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# The Influence Factors of Chinese Enterprises' Outward Foreign Direct Investment on Thai-Chinese Rayong Industrial Zone, Thailand

## Xueyi FENG[a], Khunanan SUKPASJAROEN[b], Thitinan CHANKOSON[c*]

*[a] Chakrabongse Bhuvanarth International Institute for Interdisciplinary Studies (CBIS), Rajamangala University of Technology Tawan-OK, Thailand. E-mail: fengxueyi_china@163.com*
*[b] Chakrabongse Bhuvanarth International Institute for Interdisciplinary Studies (CBIS), Rajamangala University of Technology Tawan-OK, Chonburi, Thailand. Email: khunanan_su@rmutto.ac.th*
*[c] Faculty of Business Administration for Society, Srinakharinwirot University, Thailand. Email: tchankoson@gmail.com, thitinanc@swu.ac.th*

**Abstract**

With the growing development of Chinese enterprises, Chinese enterprises want to go out and look for overseas markets, the Chinese government in order to expand exports, in the past two decades, there is a significant trend, that is, more and more Chinese enterprises go outside of China, invest to overseas. This paper examines the issue of Chinese enterprises' direct investment in Thailand, using data from 1987 to 2022 to analyze Chinese enterprises' direct investment and investment environment in Thailand; Through these data, this paper exam Chinese outward FDI is promote Thailand eco-nomic and GDP increasing for past two dec-ades.Chinese enterprises willing to invest in Thailand? This research based on PESTEL framework, this model which consists of 6 factors which are PF (political factors), GF (government regula-tions and laws factors), LF (location factors), MF (market Fac-tors), SF (social and cultural factors), and FF (financial factors).

## 1. INTRODUCTION

1.1 Background:

According to (France Médias Monde, Year 2012), the European Union has imposed anti-dumping measures on some Chinese solar panels since Friday, December 6 ,2012, and manufacturers of these products have refused to participate in the friendly settlement reached between China and the EU in July.   The European Commission will implement anti-dumping measures on some Chinese solar panels for a period of two years starting on 2 December 2012 and will take effect on Friday, 6 December 2012, with an average anti-dumping duty rate of 47.7%. In general, the EU's long-term anti-dumping measures are limited to five years, but the EU says they are valid for two years, given the volatility of the photovoltaic products market. China is now the world's largest manufacturer of solar panels. Production of solar panels in China has expanded rapidly in recent years, and the country's solar panel supply capacity has exceeded global demand.

U.S. President Donald Trump signs a presidential memorandum imposing tariffs on Chinese exports to the U.S(2018.) at the White House on March 22, China's Ministry of Commerce issued a list of products that have been suspended under 232 measures for U.S. steel and aluminum products, with a view to imposing tariffs on some products imported from the U.S.   Many learn to think that the Sino-US trade war began. (Gao Yifan, Year 2018), analysis of Sino-US trade war - look at China), Chinese enterprises in order to avoid the impact of trade war on enterprises, so actively carry out overseas expansion of production help, reduce the impact of trade war on enterprises. The public

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* Corresponding author.

relations between the Thai and Chinese governments are good, with frequent exchanges in the fields of economy, trade, investment and tourism, and a good investment environment. Thailand has always been committed to developing a trade partnership with China. Especially in recent years, the leaders of the two countries have met frequently and held exchange meetings. Recently, Premier Li Keqiang visited Thailand. China and Thailand agreed to promote the in-depth docking of industrial planning policies, rely on cooperation platforms such as the Sino-Thai Rayong Industrial Zone, expand production capacity cooperation, and use Thailand's strategic position as the meeting point of supply chain and logistics chain in the Mekong River basin to strengthen mutually beneficial cooperation among the next generation of automotive, high-tech medical equipment, new energy and energy-saving transportation, rubber and other advantageous industries, and build industrial clusters. Thailand welcomes increased investment by Chinese companies in the eastern economic corridor. The two sides agreed to expand trilateral cooperation in the European Community and believed that the concept would serve as a model for promoting similar cooperation and benefiting more regions. The Central Rayong Industrial Zone is conveniently located close to Uta Apo Airport and Lemchabon Puot. As the main development target of the Thai government, there are already many Chinese enterprises in the Thai-China Rayong Industrial Zone, which provides good resources for in-depth exchanges and cooperation between the companies

