector of $d \in \mathbb{N}_{>0}$ uncertain input parameters. Each input parameter X_i for $i \in \{1, 2, \cdots, d\}$ is assigned a known PDF to reflect the uncertainties, to which it is subjected. The main objective of GSA is to assess the uncertainty of the output Y with respect to the variation of the input parameters $\boldsymbol{X}$.

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2.1. Variance-based GSA

Variance-based GSA assumes that the variance is a reliable indicator of uncertainty. For this reason, $f(\boldsymbol{X})$ is decomposed into finite orthogonal components based on the high dimensional model representation (HDMR) technique (see [31] for further details). Subsequently, applying the law of variance and under the assumption that the uncertain input parameters $\boldsymbol{X} = [X_1, X_2, \cdots, X_d]^{\mathrm{T}}$ are independent, the output variance $\mathbb{V}[Y]$ is written as:

$$\mathbb{V}[Y] = \sum_{i=1}^{d} \mathbb{V}\big[\mathbb{E}[Y|X_i]\big] + \sum_{1 \leq i < j \leq d} W_{i,j} + \cdots + W_{i,j,\dots,d}, \tag{2}$$

where

$$W_{i,j} = \mathbb{V}\Big[\mathbb{E}\big[Y|X_{i,j}\big]\Big] - \mathbb{V}\big[\mathbb{E}[Y|X_i]\big] - \mathbb{V}\Big[\mathbb{E}\big[Y|X_j\big]\Big]. \tag{3}$$

Here, $\mathbb{V}[\cdot]$ and $\mathbb{E}[\cdot]$ denote the variance and the expected value operators, respectively. The contributions of the input parameters $\boldsymbol{X}$ to the uncertainty of the output Y is then quantified using the sensitivity measures, also known as the Sobol' indices. These are acquired by dividing both sides of Eq. 2 by $\mathbb{V}[Y]$. Here, three major Sobol' indices are defined:

1. The first-order Sobol' index S_i measures the main effect of an input parameter X_i on the output uncertainty and is described as follows:

$$S_i = \frac{\mathbb{V}\big[\mathbb{E}[Y|X_i]\big]}{\mathbb{V}[Y]}. \tag{4}$$

2. The second-order Sobol' index $S_{i,j}$ measures the interaction effect between the i-th and j-th input parameter, X_i and X_j ($i, j \in \{1, 2, \cdots, d\}$), on the output uncertainty and is described by:

$$S_{i,j} = \frac{\mathbb{V}\Big[\mathbb{E}\big[Y|X_{i,j}\big]\Big]}{\mathbb{V}[Y]}. \tag{5}$$

3. The total Sobol' index S_{Ti} measures the main effect of X_i as well as its interaction effect with the other input parameters $\boldsymbol{X}_{\sim i}$. Here, $\sim i$ denotes the indices of all input parameters except the index i. S_{Ti} is defined as follows:

$$S_{Ti} = 1 - \frac{\mathbb{V}\big[\mathbb{E}[Y|\boldsymbol{X}_{\sim i}]\big]}{\mathbb{V}[Y]} = S_i + \sum_{j=1, j \neq i}^{d} S_{i,j} + \cdots + S_{i,j,\dots,d} \tag{6}$$

From Eq. 6, one can deduce that the difference $S_{Ti} - S_i$ is an indicator for the interaction effect of the i-th input parameter with the remaining input parameters on the output uncertainty.

2.2. Numerical approximation of variance-based GSA

The calculation of the Sobol' indices based on Eq. 4, 5 und 6 requires solving multiple integrals stemming from the variance $\mathbb{V}[\cdot]$ and expected value $\mathbb{E}[\cdot]$ operators. This is only possible if an analytical function is given to compute the output Y. Even in this case, solving such multiple integrals can be an exhausting task. As a remedy, one can make use of sampling-based approaches, more precisely, Monte-Carlo methods to estimate the value of multiple integrals. Within the scope of this paper, only one Monte-Carlo based approach is considered, namely the Sobol' method [31]. More precisely, the implementation of this approach in the Python library SALib [14] is used. Here, there are three main steps (see Figure 1):

    i. The input parameters are randomly sampled based on the PDFs assigned to them. To reduce clustering and gaps in the input parameter space, low-discrepancy sequences such as the Sobol' sequence are used for sampling. In this paper, the Saltelli's sampling scheme is considered. It enhances the Sobol' sequence to lower the error rates in the Sobol' index calculations [11, 26].

    ii. The model f is evaluated at each sample point.

  iii. The Sobol' indices S_i, S_{ij} and S_{Ti} are computed by making use of estimators for $\mathbb{V}[\cdot]$ and $\mathbb{E}[\cdot]$ (see [31] for further details).
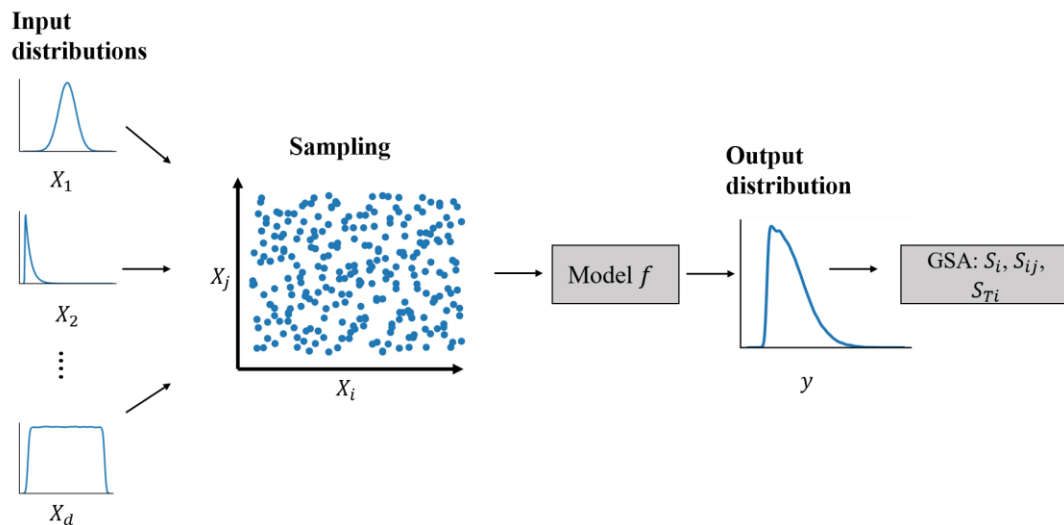
Figure 1: Global sensitivity analysis

3. MULTIDISCIPLINARY CONCEPTUAL DESIGN PHASE

Due to the complex system architecture of road vehicles, there are multiple disciplines involved in the conceptual design phase. Each of these disciplines has its own set of computational tools that encapsulate domain-specific expertise. This presents challenges for cross-team collaboration, particularly in the integration of computational tools during the conceptual design phase, and prompts the following question:

- *How can the methodologies and computational tools of the involved disciplines be fused into an integrated design process?*

In order to tackle the above-mentioned problem, a framework is needed that aims at digitizing and automating the conceptual design phase of road vehicles. For this purpose, the framework in figure (2) is considered.
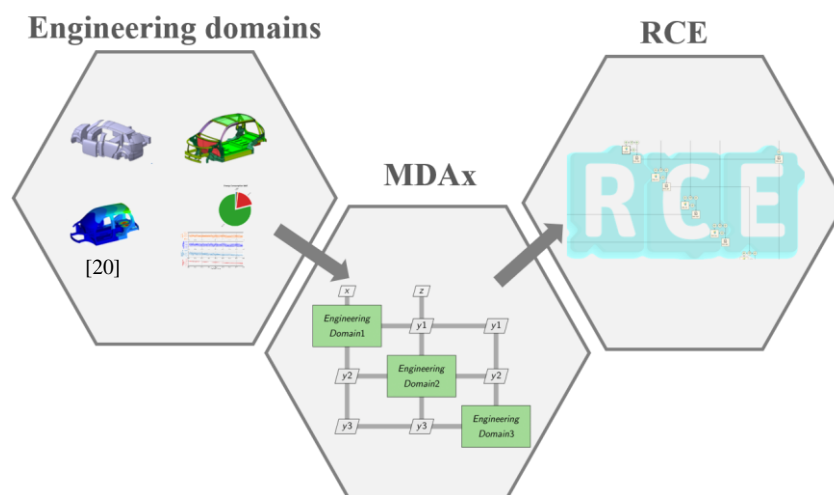
Figure 2: Framework to digitize and automate the conceptual design phase of road vehicles (MDAx: multidisciplinary design analysis and optimization workflow design accelerator RCE: remote component environment)

MDAx to RCE

The framework presented in Figure 2 facilitates the involvement of discipline experts across various locations in the design process [1]. The open-source software **r**emote **c**omponent **e**nvironment (RCE) [4], developed primarily at DLR, serves as a good example for such a process integrating framework. RCE allows designers to build automated workflows consisting of several analysis modules, i.e. computation tools. The workflow is then executed in an automated manner. More precisely, each computational tool, hosted on its respective server, is invoked, and the necessary data is exchanged automatically [4]. However, the process of building such a workflow can become a tedious task, especially if the workflow at hand is a complex one. Even with a complex workflow in place, implementing modifications, verifying tool couplings and ensuring proper tool functionality will remain a time-consuming process. For this purpose, the multidisciplinary design analysis and optimization (MDAO) workflow design accelerator, abbreviated as MDAx, comes into play. To simplify the process of modeling complex engineering workflows, Risueño et al. [23] introduced MDAx in 2020. MDAx is a user-friendly tool, which enables the user to easily build and modify an engineering workflow using drag and drop operations. More precisely, the user can define computational tools and specify the corresponding input and output parameters for each tool. The workflow is then automatically modeled in the form of an extended design structure matrix (XDSM) [17]. Additionally, MDAx provides some verification functionalities. To be more precise, it checks if the system requires any parameters before it can provide them and if the same parameters are being provided by more than one tool [23]. Finally, after modeling the workflow, the XDSM can be exported to a process integration software, such as RCE, where the workflow execution is carried out [20].

4. IMPLEMENTATION: INTERURBAN VEHICLE

4.1. Interurban vehicle (IUV)

The Interurban Vehicle (IUV) is a vehicle concept developed within the DLR "Next Generation Car" project. The development of the IUV concept focuses on four key pillars: comfort, performance, safety and sustainability. These four elements define the high-level multidisciplinary requirements of the IUV. Passenger comfort is addressed by specifications such as driving automation at an automation degree of SAE (Society of Automotive Engineers) level 4, a flexible interior and an ergonomic entrance concept. To ensure an ergonomic entrance, a wide entry way to the vehicle was established by relinquishing the b-pillar from being a fixed part of the IUV's body-in-white. This poses some challenges with respect to the IUV's passive safety. More precisely, the IUV's body-in-white has to be modified to maintain the vehicle's structural integrity despite the missing b-pillar.

In terms of performance, a total driving range of up to 1000km is defined. The challenge of enabling such long ranges for a five-seater vehicle is addressed by using hydrogen and a high voltage battery as energy sources combined with the development of lightweight structures for weight reduction. A zero-emission powertrain is achieved with an electrified driving system extended by a hydrogen-powered fuel-cell system.

Considering the above, there are several design questions that should be addressed in the conceptual design phase. For instance:

- *How should the IUV's powertrain be configured in terms of the energy ratio between the battery and the hydrogen tank, to meet the required driving range?*

- *Which material and structural concept should be adopted for the IUV's body-in-white such that the multidisciplinary requirements, sustainability, performance, safety and comfort standards are met?*

4.2. IUV's design workflow

To answer the above questions, a design workflow is developed. Its objective is to generate a consistent gravimetric and volumetric/geometric vehicle concept that meets the defined high-level requirements. Within the context of this paper, this is achieved by means of a parametric model. Such parametric models allow varying vehicle configurations, i.e. vehicle parameters, with the aim of examining various design concepts and conducting sensitivity analysis. After evaluating the vehicle concepts, the selected concept establishes the necessary boundary conditions and requirements for the subsequent detailed development process. More precisely, the design process of electrified road vehicles, such as the IUV, involves defining numerous design parameters that are, either directly or indirectly, interconnected. Moreover, vehicle designers must take into consideration multidisciplinary requirements and constraints, such as

range, maximum speed, ride comfort, safety, etc. For instance, when targeting a specific driving range, the sizing of the electric drive system is heavily influenced by the vehicle's energy consumption. The electric drive system includes batteries, motors, transmission and, in the case of a fuel cell vehicle, the fuel cell system and hydrogen tanks, whose dimensions should be defined such that the needed energy is supplied. The vehicle's energy consumption, in turn, strongly depends on the total vehicle mass, which is the sum of all vehicle components including the electric drive system. Moreover, considering the packaging of the electric drive system, it is evident that the vehicle's overall size is strongly dependent on the volume of the individual components, such as the battery. For instance, to cover a higher driving range, a larger battery can be considered to increase the energy supply. Therefore, this increase in the battery volume necessitate an increase in the vehicle's overall size to accommodate these larger components. If, in this case, the vehicle's height is increased, then the aerodynamic drag coefficient changes drastically. Subsequently, the aerodynamic drag coefficient impacts the vehicle's energy consumption and requires adjustments to the sizing of the electric drive system. These interactions between the vehicle parameters are mimicked by the design workflow, which in turn consists of computational tools of each of the engineering disciplines (domains) involved in the conceptual design phase. Table 1) lists the requirements, constraints, design variables and evaluation criteria used for the design workflow of the IUV. Here, it is important to differentiate between design parameters and design variables. Design variables are design parameters that are varied to generate distinct vehicle concepts.