Thailand has a wealth of human resources, a sound industrial base and a complete supply chain system. At the same time, the products invested by Chinese enterprises are also in line with the direction of the industry and the positive of the company's global layout, which are strongly encouraged by the Thai government. Thailand's stable policy and legal environment is more trustworthy than the changing environment in other Southeast Asian countries. *Many Thais have a good Chinese foundation, can develop and solve some communication barriers with Chinese company, can provide good labor resources, Thailand's long industrial time, industrial zone management system is perfect, has a beautiful environment, adequate infrastructure, and for Chinese enterprises to build factories laid a good foundation (PANIDA 2017).* The Chinese companies that invest in Thailand are mostly high-tech companies and have a number of diversified industries, and the products involved in Thailand are in line with the industrial direction strongly encouraged by the Thai government.

1.2 Research purpose

To study the influence factors of Chinese enterprises' outward Foreign Direct Investment on Thai-Chinese Rayong Industrial Zone, Thailand

1.3 Study limitations

The Covid-19, the satisfaction Survey report just 2020 for The Thai-Chinese industry Park due to Covid-19 pandemic, Don't use the SPSS analysis the satisfaction survey report, just use the original data to analysis.

**2. LITERATURE REVIEW**

The Literature review of Chinese enterprises' outward Foreign Direct Investment on Thai-Chinese Rayong Industrial Zone, Thailand as the follows.

2.1 FDI and Innovation as Drivers of Export Behaviors

(Maastricht Economic and social Research:2011) Training center on Innovation and Technology Keizer Karelplein 19, 6211 TC Maastricht, The Netherlands used data from electronics firms in China, Thailand and the Philippines to verify the relationship between exporting, ownership and innovation with other countries. In all of countries, there is showing evidence of the relation between exporting, ownership and innovation as has been found. The results meaning that higher levels of foreign equity and technological capabilities increase export of firms in all three countries. This result confirms the argument made by Westphal et al. (1990), Guan and Ma (2003) and Bhadhuri and Ray (2004) that an innovation measure based on a range of technical functions performed by firms is a robust proxy for innovation at the firm-level in late industrializing East Asian countries. Typically, little R&D is performed at the firm-level in such economies (particularly towards the development of new products and processes at the frontiers of technology) and most of the technological effort is directed towards learning to use imported technologies efficiently.

S. Boonlua, "A comparative analysis of the US and Japan FDI in Thailand," Journal of Academy of Business and Economics, vol. 11

2.2 Financial risk management in Thailand

Liu;Li,Ye;Chen;(Economist, 3, 2020) "Financial risk analysis of Chinese vaccine enterprises' investment in Thailand" At present, the trend of economic internationalization is increasing day by day. Investment in Thailand, 1.

Financing risk. Financing risk control mainly starts from two aspects: interest rate and exchange rate. In project investment, the changes of interest rate and exchange rate will affect the investment income of enterprises. Thailand has a foreign exchange control policy of free exchange, and the exchange rate is prone to fluctuations in the international market. With little state intervention, it is easy to cause losses if the bank is not properly controlled.

2.3 Tax risks.

Foreign-invested enterprises mainly need to pay taxes related to dividend withholding tax and capital gains tax. Therefore, enterprises should strengthen tax risk management. In order to avoid related risks, bilateral tax agreements and intermediate holding companies can be signed. In particular, Chinese high-tech enterprises, Thailand Drum, also introduced preferential tax policies; many enterprises in the process of enjoying preferential tax policies must fully understand the local tax policies, reasonable and effective to enjoy tax incentives. 3. Business risks. The lack of understanding of the market will directly affect the receivables and economic benefits of enterprises, especially the customers of enterprises are government departments or local enterprises, so the bad debt rate will be relatively high

2.4 The current situation of Chinese enterprises' direct investment in Thailand and political risk

According to China Economic and trade Guide, 2018 7 "Political Risk analysis of Chinese enterprises' investment in Thailand" Zhou Wei report, FDI invest in Thailand, Chinese enterprise need special note Thailand's political regime changes too frequently, the construction of clean government is not optimistic, regional terrorist incidents are frequent, so it faces high investment risks. To ensure the safety of Chinese investment in Thailand, it is necessary to establish a risk assessment mechanism at the government level, improve the laws and regulations on overseas investment and bilateral investment protection agreements as soon as possible, and establish and improve the overseas investment insurance system. Enterprises should make full use of existing cooperation platforms, attach importance to pre-investment evaluation, take the initiative to shoulder social responsibilities and accelerate the implementation of localization strategy.