Table 1: IUV's design workflow: high-level multidisciplinary requirements, constraints, design variables and evaluation criteria used in the conceptual design phase of the IUV

Design object	Electrified road vehicle concept
High-level requirements	• Driving performance (acceleration, top speed, range) • Comfort (noise, vibration, harshness, bending and torsional stiffness) • Safety (crash load cases) • Sustainability (sustainable materials, sustainable energy sources)
Constraints	• Max. outer dimensions • Min. interior dimensions • Max. curb weight
Design variables	• Powertrain configuration (e.g. Energy storage ratio battery/hydrogen tank) • Material concept of vehicle structure (body in white)
Evaluation criteria	• Costs (Acquisition Cost, Operating Cost, Total Cost of Ownership) • Energy consumption (Tank-to-wheel, Well-to-wheel)
Workflow builder	MDAx
Workflow executor	RCE

4.3. IUV's simplified design workflow

Within the scope of this paper, the IUV's design workflow, summarized in Table 1, is simplified with the aim of reducing the complexity of the considered system. To be more precise, the constraints, comfort and safety requirements as well as the material and structural concept are not taken into consideration as design variables. Furthermore, rather than taking all types of costs into account, only the operating costs are used as an evaluation criterion in addition to the energy consumption (see Table 2).

Table 2: IUV's simplified design workflow: high-level multidisciplinary requirements, constraints, design variables and evaluation criteria used in the conceptual design phase of the IUV

Design object	Electrified road vehicle concept			
High-level requirements	**Name**	**Symbol**	**Value**	**Unit**
	Acceleration time from 0 to 100 km/h	t_{0-100}	8.4	s
	Top speed	v_{max}	180	km/h
	Cruise speed	v_{cont}	160	km/h
	Range	R	1000	km
Constraints	−			
Design variables	**Name**	**Symbol**	**Distribution**	**Unit**
	Energy storage ratio	x	$\mathcal{U}[0.1,0.9]$	−
	Fuel cell efficiency	η_{fc}	$\mathcal{U}[0.4,0.6]$	−
	Gravimetric energy density of hydrogen including tank	$\rho^E_{\text{G,h}_2\text{,tank}}$	$\mathcal{U}[1400,1600]$	Wh/kg
	Gravimetric energy density of battery	$\rho^E_{\text{G,batt}}$	$\mathcal{U}[250,300]$	Wh/kg
Evaluation criteria	**Name**	**Symbol**		**Unit**
	Operating cost	C_{op}		€/km
	Tank-to-wheel energy consumption	E^{ttw}		kWh/km
	Well-to-wheel energy consumption	E^{wtw}		kWh/km
Workflow builder	MDAx			
Workflow executor	RCE			

Four design variables are considered for the IUV's simplified design workflow (see Table 2):

- The energy storage ratio $x \in (0,1)$, i.e., the ratio of the energy stored in the battery to that stored in the hydrogen tank is considered as a design variable. If $x = 0$, then the energy is being solely supplied from the hydrogen tank, i.e. the vehicle is a purely hydrogen-powered one. Whereas, $x = 1$ means that the energy is being completely supplied from the battery. Thus, the vehicle is purely an electric one. Varying x allows the vehicle designer to examine various scenarios regarding the IUV's energy mix. For this purpose, x is assigned a uniform PDF $\mathcal{U}[0.1,0.9]$ with a lower bound of 0.1 and an upper bound of 0.9. Since the IUV is a hybrid road vehicle, the extreme cases, i.e. $x = 0$ and $x = 1$ are excluded.

- The fuel cell efficiency η_{fc} is defined as the ratio of electricity generated to the amount of hydrogen used by the fuel cell [3]. η_{fc} strongly depends on the type of fuel cell technology used. Typically, η_{fc} varies between 40% and 60% [27, 35]. In order to account for various fuel cell technologies, η_{fc} is assigned a uniform PDF ranging between 0.4 and 0.6: $\mathcal{U}[0.4,0.6]$.

- $\rho^E_{\text{G,h}_2\text{,tank}}$ is the gravimetric energy density of hydrogen including the tank used for storage. In other words, $\rho_{E,\text{h}_2\text{,tank}}$ denotes the amount of energy stored per unit mass of the storage system, i.e., hydrogen and tank. Within the context of this paper, a variation ranging between 1400 and 1600 Wh/kg is considered. For this reason, $\rho^E_{\text{G,h}_2\text{,tank}}$ is a assigned a uniform PDF: $\mathcal{U}[1400,1600]$ Wh/kg.

- $\rho^E_{\text{G,batt}}$ is the gravimetric energy density of the entire battery pack including casings, cooling systems, etc. Lithium-ion batteries are currently a well-established technology in electrified vehicles [29]. For such battery systems, Thielmann et al. [34] have provided a forecast of $\rho^E_{\text{G,batt}}$ for the years 2025 and 2030. Thielmann et al. predicted that $\rho^E_{\text{G,batt}}$ can reach approximately 300 Wh/kg by the year 2030. To consider such future developments of battery energy systems, this forecast is adopted within the scope of this paper. More precisely, $\rho^E_{\text{G,batt}}$ is assigned a uniform distribution $\mathcal{U}[250,300]$ Wh/kg.

Two main evaluation criteria (output parameters) are used to evaluate the IUV concepts (see Table 2):

- Operating costs C_{op} refers to the costs needed to supply the IUV with energy, i.e., hydrogen and electricity.

- Energy consumption of the IUV is an essential metric for economic and ecological reasons. The energy consumption impacts strongly the operating costs as well as the greenhouse gas emissions. Here, two types of energy consumption are considered:

  - Tank-to-wheel energy consumption E^{ttw} refers to the energy consumed from the time the energy source, in the IUV's case electricity and hydrogen, is loaded to the vehicle until it is converted to set the vehicle in motion.

  - Well-to-wheel E^{wtw} considers on the other hand the energy needed to produce and transport electricity and hydrogen in addition to the energy consumption of the vehicle. In other words, E^{wtw} provides an overview of all energy-consuming processes involved from the energy source (well) to the wheels of the vehicle.

The IUV's simplified design workflow consists of the following engineering disciplines/domains: vehicle performance, engine, fuel cell, mission, energy storage, mass, cost and lastly well-to-wheel energy consumption.

4.4. Disciplines

In general, the computational tool of each discipline can be mathematically represented as follows:

$$\boldsymbol{y}_{discp} = \boldsymbol{f}_{discp}(\boldsymbol{d}_{discp}, \boldsymbol{c}_{discp}, \boldsymbol{z}_{discp}). \tag{7}$$

Here, $\boldsymbol{y}_{discp}$ represents the vector containing the outputs computed and $\boldsymbol{f}_{discp}: \boldsymbol{d}_{discp}, \boldsymbol{c}_{discp}, \boldsymbol{z}_{discp} \mapsto \boldsymbol{y}_{discp}$ denotes the vector containing the functions executed by the computational tool of the considered discipline. $\boldsymbol{d}_{discp}$ is defined as the vector including the design variables that are used as inputs for the considered computational tool; $\boldsymbol{c}_{discp}$ corresponds to the vector containing the constants that are used as inputs for the considered computational tool. $\boldsymbol{z}_{discp}$ denotes the vector composed of the linking outputs, i.e., the outputs computed by other computational tools but needed as inputs for the considered computational tool.

Vehicle performance

Within the scope of this discipline, the objective is to determine the power needed considering different scenarios: 1) P_{0-100} needed to accelerate the IUV from 0 to 100 km/h within the required time $t_{0-100} = 8.4$ s, 2) $P_{v_{max}}$ needed to maintain the required maximum speed $v_{max} = 180$ km/h, 3) $P_{v_{cont}}$ needed to maintain the required cruise (continuous) speed $v_{cont} = 160$ km/h and 4) P_{max} that should be supplied by the vehicle's engine.

Table 3: Vehicle performance - equations

$P_{0-100} = (\underbrace{\frac{1}{2}\rho_{air}c_d A v_{rated}^2}_{\text{aerodynamic drag force}} + \underbrace{mgc_r}_{\text{rolling force}} + \underbrace{me_i a_{max}}_{\text{inertial force}})v_{rated}$	(8)
$m = m_{cw} + m_{payload},$	(9)
$a_{max} = ka_{mean} = k\frac{\Delta v_{0-100}}{t_{0-100}} = k\frac{100 \text{ km/h}}{t_{0-100}}, k > 1$	(10)
$e_i = 1 + \frac{J_{pt,red}}{mr_{dyn}}$	(11)
$P_{v_{max/cont}} = \left(\underbrace{\frac{1}{2}\rho_{air}c_d A v_{max/cont}^2}_{\text{aerodynamic drag force}} + \underbrace{mgc_r}_{\text{rolling force}}\right)v_{max/cont}$	(12)
$P_{max} = \max(P_{0-100}, P_{v_{max}})$	(13)

In Table 3, ρ_{air} refers to the air density at room temperature; c_d denotes the drag coefficient; c_r represents the rolling resistance coefficient; A is the vehicle's frontal area and v_{rated} denotes the maximum vehicle speed at which the engine is still delivering maximum torque. Additionally, m refers to the vehicle's mass, which is the sum of the vehicle's curb weight m_{cw} and the mass of some payload $m_{payload}$ (see Eq. 9); a_{max} quantifies the maximum acceleration within the speed range 0 to 100 km/h (see Eq. 10); e_i accounts for the contribution of rotating components to the inertial resistance by taking into consideration the powertrain's reduced moment of inertia $J_{pt,red}$ and the dynamic wheel radius r_{dyn} (see Eq. 11). Lastly, g denotes the Earth's gravity. The function executed by the computational tool of this discipline is denoted by $\boldsymbol{f}_{vp}$. The outputs, linking outputs, constants and design variables are listed in Table 4.

Table 4: Vehicle performance - outputs, linking outputs, constants and design variables

Vector	Vector components
$\boldsymbol{y}_{vp}$	$P_{0-100}, a_{max}, e_i, P_{v_{max}}, P_{v_{cont}}, P_{max}$
$\boldsymbol{z}_{vp}$	m_{cw}
$\boldsymbol{c}_{vp}$	$\rho_{air}, c_d, A, g, c_r, k, t_{0-100}, r_{dyn}, J_{pt,red}, v_{rated}, v_{max}, v_{cont}, m_{payload}$
$\boldsymbol{d}_{vp}$	$-$

Engine

The sizing of the engine is determined as follows:

Table 5: Engine discipline - equations

$P_{eng} = P_{max}$	(14)
$m_{eng} = \frac{P_{eng}}{\rho_{G,eng}^P} = \frac{P_{max}}{\rho_{G,eng}^P}$	(15)
$V_{eng} = \frac{P_{eng}}{\rho_{V,eng}^P} = \frac{P_{max}}{\rho_{V,eng}^P}$	(16)

In Table 5, the engine's power P_{eng}, mass m_{eng} and volume V_{eng} are determined empirically based on the gravimetric and volumetric power density of the engine, $\rho_{G,eng}^P$ and $\rho_{V,eng}^P$, respectively. The function executed by the computational tool of this discipline is denoted by $\boldsymbol{f}_{eng}$. The outputs, linking outputs, constants and design variables are listed in Table 6.

Table 6: Engine - outputs, linking outputs, constants and design variables

Vector	Vector components
$\boldsymbol{y}_{\text{eng}}$	$P_{\text{eng}}, m_{\text{eng}}, V_{\text{eng}}$
$\boldsymbol{z}_{\text{eng}}$	P_{max}
$\boldsymbol{c}_{\text{eng}}$	$\rho^P_{\text{G,eng}}, \rho^P_{\text{V,eng}}$
$\boldsymbol{d}_{\text{eng}}$	$-$

Fuel cell

The sizing of the IUV's fuel cell is determined in a similar manner to that of the engine.

Table 7: Fuel cell - equations

$$P_{\text{fc}} = P_{v_{\text{cont}}} \tag{17}$$

$$m_{\text{fc}} = \frac{P_{\text{fc}}}{\rho^P_{\text{G,fc}}} = \frac{P_{v_{\text{cont}}}}{\rho^P_{\text{G,fc}}} \tag{18}$$

$$V_{\text{fc}} = \frac{P_{\text{fc}}}{\rho^P_{\text{V,fc}}} = \frac{P_{v_{\text{cont}}}}{\rho^P_{\text{V,fc}}} \tag{19}$$

The fuel cell's power P_{fc}, mass m_{fc} and volume V_{fc} are determined empirically based on the and gravimetric $\rho^P_{\text{G,fc}}$ and volumetric power density. Since the fuel cell is used as a secondary energy source and typically not for acceleration, it is assumed that the fuel cell's power should correspond to $P_{v_{\text{cont}}}$ and not P_{max}. The function executed by the computational tool of this discipline is denoted by $\boldsymbol{f}_{\text{fc}}$. The outputs, linking outputs, constants and design variables are listed in Table 8.

Table 8: Fuel cell - outputs, linking outputs, constants and design variables

Vector	Vector components
$\boldsymbol{y}_{\text{fc}}$	$P_{\text{fc}}, m_{\text{fc}}, V_{\text{fc}}$
$\boldsymbol{z}_{\text{fc}}$	$P_{v_{\text{cont}}}$
$\boldsymbol{c}_{\text{fc}}$	$\rho^P_{\text{G,fc}}, \rho^P_{\text{V,fc}}$
$\boldsymbol{d}_{\text{fc}}$	$-$

Mission

To compute the IUV's tank-to-wheel energy consumption, a simple model of an electric drive system is considered. For this purpose, the open-source Modelica simulation tool OpenModelica is used. The model aims at computing the IUV's energy consumption for a given driving cycle $\mathcal{C}$. Within the context of this paper, the WLTP driving cycle is used. The model consists mainly of a battery, electric drive and a gear. Here, the electric drive consists of an electrical machine, converter and controller. The electric drive is a map-based one, i.e., its efficiency is defined at different operating points, which are characterized by a torque and rotational speed. Additionally, the braking force as well as the drag force are modeled. For further details regarding the model, it is referred to [19]. One of the limitations of this model is that the fuel cell is not considered as a part of the electric drive system. However, by considering the IUV's mass, the fuel cell is taken indirectly into consideration. The contribution of the fuel cell in regards to the IUV's energy mix impacts the IUV's mass through the design variable x. To compute the IUV's tank-to-wheel energy consumption E^{ttw}, the energy delivered by the battery $E_{\text{batt}}(t)$ is needed. $E_{\text{batt}}(t)$ varies with time t depending on the driving cycle used. Typically, E^{ttw} is given in kWh/km. As a result, the energy needed to cover the required range E_R^{ttw} can be computed.

Table 9: Mission - equations

$E^{\text{ttw}} = \dfrac{E_{\text{batt}}(t_{\text{f}})}{d_{\mathcal{C}}}$	(20)
$E_R^{ttw} = E^{\text{ttw}} R$	(21)

In Table 9, t_f denotes the final time and $d_{\mathcal{C}}$ represents the distance traveled by the IUV based on the driving cycle $\mathcal{C}$. The function executed by the computational tool of this discipline is denoted by $\boldsymbol{f}_{mission}$. The outputs, linking outputs, constants and design variables are listed in Table 10.

Table 10: Mission - outputs, linking outputs, constants and design variables

Vector	**Vector components**
$\boldsymbol{y}_{\text{mission}}$	$E_{\text{batt}}(t_{\text{f}}), E^{\text{ttw}}$
$\boldsymbol{z}_{\text{mission}}$	m_{cw}
$\boldsymbol{c}_{\text{mission}}$	$\rho_{\text{air}}, c_{\text{d}}, A, g, c_{\text{r}}, r_{\text{dyn}}, J_{\text{ed,red}}, m_{\text{payload}}, \mathcal{C}, SOC_{\text{min}}, SOC_{\text{max}}, SOC_{\text{init}}, \beta_{\text{batt}}$
$\boldsymbol{d}_{\text{mission}}$	$-$

In Table 10, $J_{\text{ed,red}}$ denotes the electric drive's reduced moment of inertia; SOC_{min}, SOC_{max} and SOC_{init} represent the minimal, maximal and initial state of charge of the battery, respectively; β_{batt} denotes battery's efficiency.

Energy storage

Within the scope of this discipline, the aim is to determine the appropriate sizing, i.e., the mass and volume of the battery (m_{batt} and V_{batt}) and hydrogen tank (m_{tank} and V_{tank}), such that the required range R is covered. Moreover, the contribution of each energy source ($E_{\text{batt}}^{\text{ttw}}$ and $E_{\text{tank}}^{\text{ttw}}$) to the vehicle's energy consumption is computed.

Table 11: Energy storage - equations

$\bar{E}_{\text{batt}} = \dfrac{E_R^{ttw}}{\beta_{\text{batt}}} x$	(22)	$\bar{E}_{\text{tank}} = \dfrac{E_R^{ttw}}{\eta_{\text{fc}}}(1-x)$	(23)
$m_{\text{batt}} = \dfrac{\bar{E}_{\text{batt}}}{\rho_{\text{G,batt}}^E} = \dfrac{E^{\text{ttw}} R}{\rho_{\text{G,batt}}^E \beta_{\text{batt}}} x$	(24)	$m_{\text{tank}} = \dfrac{\bar{E}_{\text{tank}}}{\rho_{\text{G,h}_2\text{,tank}}^E} = \dfrac{E^{\text{ttw}} R}{\rho_{\text{G,h}_2\text{,tank}}^E \eta_{\text{fc}}}(1-x)$	(25)
$V_{\text{batt}} = \dfrac{\bar{E}_{\text{batt}}}{\rho_{\text{V,batt}}^E} = \dfrac{E^{\text{ttw}} R}{\rho_{\text{V,batt}}^E \beta_{\text{batt}}} x.$	(26)	$V_{\text{tank}} = \dfrac{\bar{E}_{\text{tank}}}{\rho_{\text{V,h}_2\text{,tank}}^E} = \dfrac{E^{\text{ttw}} R}{\rho_{\text{V,h}_2\text{,tank}}^E}(1-x)$	(27)
$E_{\text{batt}}^{\text{ttw}} = \dfrac{E^{\text{ttw}}}{\beta_{\text{batt}}} x$	(28)	$E_{\text{tank}}^{\text{ttw}} = \dfrac{E^{\text{ttw}}}{\eta_{\text{fc}}}(1-x)$	(29)

In Table 11, $\rho_{\text{G,batt/h}_2\text{,tank}}^E$ and $\rho_{\text{V,batt/h}_2\text{,tank}}^E$ denote the gravimetric and volumetric energy density of the battery energy system/hydrogen including tank; x denotes the energy storage ratio of battery to hydrogen tank (design variable); η_{fc} and β_{batt} represent the efficiency of the fuel cell and battery, respectively. The function executed by the computational tool of this discipline is denoted by $\boldsymbol{f}_{\text{es}}$. The outputs, linking outputs, constants and design variables are listed in Table 12.

Table 12: Energy storage - outputs, linking outputs, constants and design variables

Vector	**Vector components**
$\boldsymbol{y}_{\text{es}}$	$\bar{E}_{\text{batt}}, m_{\text{batt}}, V_{\text{batt}}, E_{\text{batt}}^{\text{ttw}}, \bar{E}_{\text{tank}}, m_{\text{tank}}, V_{\text{tank}}, E_{\text{tank}}^{\text{ttw}}$
$\boldsymbol{z}_{\text{es}}$	E^{ttw}
$\boldsymbol{c}_{\text{es}}$	$\beta_{\text{batt}}, \rho_{\text{V,batt}}^E, \rho_{\text{V,h}_2\text{,tank}}^E, R$
$\boldsymbol{d}_{\text{es}}$	$x, \rho_{\text{G,batt}}^E, \eta_{\text{fc}}, \rho_{\text{G,h}_2\text{,tank}}^E$

Well-to-Wheel

The purpose of this discipline is to compute the well-to-wheel energy consumption of the IUV E^{wtw}. In other words, the energy consumption, from the production of hydrogen and electricity to their usage during driving, is considered.

Table 13: Well-to-wheel - equations

$E^{\text{wtw}} = \dfrac{E_{\text{tank}}^{\text{ttw}}}{\eta_{\text{h}_2}^{wtw}} + \dfrac{E_{\text{batt}}^{\text{ttw}}}{\beta_{\text{el}}^{\text{wtw}}}$	(30)
$E^{\text{wtw}} = \dfrac{E^{\text{ttw}}}{\eta_{\text{h}_2}^{wtw}\eta_{\text{fc}}}(1-x) \; + \; \dfrac{E^{\text{ttw}}}{\beta_{\text{el}}^{\text{wtw}}\beta_{\text{batt}}}x$	(31)

In Table 13, $\eta_{\text{h}_2}^{\text{wtw}}$ and $\beta_{\text{el}}^{\text{wtw}}$ denote the well-to-wheel efficiency of hydrogen and electricity, respectively. The function executed by the computational tool of this discipline is denoted by $\boldsymbol{f}_{\text{wtw}}$. The outputs, linking outputs, constants and design variables are listed in Table 14.

Table 14: Well-to-wheel - outputs, linking outputs, constants and design variables

Vector	Vector components
$\boldsymbol{y}_{\text{wtw}}$	E^{wtw}
$\boldsymbol{z}_{\text{wtw}}$	$E_{\text{tank}}^{\text{ttw}}, E_{\text{batt}}^{\text{ttw}}$
$\boldsymbol{c}_{\text{wtw}}$	$\beta_{\text{el}}^{\text{wtw}}, \eta_{\text{h}_2}^{\text{wtw}}, \beta_{\text{batt}}$
$\boldsymbol{d}_{\text{wtw}}$	x, η_{fc}

Mass

Within the scope of this computational tool, the vehicle's curb weight m_{cw} is calculated by simply adding the mass of the vehicle's components as follows:

Table 15: Mass - equations

$\begin{aligned} m_{\text{cw}} &= m_{\text{eng}} \,+\, m_{\text{tank}} \,+\, m_{\text{fc}} \,+\, m_{\text{batt}} \,+\, m_{\text{fix}} \\ &= \dfrac{P_{\text{max}}}{\rho_{\text{G,eng}}^{P}} \,+\, \dfrac{E^{\text{ttw}}R}{\rho_{\text{G,h}_2\text{,tank}}^{E}\eta_{\text{fc}}}(1-x) \,+\, \dfrac{P_{v_{\text{cont}}}}{\rho_{\text{G,fc}}^{P}} \,+\, \dfrac{E^{\text{ttw}}R}{\rho_{\text{G,batt}}^{E}\beta_{\text{batt}}}x \,+\, m_{\text{fix}} \end{aligned}$	(32)

To account for masses of remaining vehicle components (body in white, wheels, etc.), which are not considered in the vehicle's curb weight, a fixed mass denoted by m_{fix} is used in Eq. 32. The function executed by the computational tool of this discipline is denoted by $\boldsymbol{f}_{\text{mass}}$. The outputs, linking outputs, constants and design variables are listed in Table 16.

Table 16: Mass - outputs, linking outputs, constants and design variables

Vector	Vector components
$\boldsymbol{y}_{\text{mass}}$	m_{cw}
$\boldsymbol{z}_{\text{mass}}$	$P_{\text{max}}, P_{v_{\text{cont}}}, E^{\text{ttw}}$
$\boldsymbol{c}_{\text{mass}}$	$\rho_{\text{G,eng}}^{P}, \rho_{\text{G,fc}}^{P}, \beta_{\text{batt}}, m_{\text{fix}}, R$
$\boldsymbol{d}_{\text{mass}}$	$x, \eta_{\text{fc}}, \rho_{\text{G,h}_2\text{,tank}}^{E}, \rho_{\text{G,batt}}^{E}$

Cost

Within the context of this paper, the operating costs are computed based on the vehicle's tank-to-wheel energy consumption as well as the electricity and hydrogen prices.

Table 17: Costs - equations

$C_{h_2} = c_{h_2} \dfrac{E_{\text{tank}}^{\text{ttw}}}{\rho_{\text{G},h_2}^E} = c_{h_2} \dfrac{E^{\text{ttw}}}{\rho_{\text{G},h_2}^E \eta_{\text{fc}}}(1-x)$	(33)
$C_{\text{el}} = c_{el} E_{\text{batt}}^{\text{ttw}} = c_{el} \dfrac{E^{\text{ttw}}}{\beta_{\text{batt}}} x$	(34)
$C_{\text{op}} = C_{h_2} + C_{\text{el}} = c_{h_2} \dfrac{E^{\text{ttw}}}{\rho_{\text{G},h_2}^E \eta_{\text{fc}}}(1-x) + c_{el} \dfrac{E^{\text{ttw}}}{\beta_{\text{batt}}} x$	(35)

In Table 17, C_{h_2} and C_{el} denote the vehicle's hydrogen costs and electricity costs, respectively. Typically, the costs of hydrogen gas supplied for hydrogen-fueled vehicles in Europe is given in € per unit mass (c_{h_2}), whereas the electricity costs are typically given in € per unit energy and denoted (c_{el}). ρ_{G,h_2}^E represents the gravimetric energy of hydrogen. The function executed by the computational tool of this discipline is denoted by $\boldsymbol{f}_{\text{c}}$. The outputs, linking outputs, constants and design variables are listed in Table 18.

Table 18: Costs - outputs, linking outputs, constants and design variables

Vector	Vector components
$\boldsymbol{y}_{\text{c}}$	C_{op}
$\boldsymbol{z}_{\text{c}}$	E^{ttw}
$\boldsymbol{c}_{\text{c}}$	$\rho_{\text{G},h_2}^E, \beta_{\text{batt}}, c_{h_2}, c_{\text{el}}$
$\boldsymbol{d}_{\text{c}}$	x, η_{fc}

4.5. Numerical implementation

The design variables used in the IUV's simplified design workflow are collected in vector $\boldsymbol{d} = \boldsymbol{d}_{\text{vp}} \cup \boldsymbol{d}_{\text{eng}} \cup \boldsymbol{d}_{\text{fc}} \cup \boldsymbol{d}_{\text{mission}} \cup \boldsymbol{d}_{\text{es}} \cup \boldsymbol{d}_{\text{mass}} \cup \boldsymbol{d}_{\text{c}} = \left[\eta_{fc}, \rho_{\text{G,batt}}^E, \rho_{\text{G},h_2,\text{tank}}^E, x\right] \in \mathbb{R}^{1\times 4}$. Similarly, all of the constants are represented by vector $\boldsymbol{c} = \boldsymbol{c}_{\text{vp}} \cup \boldsymbol{c}_{\text{eng}} \cup \boldsymbol{c}_{\text{fc}} \cup \boldsymbol{c}_{\text{mission}} \cup \boldsymbol{c}_{\text{es}} \cup \boldsymbol{c}_{\text{mass}} \cup \boldsymbol{c}_{\text{c}}$. To conduct the variance-based GSA, N samples of the design variables $\boldsymbol{d}$ are generated based on the PDFs of the design variables (see Table 2). Here, the Sobol' sequence, which is implemented in the Python library SALib [11, 14] (see Section 2.2), is used for sampling. The constants $\boldsymbol{c}$ are replicated N times. The IUV's design workflow is modeled in MDAx and executed in RCE as follows:

$$\boldsymbol{y}_i = \boldsymbol{f}^{\text{RCE}}(\boldsymbol{d}_i, \boldsymbol{c}_i, \boldsymbol{z}_i). \tag{36}$$