2.5 Research on (China Science Press, 2017) this papers point out, invest in Thailand, there are below advantage: 1) Thailand's geographical location and environment is good 2) Thailand is an export base for Asian and ASEAN countries 3) Investment promotion Policy of The Investment Promotion Board of Thailand (BOI) 4) Rich in natural resources 5) Thailand is a potential investment zone 6) Thailand is 49th in the world for doing business in 2016 7) World class infrastructure, But at same time, there are some weaknesses

2.5.1 Issues of political instability

2.5.2 sensitive to the world economy because of its dependence on exports

2.5.3 high cost of transportation services

2.5.4 shortage speak Chinese workers;

Especially, there are two threats what Chinese enterprise keeping invest in Thailand

2.5.5 Financial crisis and global economy;

2.5.6  Lower labor cost in some other ASEAN countries,

Above two threats, its lead to Chinese enterprise has big risk cost.

2.6    According to Research on Chinese enterprises' direct investment in Thailand (MA NINA 2018), China outward FDI is deeper support Thailand GDP increased, this paper research data from 2003 to 2014, the result shown that China's outward FDI has promoted the growth of Thailand's GDP, and that Thailand GDP will be a 0.023498% increased if China's outward FDI investment growth 1% in Thai.

2.7    Based on Athapol; and Chen (August 2014) research result and published paper China's Foreign Direct Investment in Thailand — Current Status and Future Prospects (Article    in    International Journal of Trade Economics and Finance ·, Chinese investors" satisfaction level has positive relation to their future business plan in Thailand.

2.8  PESTEL Analysis stands for "Political, Economic, Social, Technological, Legal, and Environmental analysis" and describes a framework of macro-environment factors used in the Environment scanning component of strategic management. It is a part of the external analysis when conducting a        strategic analysis, It is useful strategic tool for understanding market growth or business position, potential and direction for operations. It is really essential and necessary to do PESTEL analysis in the FDI decision-making process. All of factors in the PESTLE analysis are basic information need to be considered before conducting FDI in the host country.

2.9    Case study

Thai-China Rayong Industrial Park was established in 2006, which (http://www.sinothaizone.com/) is one of the first overseas economic and trade cooperation zones in China. Located in Rayong EEC area, it is jointly developed by China Huali Group and Thailand Amata Group. There are more than 30,000 Thai employees, accounting for about 90% of the total number of employees. The park is expected to accommodate 300 companies, with more than 150 Chinese companies in the park, creating 100,000 jobs for Thailand. Thai-China Rayong Industrial Park Development Co., Ltd. is a modern industrial zone in Thailand jointly developed by China Huali Group and Thailand Amada Group

for Chinese investors. The park is located on the eastern coast of Thailand, close to the Thai capital Bangkok and the deep-water port of Lam Chabang port. The overall planning area of the park is 12 square kilometers, including the general industrial zone, the bonded zone, the logistics storage area and the commercial living area, mainly attracting auto parts, machinery, home appliances and other Chinese enterprises to set up factories in the park. Through the study of Thailand-China Rayong Industrial Park, it can effectively help Chinese enterprises to invest in Thailand, the infrastructure of Thailand, political environment, technical personnel; Labor market, material cost; Land ownership; Tax laws and policies; Work in government departments; Have a complete understanding of cultural differences.

## 3. RESEARCH METHODOLOGY

3.1 Research hypothesis

**Hypothesis 1:**
China's outward FDI is helpful for Thailand's GDP Growth Rate
China's direct investment in Thailand has a great influence on the local economic development of Thailand. It not only increases the accumulation of original capital, but also provides various employment opportunities, alleviates the employment pressure in Thailand, and optimizes Thailand's human resources. Therefore, China's direct investment in Thailand is also beneficial to Thailand's economic development and contributes to its social stability. China's FDI to Thailand continues to increase and the number of foreign investment projects continues to increase. The processing services for these foreign-invested projects are provided locally, which greatly alleviates the local employment pressure.

**Hypothesis 2**
The overall FDI Chinese companies' satisfaction level can significantly influence factors for investors' future business in Thailand, Chinese investors" satisfaction level has positive relation to their future business plan in Thailand. Survey more than 125 Chinese manufacturers which local in Thai-China Rayong industrial park，the satisfaction survey report is helpful to understood what is their concern for investment in Thailand.
Thai-China Rayong is located in EEC area to attract foreign investment Direction,
a.     Campus geography and traffic satisfaction
b.     Market factors
c.     Government factors
d.     Social and cultural
e.     Political factors
f.     Financial factors
over the past years, Thai-China Rayong industrial park has overcome the impact of the epidemic raged, innovation investment "cloud", "cloud services" business model, with a total of 17 landing zone in Chinese enterprise investment project, including CIMC (China International Marine Containers), Talesun Solar, Changsheng, Fiji ling, such as expansion project, Moreover, the PV(photovoltaic) project, one of the largest projects of Chinese manufacturing investment in Thailand, was approved by BOI in 2021. By the end of 2021, 170 Chinese enterprises have entered the park, with a total investment of more than us $4.1 billion and an industrial value of more than US $22 billion, creating more than 45,000 jobs and injecting vitality into the local economy

3.2 Research design

According to literature review 2.6 of this paper: Research on Chinese enterprises' direct investment in Thailand, from Thailand student of Master ( MA 2018 Page 42), China outward FDI is deeper support Thailand GDP increased, this paper research data from 2003 to 2014, the result shown that China's outward FDI has promoted the growth of Thailand's GDP, and that Thailand GDP will lead to a 0.023498% increased if China's outward FDI investment growth 1% increase in Thai. Therefore, the Thailand GDP growth positive impact growth model has the following equation $Y=K*(Yx-Yx-1)/Yx-1*100\%$, to easy count, growth Rate can be used ACGR to replace $(Yx-Yx-1)/Yx-1*100\%$ , to easy count the growth rate of   FDI from 2003 to 2010.
Y is Thailand's GDP growth rate which China outward FDI data of year input to Thailand;
K is acceleration, it is equated 0.023498%
Yx is China outward FDI data of year input to Thailand; Yx-1 is China outward FDI data of the year of before input to Thailand
Through equation output result $Y=K*(Yx-Yx-1)/Yx-1*100\%$, it can be China will increase the quota of FDI

investment in Thailand, thus influencing the GDP in Thailand
CAGR is defined as:

Where Vt0 is the initial value, where Vtn is the end value, and Vtn – Vt0 is the number of years.
It can be used the Excel function equation =EXP(ln(end value Vtn / initial value Vt0,1/ Vtn – Vt0)-1
Actual or normalized values may be used for calculation as long as they retain the same mathematical proportion.

3.3 Research tools

The tools used the regression models and the related economic theories. And use PESTEL model to analysis.

3.4 Data collection

3.4.1 second data what China outward FDI data come from BOI website, world bank, website, and published papers from 2003 to 2020
3.4.2 Primary data was collected by survey, this paper following three years Thai-China industry park 2020 survey satisfaction report.


**4. RESEARCH RESULTS**

4.1 Chinese outward FDI in Thailand from 2003 to 2014

4.1.1 China FDI in Thailand progress in past two decade

Based on (https://data.worldbank.org/indicator) The whole capital was increasing trend year by year. According to this, FDI     accounted for about 15% of the capital of all. The FDI was shared for about 17% in 2010. After 2010, due to the political reason in Thailand, FDI investor's confidence had a great impacted. But contrast China's FDI in Thailand has increased year by year, reaching 16.86% in 2014. Even after economic crisis of 2008, China outward to Thailand FDI amount also keep increasing.