Here, $i = \{1,2,\cdots,N\}$ denotes the sample index, where $N = 20480$. $\boldsymbol{y}$ and $\boldsymbol{z}$ denote the vectors containing the outputs and linking outputs computed by the various disciplines, respectively. They are expressed as follows: $\boldsymbol{y} = \boldsymbol{y}_{\text{vp}} \cup \boldsymbol{y}_{\text{eng}} \cup \boldsymbol{y}_{\text{fc}} \cup \boldsymbol{y}_{\text{mission}} \cup \boldsymbol{y}_{\text{es}} \cup \boldsymbol{y}_{\text{mass}} \cup \boldsymbol{y}_{\text{c}}$ and $\boldsymbol{z} = \boldsymbol{z}_{\text{vp}} \cup \boldsymbol{z}_{\text{eng}} \cup \boldsymbol{z}_{\text{fc}} \cup \boldsymbol{z}_{\text{mission}} \cup \boldsymbol{z}_{\text{es}} \cup \boldsymbol{z}_{\text{mass}} \cup \boldsymbol{z}_{\text{c}}$. The function $\boldsymbol{f}^{\text{RCE}}$ encodes the RCE execution of the computational tools. Within the context of this paper, a vehicle concept, denoted by $\mathcal{V}_i$, is defined to be the set of all vehicle parameters as well as the computational tools connecting these parameters together.

$$\mathcal{V}_i = \{\boldsymbol{y}_i, \boldsymbol{d}_i, \boldsymbol{c}_i, \boldsymbol{z}_i, \mathcal{F}\}, \tag{37}$$

where $\mathcal{F} = \{\boldsymbol{f}_{\text{vp}}, \boldsymbol{f}_{\text{eng}}, \boldsymbol{f}_{\text{fc}}, \boldsymbol{f}_{\text{mission}}, \boldsymbol{f}_{\text{es}}, \boldsymbol{f}_{\text{wtw}}, \boldsymbol{f}_{\text{c}}\}$, denotes the set of all computational tools. The evaluation criteria used for the IUV's simplified design workflow (see Table 2), i.e. the outputs considered for the variance-based GSA are denoted by $\boldsymbol{y}_i^{GSA} \in \mathbb{R}^{N\times 3}$ and expressed as follows:

$$\boldsymbol{y}_i^{GSA} = [E_i^{\text{ttw}}, E_i^{\text{wtw}}, C_{\text{op},i}]. \tag{38}$$

Here, E^{ttw} denotes the tank-to-wheel energy consumption, E^{wtw} represents the well-to-wheel energy consumption and C_{op} denotes the operating costs.

5. RESULTS

After sampling the design variables and executing the IUV's simplified design workflow, the outputs considered for the variance-based GSA $\boldsymbol{y}_i^{GSA}$ (see Eq. 38) are examined. The resulting output's PDFs are illustrated in Figure 3.
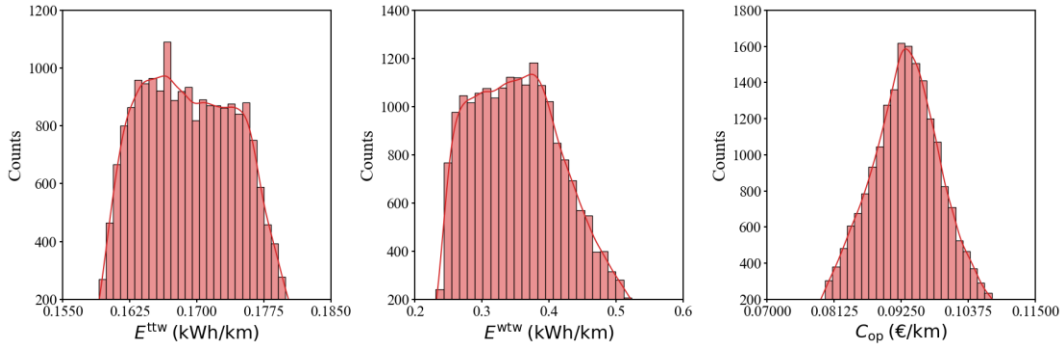

Figure 3: Distribution of the IUV's evaluation criteria (tank-to-wheel energy consumption E^{ttw}, well-to-wheel energy consumption E^{wtw} and operating costs C_{op}). 20480 samples are considered.

The variation of the outputs $\boldsymbol{y}_i^{GSA}$ as a function of the design variables $\boldsymbol{d}_i$ ($i = \{1,2,\cdots,20480\}$) is shown in Figure 4.
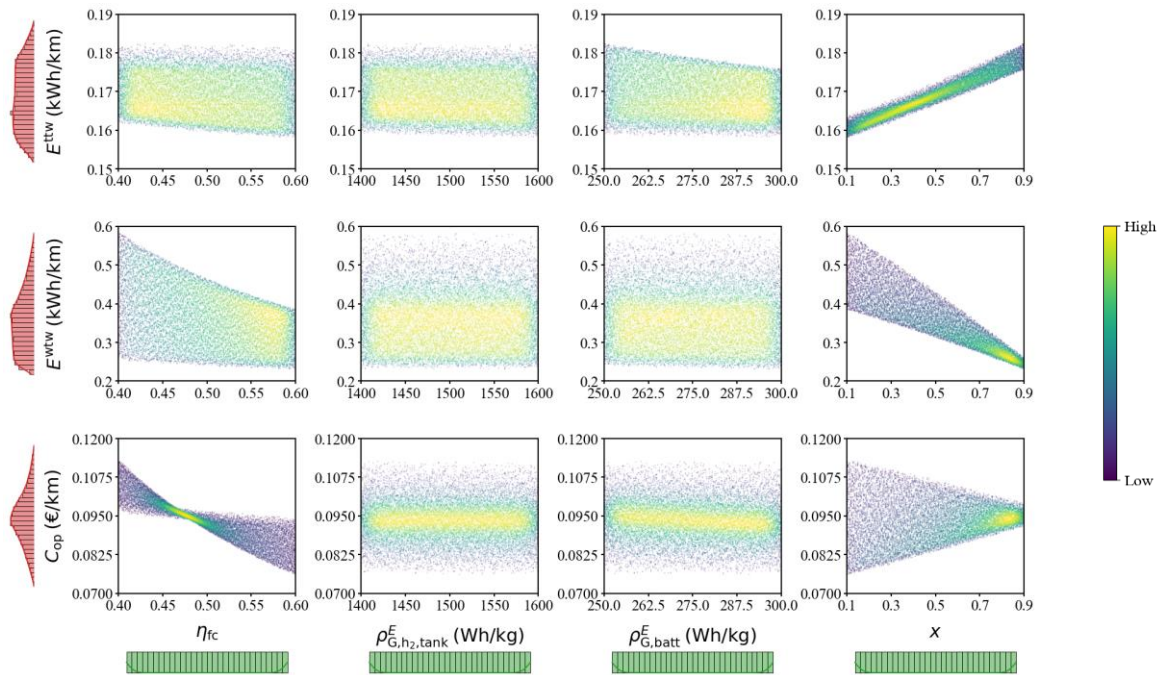

Figure 4: The relation between the outputs (operating costs C_{op}, well-to-wheel energy consumption E^{wtw} and tank-to-wheel energy consumption E^{ttw}) and design variables (fuel cell efficiency η_{fc}, gravimetric energy density of hydrogen including tank $\rho_{\text{G,h}_2\text{,tank}}^E$, gravimetric energy density of the battery $\rho_{\text{G,batt}}^E$ and energy storage ratio x) and their respective PDFs. 20480 samples are considered.

On the vertical and horizontal axis of Figure 4, the outputs and the design variables are plotted with their PDFs, respectively. The colors in the plots encode the density of the outputs in a given region of the design variable. Yellow shaded data points refer to a high-density region, whereas the purple color represents a low-density region. Such scatter plots are useful to recognize some trends and correlations between the design variables and outputs. It is important to mention that observed output fluctuations in the scatter plots, despite the constant value of the design variable on the x-axis, is attributed to the variation in the other design variables that are not held constant. Some key insights can be derived from Figure 4:

- Although the design variables are uniformly distributed, the outputs produced are not uniformly distributed. Such phenomena can be caused by nonlinear relations and the fact that the design variables of the design workflow are interconnected.

- The first column in Figure 4 represents the relation between the fuel cell efficiency η_{fc} and the outputs. It is evident that η_{fc} is strongly correlated to the operating costs C_{op}. More precisely, one observes a decreasing tendency of C_{op}, which agrees well with Eq. 35. Similarly, the well-to-wheel energy consumption E^{wtw} decreases as η_{fc} increases, which also confirms the expected tendency described by Eq. 31. However, comparing the plots of C_{op} and E^{wtw}, it becomes evident that C_{op} has a stronger correlation with η_{fc} and demonstrates a different behavior, especially for $\eta_{\text{fc}} \in [0.45, 0.50]$. Upon analyzing Eq. 31 and 35, one realizes that they share a similar form. Consequently, it is reasonable to anticipate that the outputs E^{wtw} and C_{op} would exhibit comparable behavior; however, this expectation is not fully realized due to the differing coefficients of the summands (see Table 19).

Table 19: Comparison of equations for E^{wtw} and C_{op}

E^{wtw}	C_{op}
$E^{\text{wtw}} = \underbrace{\dfrac{1}{\eta_{\text{h}_2}^{\text{wtw}}}}_{\text{coeff.}} \dfrac{E^{\text{ttw}}}{\eta_{\text{fc}}}(1-x) + \underbrace{\dfrac{1}{\beta_{\text{el}}^{\text{wtw}}\beta_{\text{batt}}}}_{\text{coeff.}} E^{\text{ttw}}x$	$C_{\text{op}} = \underbrace{\dfrac{c_{h_2}}{\rho_{\text{G},\text{h}_2}^{E}}}_{\text{coeff.}} \dfrac{E^{\text{ttw}}}{\eta_{\text{fc}}}(1-x) + \underbrace{\dfrac{c_{el}}{\beta_{\text{el}}^{\text{wtw}}\beta_{\text{batt}}}}_{\text{coeff.}} E^{\text{ttw}}x$

In contrast to E^{wtw} and C_{op}, the tank-to-wheel energy consumption E^{ttw} is poorly correlated to η_{fc}. This can be attributed to the limitation that the mission simulation (see Section 4.4) does not consider the fuel cell to be a part of the electric drive system.

- Examining the second and third columns in Figure 4, it becomes evident that the gravimetric energy densities of hydrogen, including tank, and the battery, $\rho_{\text{G},\text{h}_2,\text{tank}}^{E}$ and $\rho_{\text{G},\text{batt}}^{E}$, exhibit a weak correlation with the outputs. Taking a closer look at E^{ttw}, one realizes that correlation between $\rho_{\text{G},\text{batt}}^{E}$ and E^{ttw} is stronger than that of $\rho_{\text{G},\text{h}_2,\text{tank}}^{E}$ with E^{ttw}. To get a better understanding of this phenomena, one must examine closely the impact of $\rho_{\text{G},\text{batt}}^{E}$ and $\rho_{\text{G},\text{h}_2,\text{tank}}^{E}$ on the vehicle's curb weight m_{cw}, as m_{cw} is an input to the mission simulation, which computes E^{ttw}. Since $\rho_{\text{G},\text{h}_2,\text{tank}}^{E} > \rho_{\text{G},\text{batt}}^{E}$, a smaller mass of hydrogen is needed to deliver an equivalent amount of energy compared to the mass of a battery. Therefore, the contribution of $\rho_{\text{G},\text{batt}}^{E}$ to m_{cw} is more impactful than that of $\rho_{\text{G},\text{h}_2,\text{tank}}^{E}$, which agrees well with Eq. 32. A visual representation of the relation between the design variables and m_{cw} is illustrated in Figure 5 in a similar manner to Figure 4.
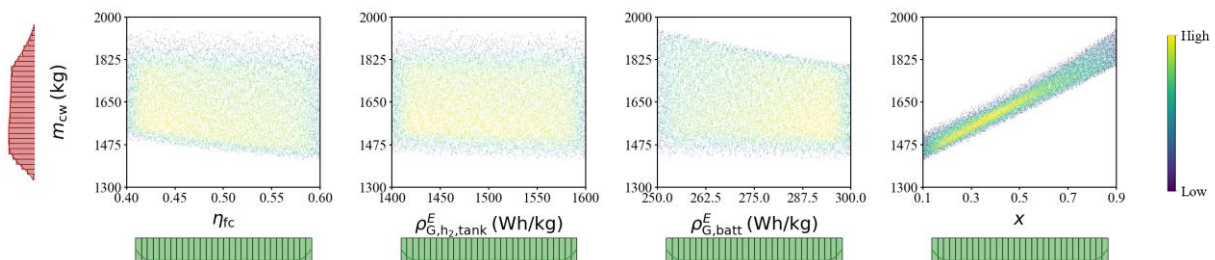

Figure 5: The relation between curb weight m_{cw} and the design variables (fuel cell efficiency η_{fc}, gravimetric energy density of hydrogen including tank $\rho_{\text{G},\text{h}_2,\text{tank}}^{E}$, gravimetric energy density of the battery $\rho_{\text{G},\text{batt}}^{E}$ and energy storage ratio x). 20480 samples are considered.

- The last column in Figure 4 illustrates the relation between the energy storage ratio x and the outputs. A strong correlation is seen between the outputs and x. A key observation is the contrasting trends of E^{ttw} and E^{wtw}. As x increases, E^{ttw} exhibits an upward trend, while E^{wtw} demonstrates a downward trend.