4.1.2 total FDI of China in Thailand (US$1 billion)



Source:(https://data.worldbank.org/indicator)
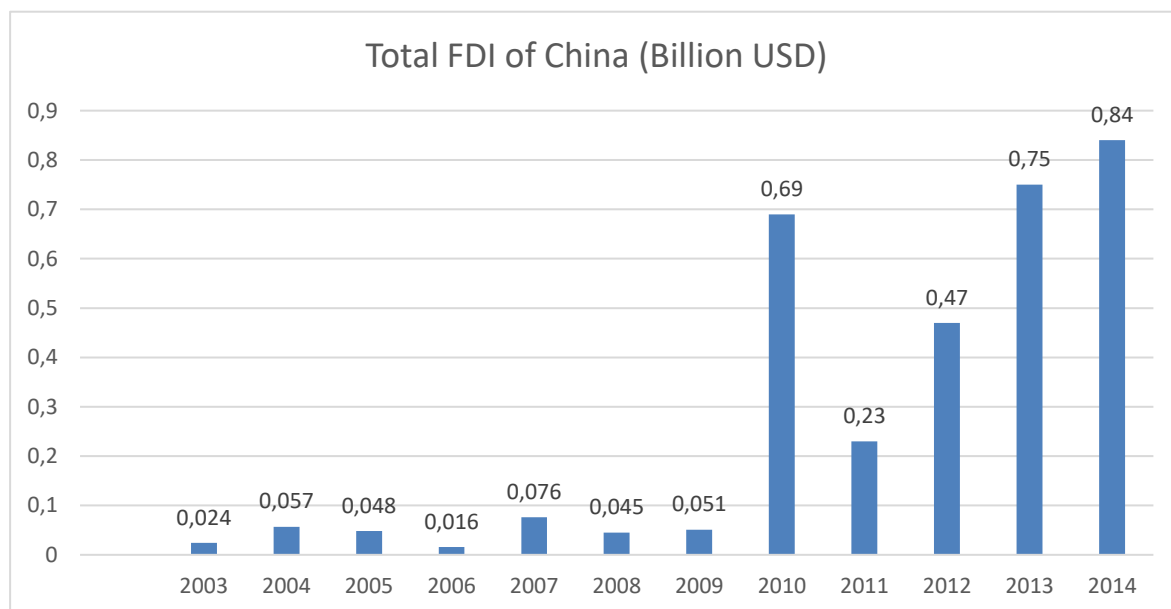
Based on this information, China outward to Thailand FDI CAGR (Compound annual growth rate) is 38.16%, CAGR is defined as:

*Reference  CAGR*

$$CAGR(t_0, t_n) = \left(\frac{V(t_n)}{V(t_0)}\right)^{\frac{1}{t_n - t_0}} - 1$$

*defined(https://money.usnews.com/invest-ing/term/cagr)*

Where Vt0 is the initial value, where Vtn is the end value, and Vtn – Vt0 is the number of years.

It can be used the Excel function equation =EXP (ln(end value Vtn / initial value Vt0,1/ Vtn – Vt0)-1, Actual or normalized values may be used for calculation as long as they retain the same mathematical proportion. Through

$$t = \frac{72 + (r - 8)/3}{r}$$

**=[72+(38.16-8)/3]/38.16=2.3 years**

rule of 72, R=38.16 account, it can be gotten result that mean the outward FDI of China to Thailand is increased one times each 2.3 years.

4.1.3 Thailand GDP and outward China FDI in Thailand table, and growth rate, according to world bank database, GDP of Thailand growth rate as below:

| Year | GDP (Billion dollars) | FDI(billion dollars | FDI/GDP | The GDP growth rate | The FDI growth rate |
|------|------|------|------|------|------|
| 2003 | 143.1 | 0.024 | 0.02% | - | - |
| 2004 | 162.4 | 0.057 | 0.04% | 13.49% | 109.27% |
| 2005 | 176.4 | 0.048 | 0.03% | 8.62% | -22.47% |
| 2006 | 207.1 | 0.016 | 0.01% | 17.40% | -71.61% |
| 2007 | 247 | 0.076 | 0.03% | 19.26% | 298.27% |
| 2008 | 272.6 | 0.045 | 0.02% | 10.36% | -46.35% |
| 2009 | 263.5 | 0.051 | 0.02% | -3.33% | 17.25% |
| 2010 | 318.9 | 0.69 | 0.22% | 21.02% | 1017.91% |
| 2011 | 345.6 | 0.23 | 0.07% | 8.37% | -69.24% |
| 2012 | 366.1 | 0.47 | 0.13% | 5.93% | 92.91% |
| 2013 | 387.3 | 0.75 | 0.19% | 5.79% | 50.84% |
| 2014 | 373.8 | 0.84 | 0.22% | -3.48% | 16.04% |

Source: (Chinese enterprises' direct investment in Thailand by MA NINA HARNCHAIWAT   2017; world bank database)

4.1.4 GDP Thailand growth Rate analysis for China outward FDI in Thailand from 2003 to 2014

This table shown the Thailand GDP growth ACGR= 8.33% from 2003 to 2014, according to the function equation

$$t = \frac{72 + (r - 8)/3}{r}$$

That mean, from 2003 to 2014, Double growth Thailand GDP time t=[72+(8.33-8)/3]/8.33=8.65 years. But at the same period, China outward FDI double growth time is 2.3 years in Thailand, and the ACGR=38.16% as above contents mentioned.

According to Research on Chinese enterprises' direct investment in Thailand, from Thailand student of Master, MA NINA HARNCHAIWAT paper design result Thailand GDP will lead to a 0.023498% increased if China's outward FDI investment growth 1% to Thailand. So, the Thailand GDP growth positive impact growth model has the following

equation

Y=K*(Yx-Yx-1)/ Yx-1*100%, to easy count the growth rate of FDI from 2003 to 2010, this paper (Yx-Yx-1)/ Yx-1*100% to ACGR function (Compound annual growth rate) ,Y is Thailand's GDP growth Rate which China outward FDI growth rate contribution to growth rate of Thailand GDP by year; Yx is China outward FDI data of year input to Thailand; Yx-1 is China outward FDI data of the year of before input to Thailand. it is mean Yx-Yx-1 is increase rate. It is ACGR=38.16%, K= K is acceleration, it is equated 0.023498%

based on above data, the China outward FDI contribute to Thailand GDP growth rate equation is:

Y=K*(Yx-Yx-1)/Yx-1*100%

Therefore, China outward FDI contribute to Thailand GDP growth rate is Y=GDP growth Rate= 0.023498%*38.16%=0.896% from 2003 to 2014.

At same time, Thailand GDP CAGR is 8.13% from 2003 to 2014, that mean China outward FDI is contribution to Thailand GDP is 0.896%/8.13%=11.02% during this period.

4.1.5 GDP Thailand growth Rate analysis for China outward FDI in Thailand from 2010 to 2020

To follow up China outward FDI influence Thailand GDP, this paper analysis more FDI and GDP data to verify.

| Year | Total FDI of China (Billion USD) | FDI of China increase Rate | GDP of Thailand (Billion USD) | GDP of Thailand (increase Rate) |
|---|---|---|---|---|
| 2010 | 0.69 | | 341.1 | 8.71% |
| 2011 | 0.23 | -67% | 370.81 | 8.71% |
| 2012 | 0.47 | 104% | 397.56 | 7.21% |
| 2013 | 0.75 | 60% | 420.33 | 5.73% |
| 2014 | 0.84 | 12% | 407.34 | -3.09% |
| 2015 | 0.4 | -52% | 401.3 | -1.48% |
| 2016 | 1.12 | 180% | 413.37 | 3.01% |
| 2017 | 1.06 | -5% | 453.36 | 9.67% |
| 2018 | 0.74 | -30% | 506.61 | 11.75% |
| 2019 | 1.37 | 85% | 544.26 | 7.43% |
| 2020 | 1.88 | 37% | 501.79 | -7.80% |

Source: (Chinese enterprises' direct investment in Thailand by MA NINA HARNCHAIWAT   2017; world bank database)

Year   Total FDI of China (Billion USD)    FDI of China increase Rate     GDP of Thailand (Billion USD) GDP of Thailand (increase Rate)

According to above same function, it is easy to get ACGR of China outward FDI to Thailand is 10.54% from 2010 to 2020,

$$\text{CAGR}(t_0, t_n) = \left( \frac{V(t_n)}{V(t_0)} \right)^{\frac{1}{t_n - t_0}} - 1$$

= (Vtn/Vt0) 1/tn-t0 -1= (1.88/0.69)1/10-1=10.54%

Based on China outward FDI contribution to Thailand GDP function is Y=K*(Yx-Yx-1)/Yx-1*100%

Y is Thailand's GDP growth Rate which China outward FDI growth rate contribution to Proportion of growth rate of Thailand GDP by year;

$$\text{CAGR}(t_0, t_n) = \left( \frac{V(t_n)}{V(t_0)} \right)^{\frac{1}{t_n - t_0}} - 1$$

Same as last And ACGR of Thailand GDP is 3.935%

 =(Vtn/Vt0 ) 1/tn-t0 -1=(501.79/341.1) 1/10-1=3.935%

Y=K*(Yx-Yx-1)/Yx-1*100%

Therefore, China outward FDI contribute to Thailand GDP growth rate is absolute Value Y=GDP growth Rate= 0.023498%*10.54%=0.2475%

At same time, Thailand GDP CAGR is 3.935% from 2010 to 2020, that mean China outward FDI is contribution to Proportion of Thailand GDP is 0.2475%/3.935%=6.29% during this period.