E^{ttw}:

To get a better understanding of the E^{ttw} trend, one must examine closely the impact of x on the curb weight m_{cw} (see Figure 5). An increase in x leads to a greater energy extraction from the battery, while reducing the energy drawn from the hydrogen tank. Consequently, this requires an increase in the size of the battery and a reduction in the size of the hydrogen tank, thereby resulting in an increase in the battery's mass m_{batt} and a corresponding decrease in the hydrogen tank's mass m_{tank}. This line of reasoning agrees well with Eq. 24 and 25. From these equations, one can additionally deduce that as x increases, the rate, at which m_{batt} increases, is higher than the rate at which m_{tank} decreases. This is due to the fact that the energy density of hydrogen including tank is higher than that of the battery ($\rho^E_{\text{G,h}_2,\text{tank}} > \rho^E_{\text{G,batt}}$). For this reason, as x increases, the sum of m_{tank} and m_{batt} increases, thus leading to an increase in m_{cw} (see Eq. 32). In other words, the vehicle is heavier, which increases its energy consumption E^{ttw}. Figure 6 illustrates this interplay between m_{tank}, m_{batt} and m_{cw} as a function of x.
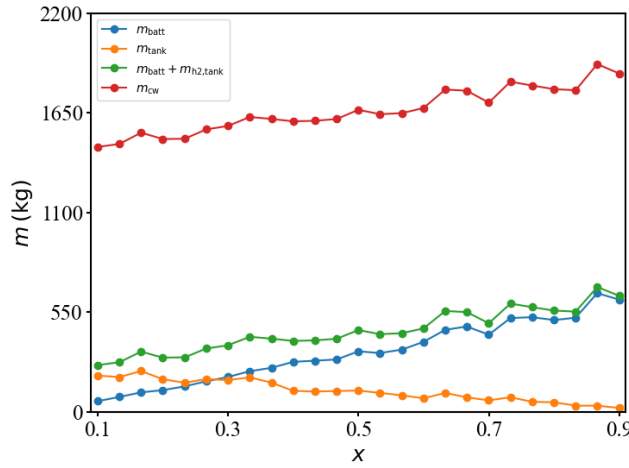
Figure 6: The variation of the battery's mass m_{batt}, the hydrogen tank's mass m_{tank} and the IUV's curb weight m_{cw} as a function of the energy storage ratio x. 25 samples are drawn from 20480 samples.

E^{wtw}:

Intuitively, one expects that E^{wtw} and E^{ttw} would have a similar behavior, since the well-to-wheel energy E^{wtw} accounts for the entire energy lifecycle including the energy consumption during the vehicle's operation E^{ttw}. However, closely examining Eq. 31, it becomes evident that E^{wtw} does not only depend on E^{ttw}, but also on the infrastructure's efficiency and the efficiency of the vehicle's energy systems, i.e., the well-to-wheel efficiency of hydrogen $\eta^{\text{wtw}}_{\text{h}_2}$, electricity $\beta^{\text{wtw}}_{\text{el}}$, the fuel cell's efficiency η_{fc} and the battery's efficiency β_{batt}. Here, it is assumed that $\beta^{\text{wtw}}_{\text{el}} > \eta^{\text{wtw}}_{\text{h}_2}$ and $\beta_{\text{batt}} > \eta_{\text{fc}}$. In other words, the electric-powered system is more efficient than the hydrogen-fueled one. For this reason, as x increases, the dependency on the electric-powered system increases, thus, resulting in a decrease in E^{wtw}.

Sobol' Indices

In order to quantify the uncertainties of the outputs, i.e. operating costs C_{op}, tank-to-wheel energy consumption E^{ttw} and well-to-wheel energy consumption E^{wtw} caused by the uncertainties of the design variables, i.e. fuel cell efficiency η_{fc}, gravimetric energy densities $\rho^E_{\text{G,h}_2,\text{tank}}$, $\rho^E_{\text{G,batt}}$ and energy storage ratio x, the Sobol' indices come into play. Figure 7 visualizes the notion of the output uncertainties using as an example the relation between the outputs and η_{fc}.
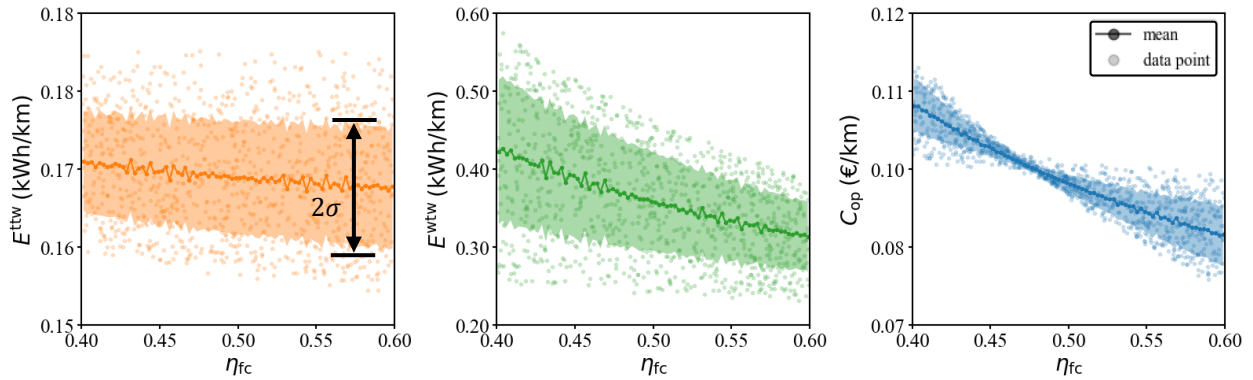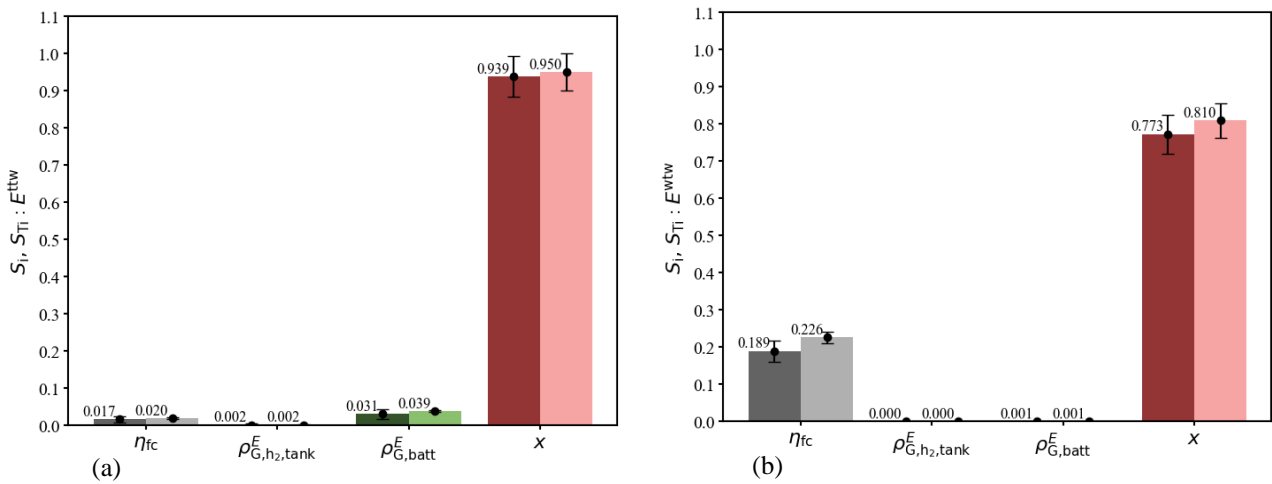
Figure 7: The variation of operating costs C_{op}, tank-to-wheel energy consumption E^{ttw} and well-to-wheel energy consumption E^{wtw} as a function of the design variable fuel cell efficiency η_{fc}. The mean is computed based on 20480 samples. Additionally, 1000 data points are illustrated.

The scattered data points in Figure 7 represent 1000 samples drawn from 20480 samples. Additionally, the mean of each output for a constant η_{fc} is computed over the remaining varying design variables $\rho^E_{G,h_2,tank}$, $\rho^E_{G,batt}$ and x. The shaded area in Figure 7 illustrates the range between the mean plus one standard deviation $\sigma[\cdot]$ and the mean minus one $\sigma[\cdot]$. Since $\sigma[\cdot] = \mathbb{V}[\cdot]^2$ and the variance $\mathbb{V}[\cdot]$ is regarded as a measure for uncertainties within the context of variance-based GSA, the shaded area is considered to be an illustration of the output uncertainties for a constant η_{fc}. However, interesting is the quantification of the output uncertainties considering all design variables:

- *The uncertainties of which design variables contribute the most to the output uncertainties? In other words, which design variables are the most influential on the outputs?*

To answer these questions, the first-order and total Sobol' indices, S_i and S_{Ti}, of all outputs are represented in Figure 8. Here, i denotes the index of the design variables η_{fc}, $\rho^E_{G,h_2,tank}$, $\rho^E_{G,batt}$ and x. It is to be noted that the error bars in Figure 8 represent a confidence level of 95%. In other words, there is a 95% probability that the calculated values of $S_{i/Ti}$ fall within the range indicated by the error bars.
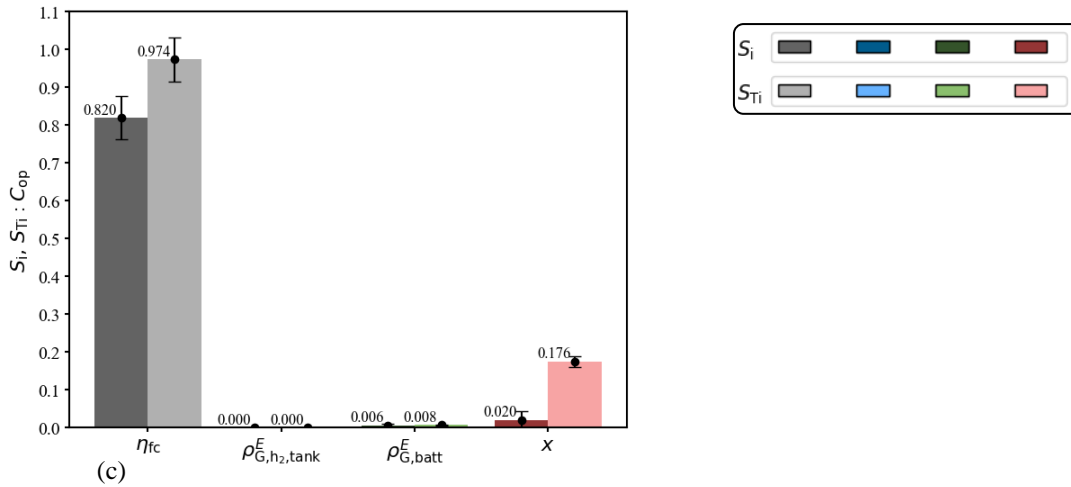
Figure 8: First-order S_i and total order Sobol' indices S_{Ti} of the outputs: tank-to-wheel energy consumption E^{ttw} (a), well-to-wheel energy consumption E^{wtw} (b) and operating costs C_{op} (c).

From Figure 8 (a), it becomes evident that the energy storage ratio x is the most influential design variable with respect to the tank-to-wheel energy consumption E^{ttw}. This agrees well with the scatter plots of E^{ttw} (see Figure 4, upper row). The fact that x exhibits the greatest impact on E^{ttw}, while the effect of the fuel cell efficiency η_{fc} and gravimetric energy densities, $\rho_{G,h_2,tank}^E$ and $\rho_{G,batt}^E$ is minimal, suggests that any technological improvements regarding the fuel cell and battery have a much lower impact on the vehicle's tank-to-wheel energy consumption in comparison to the vehicle's energy storage configuration. However, since within the mission simulation (see Section 4.4) the fuel cell was not modelled, an extension of the simulation is required to get more accurate results regarding the impact of the fuel cell efficiency on the tank-to-wheel energy consumption. Moreover, since $S_i - S_{Ti} \approx 0$, one can assume that the interaction between the design variables, η_{fc}, $\rho_{G,h_2,tank}^E$, $\rho_{G,batt}^E$ and x, has a negligible effect on the sensitivity of E^{ttw}.

Taking a closer look at Figure 8 (b), one realizes that the impact of the gravimetric energy densities, $\rho_{G,h_2,tank}^E$ and $\rho_{G,batt}^E$, on the well-to-wheel energy consumption E^{wtw} is negligible. The most impactful design variables are the energy storage ratio x followed by the fuel cell efficiency η_{fc}. This indicates that although x exhibits the dominant influence on the sensitivity of E^{wtw}, improvements in η_{fc} can reduce E^{wtw}. What is particularly evident is the slight difference between S_i and S_{Ti} for both x and η_{fc}, which implies that there exists an interaction between x and η_{fc}. This interplay, which affects the sensitivity of E^{wtw}, aligns well with Eq. 31, which shows that x and η_{fc} influence simultaneously the first summand of E^{wtw}. To get a better understanding of this interplay and its impact on E^{wtw}, Figure 9 illustrates E^{wtw} as a function of x and η_{fc}. The colors in Figure 9 (a) and (b) represent the variation of x and η_{fc}, respectively. Examining Figure 9 (a), it becomes evident that for small values of x (blue dots, $x < 0.5$) the impact of η_{fc} on E^{wtw} is bigger. In other words, the rate at which E^{wtw} decreases, as η_{fc} increases, is bigger for small x values. This is due to the fact that, for small x values, the vehicle's reliance on the hydrogen-powered system is greater. Thus, the impact of the fuel cell becomes greater. Shifting the attention to Figure 9 (b), one can deduce that for small η_{fc} values (blue dots, $\eta_{fc} < 0.5$), E^{wtw} is greater, which is consistent with intuitive expectations. Moreover, for all η_{fc} values, as x increases, E^{wtw} tend to converge to a single value region. This is attributed to the increase in the vehicle's reliance on the electric system. Thus, the impact of the fuel cell becomes smaller.
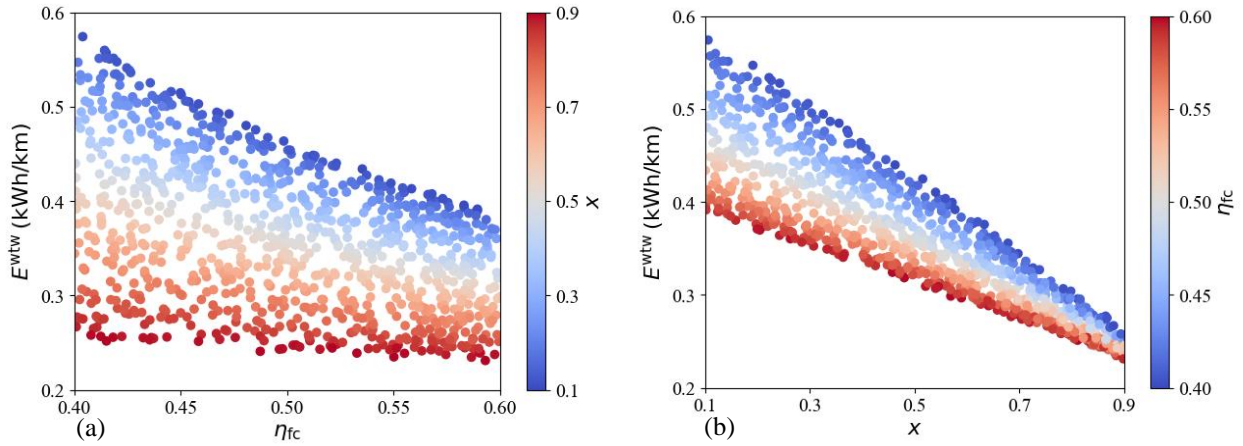
Figure 9: The variation of the well-to-wheel energy consumption E^{wtw} as a function of fuel cell efficiency η_{fc} and the energy storage ratio x. 1000 samples are drawn from 20480 samples.

Figure 8 (c) shows as well no significant impact of the gravimetric energy densities, $\rho^E_{\text{G},\text{h}_2,\text{tank}}$ and $\rho^E_{\text{G},\text{batt}}$, on the operating costs C_{op}. In contrast to E^{wtw}, the most influential design variable with respect to C_{op} is the fuel cell efficiency η_{fc} followed by the energy storage ratio x. A key observation is that for x, $S_{\text{T}i} \gg S_i$ and $S_i \approx 0$. The fact that $S_i \approx 0$ indicates that x does not directly impact C_{op}. Moreover, since $S_{\text{T}i} \gg S_i$, one deduces that x influences C_{op} indirectly. More precisely, x impacts C_{op} through its interaction, particularly with the fuel cell efficiency η_{fc} since $S_i - S_{\text{T}i} \neq 0$, for both x and η_{fc}. To gain a deeper insight into the interaction between x and η_{fc} and their impact on C_{op}, Figure 10 (a) and (b) represent C_{op} as a function of η_{fc} and x, respectively. From Figure 10 (a) it becomes evident, the impact of η_{fc} on C_{op} diminishes for high x values (red dots), which is as well attributed to the increase in the vehicle's reliance on the electric system. Thus, the impact of η_{fc} becomes smaller. Additionally, Figure 10 (b) shows that to understand the relation between C_{op} and x, the values of η_{fc} should be taken into consideration as well. As x increases, C_{op} increases for high η_{fc} values (red dots, $\eta_{\text{fc}} > 0.5$), while C_{op} decreases for low η_{fc} values (blue dots, $\eta_{\text{fc}} < 0.5$).
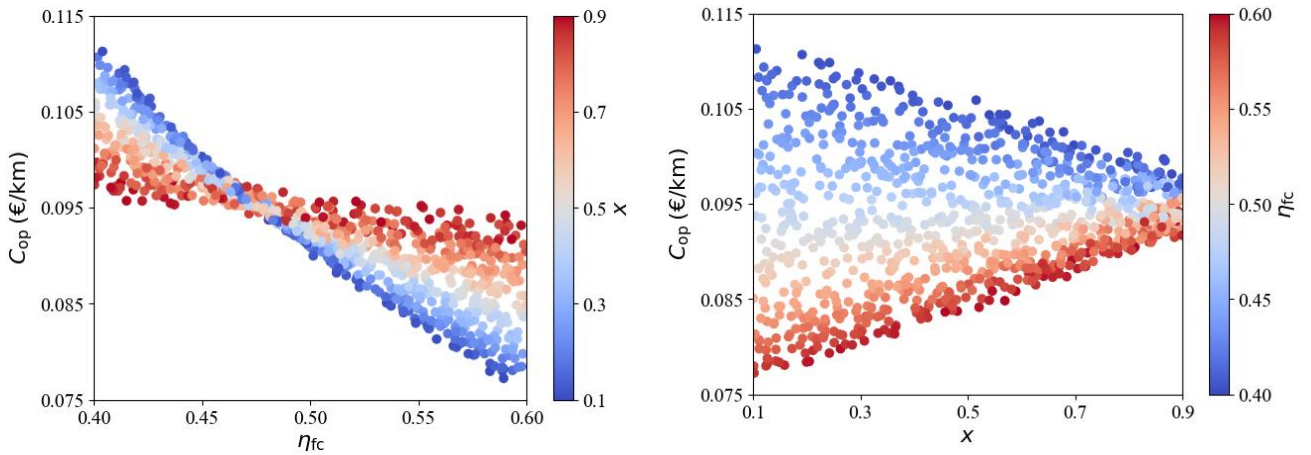

Figure 10: The variation of the well-to-wheel energy consumption C_{op} as a function of fuel cell efficiency η_{fc} and the energy storage ratio x. 1000 samples are drawn from 20480 samples.

6. SUMMARY AND OUTLOOK

Within the context of this paper, a framework was provided to integrate a variance-based global sensitivity analysis (GSA) in the multidisciplinary conceptual phase of road vehicles. To ensure the applicability of this framework, the conceptual design phase of the so called "Inter-urban vehicle" (IUV) was examined. The IUV is a research plug in

fuel cell electric vehicle, which is conceptualized at German Aerospace Centre (DLR[5]). With the aim of digitizing and automating the conceptual design phase, a digital vehicle design workflow was modeled using the multidisciplinary design analysis and optimization workflow design accelerator, abbreviated as MDAx. To guarantee an efficient exchange of computational tools between the engineering teams involved in the conceptual phase, the vehicle design workflow was executed in the open-source software RCE, short for **r**emote **c**omponent **e**nvironment. Within the context of this paper, the energy storage ratio x, fuel cell efficiency η_{fc} and the gravimetric energy densities of the battery as well as hydrogen including tank, $\rho_{G,batt}^{E}$ and $\rho_{G,h_2,tank}^{E}$, were regarded as design variables. The uncertainties of the design variables, which can be due to future technological advancements or different vehicle configurations, were quantified using probability distribution functions (PDF). Based on these PDFs, the design variables were sampled using the Sobol' sequence. Subsequently, the resulting design workflows were executed in the process-integrating software RCE. Here, the tank-to-wheel E^{ttw} and well-to-tank energy consumption E^{wtw} as well as the operating costs C_{op} were considered as quantities of interest (outputs) for the subsequent GSA, where the Sobol' indices of the outputs were computed based on the Sobol' method. It was shown that the Sobol' indices did not only quantify the uncertainties of the outputs, but also helped to identify which design factors are the most influential on the final vehicle design. Additionally, Sobol' indices helped in comprehending the intricate mechanisms of the system under consideration, which facilitates the decision-making process in the conceptual design phase of road vehicles.

An important factor that was not considered in this paper is the computational time. Since the Sobol' method require a large number of samples to achieve an acceptable accuracy, a high computational effort was needed to evaluate the IUV's design workflows. For this reason, further investigations can be conducted with the objective of applying surrogate models, that can replace the IUV's design workflow while reducing the computational effort required. What was also not considered in this paper, are uncertainties related to the computational tools used for the design workflow, such as, uncertainties due to numerical errors. Within the context of upcoming work, the framework presented in this paper can be extended to include such uncertainties. Future research could also include extending the IUV's design workflow to account for additional engineering domains, which are involved in the conceptual design phase, such as aerodynamics, lateral dynamics, packaging, etc. Finally, different methods could be investigated in future work with the aim of evaluating the large number of vehicle concepts resulting from sampling. Subsequently, the values of the design variables yielding to the optimal vehicle concept can be selected based on the evaluation method chosen.

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A Fuzzy Cognitive Map Methodology for Assessment of Immersive Technologies

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Abstract

This paper presents an analytical approach utilizing Fuzzy Cognitive Map (FCM) to assess the impact and effectiveness of immersive technologies in various domains, including education, training, and entertainment. By integrating qualitative and quantitative data, FCM provides a flexible framework for modeling the complex relationships and dynamics between different factors influencing user experiences with immersive technologies. The study identifies critical factors and employs FCM to visualize and analyze their interconnections. Through a case study, the findings demonstrate the potential of FCM to enhance decision-making processes and guide the adoption of immersive solutions. At the end of the case study, the role of international cooperation is the most critical assessment factor of immersive technologies. This study offers insights into the opportunities and challenges of immersive technologies and contributes to developing a robust assessment methodology that can adapt to evolving technological landscapes.

Keywords: FCM, fuzzy sets, immersive technologies, technology.

1. INTRODUCTION

Immersive technologies have been slowly making their way into our daily lives and have been used in various industries in recent years. Thanks to immersive technologies, users can achieve a high level of immersion, which also makes it harder to distinguish between the real and virtual worlds. The phrase "immersive technology" typically refers to a variety of technological platforms, including mixed reality (MR), augmented reality (AR), and virtual reality (VR) [1]. Technology mediates many experiences that service researchers wish to comprehend, including virtual medical consultations, online shopping, and even artificial intelligence (AI) - assisted surgery [2]. For this reason, this paper is motivated by the need to understand the adoption of immersive technologies.

This paper aims to provide a realistic methodology by considering the importance of the requirements in immersive technologies. In this context, Fuzzy Cognitive Map (FCM) is implemented as a framework to analyze the complex relationships between different elements that affect user experiences. By combining qualitative and quantitative data, FCM facilitates a deeper understanding of how various factors interconnect and influence one another. FCMs illustrate the whole system by a graph showing the cause and effect along concepts. They are a simple way to symbolically describe the system's model and behavior, exploiting the accumulated knowledge of the system. FCMs symbolically represent knowledge and relate states, processes, events, values, and inputs.

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This study first identified the factors influencing existing immersive technologies by conducting literature research and reviewing industry reports. The twelve criteria obtained are divided into two main categories: opportunities and challenges. A case study is provided to illustrate the potential applicability of the proposed approach. At the end of the case study, the most critical factors for immersive technology adoption are determined as the role of international cooperation, societal benefits from improved service delivery and access, and security, safety, and well-being.

The following sections of the paper are organized as follows. The background of the immersive technologies and the assessment framework are provided in the following section. *Section 3* presents the methods used in our proposed approach. The case study is provided in *Section 4*. The concluding remarks are provided in the last section.

2. IMMERSIVE TECHNOLOGIES

2.1. Background

Immersive technologies have the potential to revolutionize several industries, offer safer training and testing methods, individualized learning solutions, remote and customized healthcare delivery, enhanced entertainment and access to cultural treasures, and promote human interactions [3]. Immersive technology is redefined and revolutionizing the staging of experiences and the co-creation of value, which has implications for customer experience management [4].

In the literature, Tom Dieck et al. [4] have suggested a framework using customer experience management to investigate the impact of immersive technologies. Zhao et al. [1] analyzed the user engagement part of immersive technologies by taking into consideration the medical students' know-how. Kozinets [2] proposed a conceptual paper to present a qualitative approach to the use of immersive technologies in VR, AR, and metaverse contexts. Irfan et al. [5] proposed an analytical methodology to analyze the barriers to the adoption of the metaverse. Clay et al. [6] reviewed the VR training and provided research directions.

2.2. Assessment Framework

In this study, an assessment framework was determined by analyzing the academic studies and industry reports to understand immersive technologies' impacts. This model considers the opportunities and challenges of immersive technologies. Fig. 1 illustrates the assessment framework of the study.

Opportunities

- O1. Economic opportunities
- O2. Societal benefits from improved service delivery and access
- O3. Convergence with AI and other digital technologies
- O4. Environmental benefits through energy efficiency gains
- O5. Expected needs of immersive technology ecosystems
- O6. The role of international cooperation

Challenges

- C1. Responsible corporate engagement ensuring human rights
- C2. Security, safety and well-being
- C3. Environmental impact
- C4. Accessibility and inclusion
- C5. Fragmented cooperation and lack of interoperability
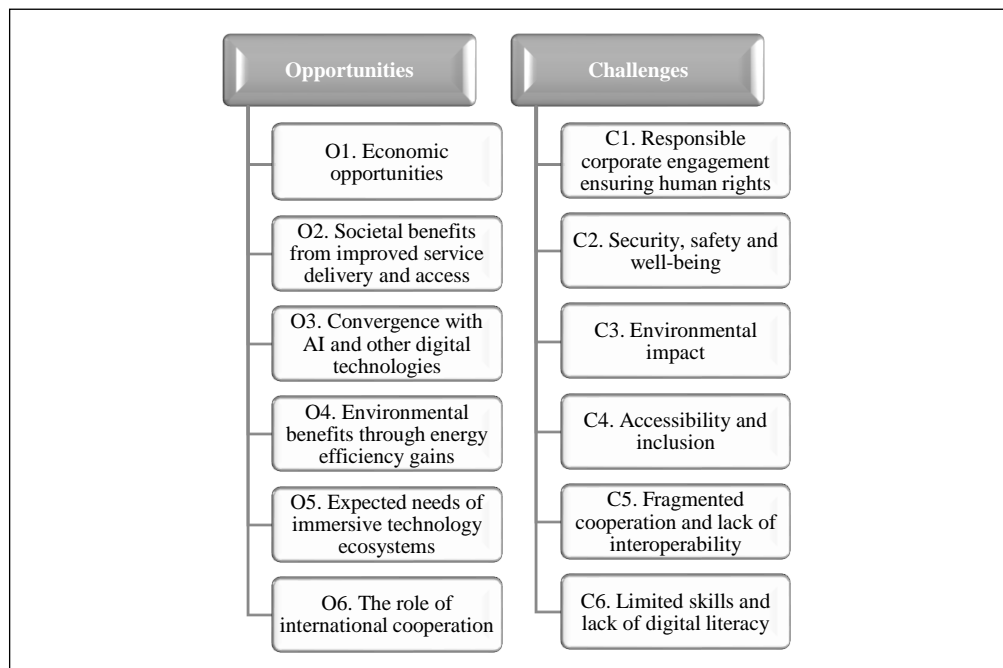- C6. Limited skills and lack of digital literacy

Fig. 1. The assessment framework [3].

The assessment framework is primarily based on the report of the Global Forum on Technology [3]. The immersive technologies focus group, which started in November 2023, includes 41 specialists from 19 nations. The organization consists of stakeholders from academia, business, technology, and policy to gather and contribute data that supports strategic discussions and global collaboration on immersive technologies.

3. FUZZY COGNITIVE MAP METHODOLOGY

Fuzzy Cognitive Map (FCM) methodology is a symbolic representation for the description and modeling of complex systems. Some studies [7,8] enhanced the power of cognitive maps, considering fuzzy values for the concepts of the cognitive map and fuzzy degrees of interrelationships between concepts. After this pioneering work, FCMs attracted the attention of scientists from many fields and have been used in various scientific problems [9].

FCMs describe different aspects of the behavior of a complex system in terms of concepts; each concept represents a state or a characteristic of the system, and these concepts interact with each other, showing the system's dynamics. The knowledge accumulated for years on the operation and behavior of a system can be adequately explained using FCMs. Fig. 2 illustrates a graphical representation of an FCM consisting of five concepts (C1 to C5) and related weights, w_{ji} (cause-effect relationships among the concepts) [10].
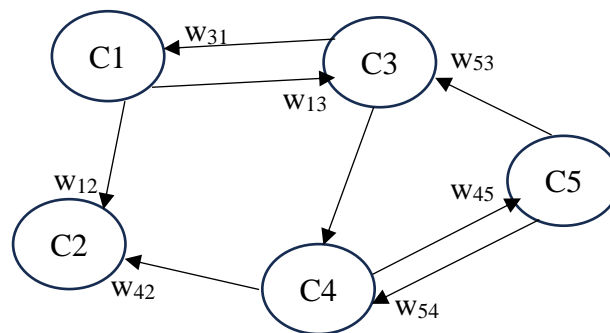

Fig. 2. An example of FCM.

The cause and effect interconnection between two concepts C_j and C_i is described with the weight w_{ji}, taking a value in the range –1 to 1. Three possible types of causal relationships exist:

- $w_{ji} > 0$ which indicates positive causality between concepts C_j and C_i,

- $w_{ji} < 0$ which indicates negative causality between concepts C_j and C_i, and

- $w_{ji} = 0$ which indicates no relationship between C_j and C_i.

Step 1. Concept nodes are determined, defined, and shown as *Ci* with $i = 1, 2, \ldots, N$.

In this study, concepts are the factors affecting the adoption of immersive technology. Hence, $N = 12$ in this paper.

Step 2. The experts use three categories—positive, negative, and null—to identify the direction of causal links between concepts. The cognitive map features concept nodes and arrows indicating causal relationships.

Step 3. Experts used the linguistic terms provided in Table 1 to assess the weights of the relationships.

Table 1. Linguistic scale [11]

Linguistic term	TFN
Very very low (VVL)	(0,0.1,0.2)
Very low (VL)	(0.1,0.2,0.35)
Low (L)	(0.2,0.35,0.5)
Medium (M)	(0.35,0.5,0.65)
High (H)	(0.5,0.65,0.8)
Very high (VH)	(0.65,0.8,0.9)
Very very high (VVH)	(0.8,0.9,1)

Step 4. The experts' assessments are aggregated using the arithmetic mean of the fuzzy weights.

Step 5. The centroid method is used for defuzzifying the fuzzy weights of the attributes. The Best Non-fuzzy Performance (BNP) of a triangular fuzzy number $\tilde{A}=(l,m,u)$ is calculated [12]:

$$BNP_i = \frac{[(u_i-l_i)+(m_i-l_i)]}{3} + l_i, \ \forall_i \tag{1}$$

Step 6. At each simulation step, the value A_i of concept C_i is computed by computing the influence of other concepts C_i's on the specific concept C_j following the rule [10]:

$$A_i^{(k+1)} = f(A_i^{(k)} + \sum_{j\neq i}^{N} A_j^{(k)} \cdot w_{ji}) \tag{2}$$

where $A_i^{(k+1)}$ is the value of concept C_i at simulation step $k + 1$, where $A_j^{(k)}$ is the value of concept C_j at simulation step k, w_{ji} is the weight of the interconnection from concept C_j to concept C_i and f is a sigmoid threshold function [10]:

$$f = \frac{1}{1+e^{-\lambda x}} \tag{3}$$

where $\lambda > 0$ is a parameter that determines its steepness.

4. CASE STUDY

Immersive technologies make possible opportunities to revolutionize businesses, offer safer training and testing, offer individualized learning solutions, provide remote and customized healthcare delivery, enhance entertainment and access to cultural treasures, and promote human interactions [3].

In this section, a case study examines the adoption of immersive technologies. Three experts working in different departments of a mobile game company are chosen to assess the causality relationships among the factors. They all have sufficient experience and knowledge of immersive technologies. After consulting the experts, a consensus is reached.

Section 2.2 summarizes the twelve assessment factors. Experts assessed these factors using the linguistic scales in Table 1. Table 2 displays the experts' evaluations with linguistic terms. Eq. (1) defuzzifies the values to obtain the weight matrix, which is displayed in Table 3.

Table 2. The assessment with linguistic terms

	O1	O2	O3	O4	O5	O6	C1	C2	C3	C4	C5	C6
O1	-	M	-	-	VL	L	-	-	-	M	-	Negatively VL
O2	VL	-	-	-	L	-	M	-	-	-	-	-
O3	M	-	-	-	H	-	-	-	-	-	Negatively M	-
O4	-	-	-	-	-	-	VVL	L	-	-	-	-

O5	-	-	-	-	-	VVL	-	-	-	VL	-	-
O6	-	H	VL	-	-	-	L	VL	-	-	-	-
C1	-	VL	-	-	-	L	-	VL	-	-	-	-
C2	-	H	-	-	-	-	-	-	-	VL	-	-
C3	-	-	-	Negatively M	-	-	-	-	-	-	-	-
C4	-	M	VVL	-	-	M	-	-	-	-	-	Negatively M
C5	-	Negatively L	Negatively M	-	-	-	-	-	-	Negatively M	-	-
C6	-	Negatively L	-	-	-	-	-	-	-	Negatively VL	-	-

Table 3. The weight matrix

	O1	O2	O3	O4	O5	O6	C1	C2	C3	C4	C5	C6
O1	0	0.5	0	0	0.2	0.35	0	0.8	0	0.5	0	-0.2
O2	0.2	0	0	0	0.35	0.8	0.5	0	0	0	0	0
O3	0.5	0	0	0	0.65	0	0	0	0	0	-0.5	0
O4	0	0	0	0	0	0	0.1	0.35	1	0	0	0
O5	0	0	0	0	0	0.1	0	0	0	0.2	0	0
O6	0	0.65	0.2	0	0	0	0.35	0.2	0	0	0	0
C1	0	0.2	0	0	0	0.35	0	0.2	0	0	0	0
C2	0	0.65	0	0	0	0	0	0	0	0.2	0	0
C3	0	0	0	-0.5	0	0	0	0	0	0	0	0
C4	0	0.5	0.1	0	0	0.5	0	0	0	0	0	-0.5
C5	0	-0.35	-0.5	0	0	0	0	0	0	-0.5	0	0
C6	0	-0.35	0	0	0	0	0	0	0	-0.2	0	0

Eqs. (2)—(3) are employed to calculate the factor concept values. FCMapper software runs the FCM algorithm. The methodology stabilizes after 21 iterations. At the end of the application, the factor indegree, outdegree, centrality, and concept values are determined. They are displayed in Table 4.

Table 4. The results of FCM

Concepts	Outdegree	Indegree	Centrality	Concept values
O1	2.550	0.700	3.250	0.786
O2	1.850	3.200	5.050	0.937
O3	1.650	0.800	2.450	0.655
O4	1.450	0.500	1.950	0.535
O5	0.300	1.200	1.500	0.854
O6	1.400	2.100	3.500	0.938
C1	0.750	0.950	1.700	0.845
C2	0.850	1.550	2.400	0.887
C3	0.500	1.000	1.500	0.790
C4	1.600	1.600	3.200	0.754
C5	1.350	0.500	1.850	0.557
C6	0.550	0.700	1.250	0.489

According to the result of the FCM method, "O6. The role of international cooperation" is the most critical factor. The second important factor is "O2. Societal benefits from improved service delivery and access", and the third one is "C2. Security, safety and well-being".

5. CONCLUSION

Immersive technology could shift the customer journey toward immediacy, ensuring that customers receive the most recent material and information when they need it [4]. AI-enabled computer vision as well as new devices that leverage breakthroughs in computing power, expand the potential economic and societal impacts of immersive technologies and increase their attractiveness. Evidence collection and analysis can assist policymakers in exploring policy implications and potential solutions to address the risks and take advantage of the benefits as they work to better understand how these technological advancements will apply [3].

This study proposed an FCM framework for the immersive technology assessment problem. The twelve factors were constructed by investigating the related literature. A case study was presented to illustrate the potential of the proposed framework. At the end of the case study, the most promising benefit of immersive technologies is the role of international cooperation, and the second benefit is societal benefits from improved service delivery and access. On the other hand, the most influential risk is found to be security, safety, and well-being.

Fuzzy set extensions (such as hesitant fuzzy sets, intuitionistic fuzzy sets, and Pythagorean fuzzy sets) are expected to be used in future research to expand on this topic.

Acknowledgments

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A Study of Travel Time Prediction Model Based on Kalman-Filter Using Point Information in Autonomous Driving Environment

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Abstract

The application of traffic sensors for the accuracy of section travel time estimation in a dynamic environment is essential for the selection of routes for advanced traffic information support systems (ATIS) and autonomous vehicles. For the selection of routes for autonomous vehicles in changing traffic environments, data collected by traffic sensors such as loops, images, radars, etc. under poor outdoor conditions must meet the requirements such as accuracy, reliability, and timeliness, and operate in synchronization with the traffic information system in real time. The section travel time estimation method using the Kalman filter technique (KFT) is proposed to combine traffic sensor collection data with the dynamic system model to achieve robust and accurate travel time estimation. This study creates a controlled environment for data processing by utilizing the Law-abiding operation certification evaluation system (PADL-LOCES) of the National Police University Policing Autonomous Driving Research Center in Korea. Data processing and analysis are performed by using SAS. Qualitative (estimated travel time versus actual travel time) and quantitative evaluation are used for performance evaluation by applying metric indicators (RMSE, MAE). The initial results of the model using the data from the traffic sensor show relatively accurate distance estimation compared to the actual travel time. The optimal estimation sensitivity enhancement within the KFT and noise correction parameters through the Gain Matrix are identified and the algorithm is validated with real data from the Toll Collection System (TCS).

Keywords: Autonomous driving, Travel time, Kalman filter

1. INTRODUCTION

Traffic Management System for Autonomous Driving in Korea, there is no doubt that the success of Intelligent Transport Systems (ITS) is determined by the collection of traffic information, and the core equipment is the vehicle detector. The Advanced Travel Information System (ATIS), which is an advanced traffic management function in ITS, has the function of collecting and processing various traffic information in real time by installing detection sensors on the road. The collection and processing of traffic information is not only an essential function for achieving the goals

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of the ATIS, but the database formed here is the basis for enabling other intelligent transportation system (ITS) linkage services.

Currently, travel speeds are generated and provided using simple arithmetic techniques only for specific sections of highways, resulting in very poor reliability of the information provided for various traffic conditions. In addition, the travel time information provided by the existing ITS Advanced Traffic Information System (ATIS) is mostly calculated by the Space Mean Speed method, and it is difficult to calculate the delay time for congestion situations experienced by vehicles with traffic information collected from the Vehicle Detector System (VDS) based on spot information. To overcome this, information at the link level in the city or at the zone level in the highway is required, but it is difficult to find a means of collecting zone information in reality. As an alternative, it is possible to obtain sectional information by collecting traffic information using the Prove Car method, but it has the disadvantage of being costly and time-consuming.

Therefore, this study proposes a method to estimate the travel time by collecting traffic data mainly with point information, but continuously verifying the model with a small amount of section information. To prove the feasibility and applicability of this model concept, point traffic information is collected using vehicle detectors (VDS) in the highway traffic control system, and a travel time prediction model is built. The built prediction model is compared and verified by assuming the section traffic information of the toll collection system (TCS) of the target section as the true value. In addition, by applying the Kalman filter method to predict the travel time after a certain period of time, we aim to provide better real-time travel time information to the advanced traffic information system (ATIS) and road users. In addition, we aim to develop a travel time prediction algorithm that can be applied to route design for AI driving systems that will be installed to perform dynamic driving tasks (DDT) in the operational domain (ODD) of autonomous vehicles in the future.

2. RESEARCH CONTENT AND METHODS

In this study, we aim to build a model using point information-based vehicle detector data and Kalman filtering technique. Therefore, a theoretical review of these methods is conducted to establish the model to be built in this study. To process the vehicle detector data, various statistical techniques are applied to remove outliers, and through this, more refined point information is selected and applied to the model. Model construction is to build a prediction model using the Kalman filter technique. The form of the model is to build a prediction model by connecting point traffic information to generate section traffic information. Experimentation and verification of the model is performed by comparing the information on the inflow and outflow time of the highway toll gate provided by the Freeway Traffic Management System (FTMS) and the toll gate traffic settlement system (TCS) of the toll gate office.
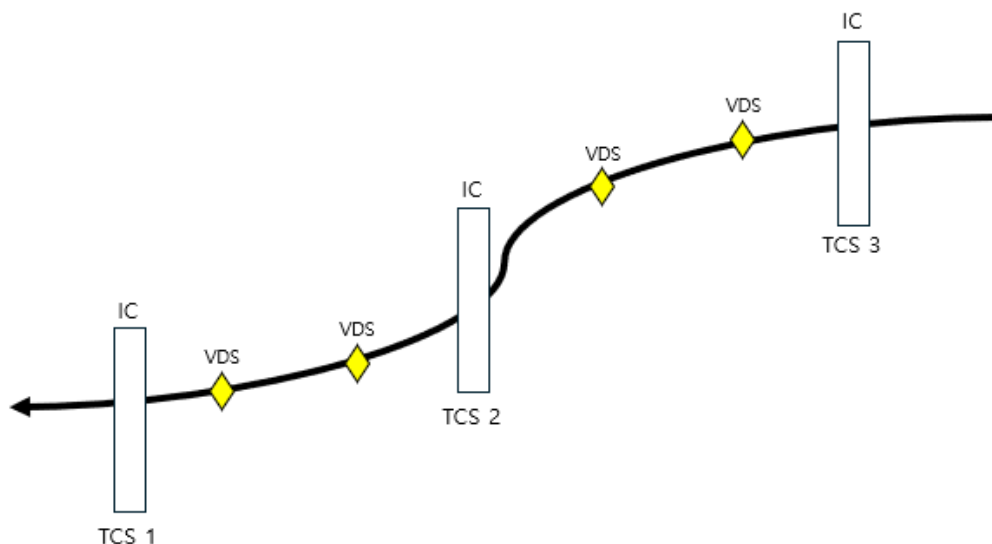

Fig. 1. Conceptual diagram of data collection and model building

3. PREDICTIVE MODEL MECHANISM

Since the Kalman filter model is based on the Bayesian estimation method in its theoretical nature, the mechanism of the applied model is also divided into 'Prior Estimation' and 'Posterior Estimation' in stages, and this characteristic corresponds to the process of estimating the prediction error to calculate the Kalman gain metric, which is the most core element of the Kalman filter model. The gain metric in the Kalman filter model is calculated by the error covariance, which is performed for both the 'Prior Estimation' and 'Posterior Estimation'. The process of calculating the 'Posterior Error Covariance' is called the 'Time Update' process, and the process of calculating the 'Prior Error Covariance' is called the 'Measurement Update' process.

Therefore, iteration 1, which is performed by the initial value for the constructed Kalman filter model, ends by first going through the process of "Time Update" and secondly completing "Measurement Update". However, the result at the end of Iteration 1 is not a prediction, and the value determined in Iteration 1 is only an estimate. Therefore, in order to produce a prediction, after Iteration 1 ends, it is possible to "Time Update" it again to produce a prediction. If the Prediction Lead-Interval is 1, then to predict the situation after iteration 2, the State Transition Matrix of the system equation must be calculated and applied. The conceptual diagram of the interconnection of "Time Update" and "Measurement Update" in the above Kalman Filter Model calculation process is shown in the following figure.
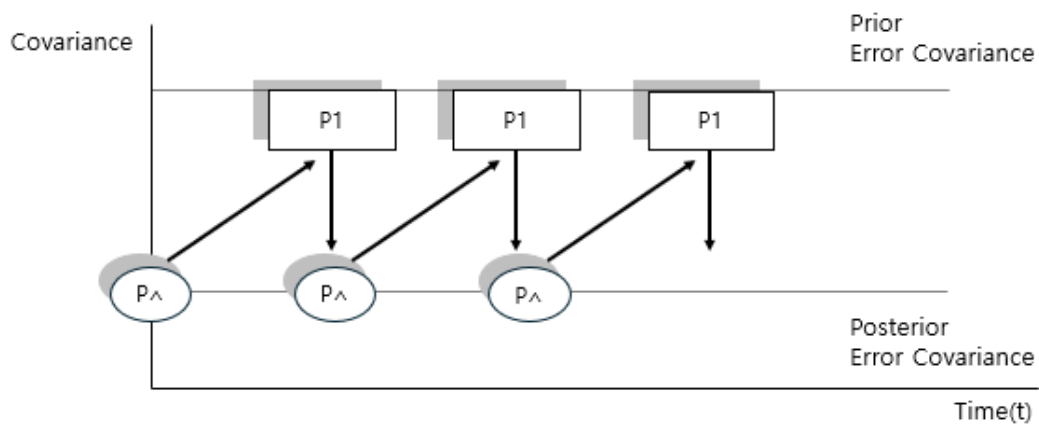

Fig. 2. Interlinking "Time Update" and "Measurement Update"

4. PREDICTIVE MODEL DEVELOPMENT

The data used in this study is processed and calculated in 5 minute increments using the 'Rolling Horizon' technique for the speed of the point-based vehicle detector (VDS) data and the entry and exit time information of the toll gate toll payment system (TCS). This information is used to build a model that predicts the traffic situation after 5 minutes through a Kalman filter prediction model.

While the traffic information produced by conventional data processing and processing estimates the current traffic information, the information predicted by the method proposed by the Kalman filter model can predict the future traffic information in a time series of 5 minutes. The following figure shows how to apply the Kalman filter model for travel time prediction.
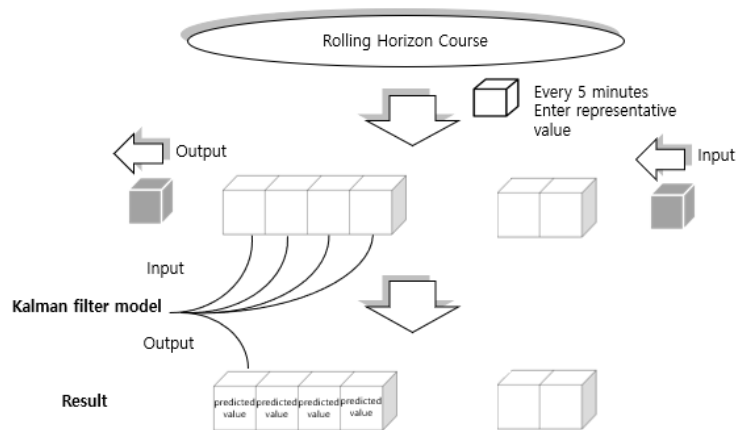
Fig. 3. Kalman filtering for prediction

For example, if the traffic condition is continuously congested and the traffic volume is increasing, the information for only 5 minutes is a very short-term forecast, which is not very meaningful from the perspective of traffic operations and road users. Prediction information that covers the general OD travel time (travel time) is more useful to predict traffic conditions for 15 minutes or longer. Therefore, based on this information utility, the results of this study can provide time-series traffic analysis and information on time and space, which is very valuable information. For model development, a 5-minute Kalman filter prediction model was developed as the basic model. In addition to the basic model, 16 models were built by increasing the prediction time by 5 minutes. The data used were VDS and TCS data from Seoul, Suwon, and Osan sections of the Gyeongbu Line in Korea.
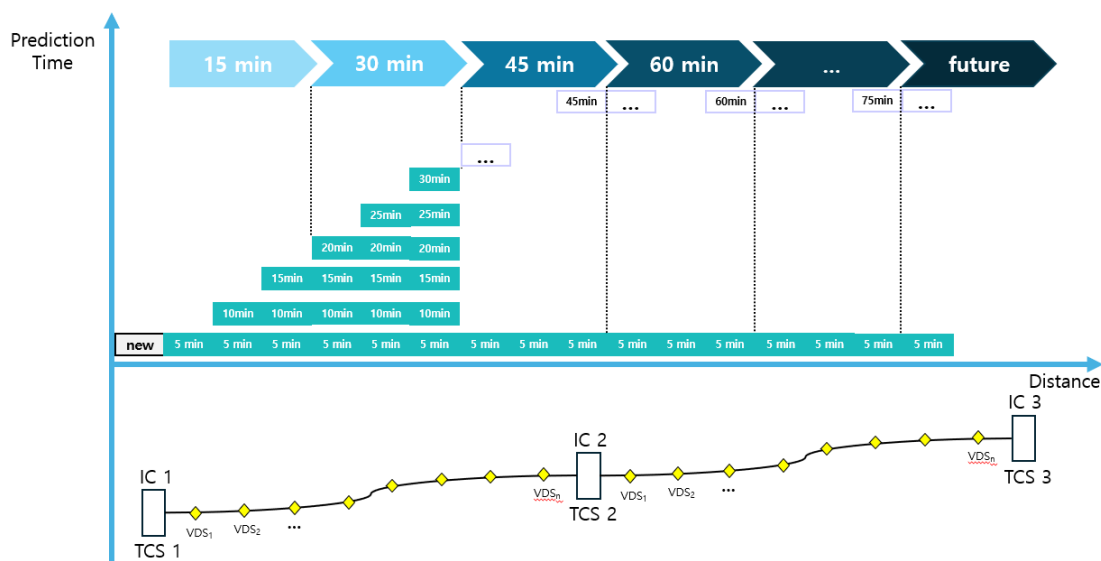

Fig. 4. Design of Travel Time Prediction Model

5. MODEL EVALUATI ON AND VALIDATION

In general, there are many ways to evaluate the performance of a predictive model, but there are no standardized evaluation criteria. Most of them use quantitative or qualitative metrics, or a mixture of relative and absolute metrics. In this study, we used four metrics to evaluate the models: MARE, MAE, RMSE, and EC.

1.   MARE(Mean Absolute Relation Error)

$$MARE = \frac{1}{N} \sum_{i=1}^{N} \frac{|x(i) - \widehat{x(i)}|}{x(i)}$$

2.   MAE(Mean Absolute Error)

$$MAE = \frac{1}{N} \sum_{i=1}^{N} |x(i) - \widehat{x(i)}|$$

3.   RMSE(Root Mean Square Error)

$$RMSE = \frac{1}{N} \sqrt{\sum_{i=1}^{N} |x(i) - \widehat{x(i)}|^2}$$

4.   EC(Equality Coefficient)

$$EC = 1 - \frac{1}{N} \frac{\sqrt{\sum_{i=1}^{N} |x(i) - \widehat{x(i)}|^2}}{\sqrt{\sum_{i=1}^{N} x(i)^2} + \sqrt{\sum_{i=1}^{N} \widehat{x(i)}^2}}$$

The results of the validation of the Kalman filter-based travel time prediction model developed in this study using MARE, MAE, RMSE, and EC evaluation metrics are as follows. There were 16 models in total, and the prediction time for each model started at 5 minutes and increased by 5 minutes to 80 minutes. As a result, MARE was 0.1440 to 0.1874, MAE was 1.9831 to 2.9575, RMSE was 0.1002 to 0.1618, and EC was 9.6618 to 9.2956.

Table 1. Multibinomial Prediction Models

No	EST time	MARE	MAE	RMSE	EC	Max Error
KO001	5 min	0.1440	1.9831	0.1002	0.9062	9.6618
KO002	10 min	0.1511	2.1246	0.1066	0.9046	9.7090
KO003	15 min	0.1577	2.2013	0.1108	0.8972	9.3357
KO004	20 min	0.1492	2.1268	0.1094	0.9025	7.9606
KO005	25 min	0.2185	2.9297	0.2973	0.7654	76.0332
KO006	30 min	0.1959	2.7282	0.2792	0.7846	75.8460
KO007	35 min	0.2197	2.9268	0.3004	0.7638	76.1477
KO008	40 min	0.1933	2.6754	0.2797	0.7842	75.7432
KO009	45 min	0.1445	2.1149	0.1177	0.9032	9.9764
KO010	50 min	0.1399	2.0838	0.1210	0.9046	10.2944
KO011	55 min	0.1506	2.2613	0.1294	0.8940	10.0350
KO012	60 min	0.1416	2.1185	0.1192	0.9063	7.8984
KO013	65 min	0.1766	2.6805	0.1423	0.8836	9.1193
KO014	70 min	0.1743	2.7135	0.1492	0.8834	9.9586

| KO015 | 75 min | 0.1791 | 2.7261 | 0.1445 | 0.8822 | 8.8605 |
| KO016 | 80 min | 0.1874 | 2.9575 | 0.1618 | 0.8748 | 9.2956 |

6. CONCLUSION

This study develops a travel time prediction algorithm and builds a model by using point vehicle detector data collected from a freeway traffic management system (FTMS). The algorithm aimed at this study uses point traffic information collected in real time in the field and preprocesses the data at 5-minute intervals using the 'Rolling Horizon' technique to apply the dynamic-based Kalman filter model. MARE, MAE, RMSE, and EC were calculated and compared to determine the comparative advantage of the developed model for the purpose of this study.

The overall conclusions from this study are as follows The theoretical travel time based on point traffic information is different from the actual travel time measured by segment traffic information. Point traffic information measured at vehicle detectors is significantly different from actual OD travel times when converted to spatial average speeds. This difference is believed to be due to the fact that it cannot reflect the congestion that vehicles actually experience on the road. In order to solve this problem, this study builds an algorithm and model that converts point data into sectional travel time using point data, and presents the verification results using MARE, MAE, RMSE, EC, etc. as evaluation indicators to verify the effectiveness of the model.

Acknowledgement

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CIAE
Czech Institute of Academic Education z.s.

Title:

"Proceedings of IAC in Budapest 2024", ISBN 978-80-88203-40-7

December 2024 in Prague, *1st edition*

Publisher / Creator / Copyright holder:

Czech Institute of Academic Education z.s.

Address of Publisher:

Vodnicka 309/20, 149 00 - Prague 4, Czech Republic

Email: info@conferences-scientific.cz

Web: www.conferences-scientific.cz