4.2 Questionnaire Survey - the survey collects the information about the Rayong China-Thai industry park satisfaction Survey report.

The satisfaction questionnaire is divided into six parts, namely:
1.  Campus geography and traffic satisfaction
2.  Market factors
3.  Government factors
4.  Social and cultural
5.  Political factors
6.  Financial factors

Through this survey report, hope to understand what is enterprise really concern and what the Detail as below report. through analyses the survey report, there are two issues need be improved:
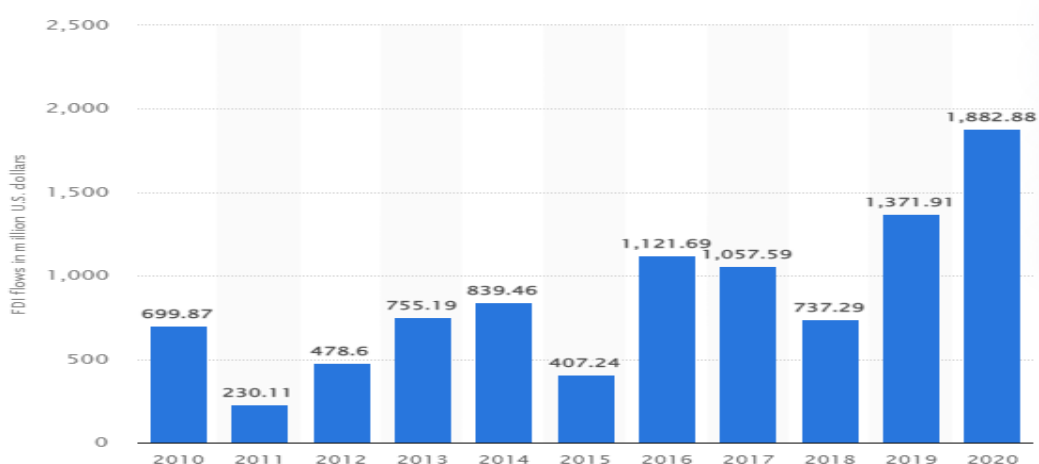


4.2.1 Data acquisition

In order to further improve the service quality of the industrial park, The Thailand-China Rayong Industrial Park conducted a satisfaction survey on the park for 125 enterprises (82 in production and 43 in preparation) that have entered the park and have started the project operation and preparation period. At present, 79 receipts have been received, and the questionnaire recovery rate is 63.2%.

4.3 Satisfaction Survey Report Summary:

In summary, the average score of the satisfaction survey of the first and sixth parts of the park is 92.15 points. The higher score of satisfaction lead to China outward FDI keeping growth in Thailand, the FDI CAGR (Compound annual growth rate) almost 10.54% each year from 2010 to 2020

As Eastern Economic Corridor, the Thai-Chinese Rayong Industrial Park is the largest Chinese-funded industrial park in Thailand, even Southeast Asia, and with its excellent location advantages and perfect infrastructure, it is attracting more and more Chinese enterprises to invest in Thailand, is the first platform for Chinese enterprises to invest in Thailand, and has become the industrial agglomeration center and manufacturing export base of China's traditional advantageous industries in Thailand. An important platform for capacity cooperation between China and ASEAN.

This survey report is aimed at the satisfaction survey of Chinese enterprises in industrial parks, which will help speed up the construction process of Thailand's Eastern Economic Corridor, so that the industrial park and the local Rayong government can better serve Chinese enterprises investing in Thailand and become high-quality promotion    Therefore, an in-depth analysis of the development model of    Rayong Industrial Park and the evaluation of benefits can provide replicable experience for the construction and development of China's overseas economic and trade cooperation zones. The development model and investment of The Thailand-China Rayong Industrial Park are more satisfied with the geographical location, infrastructure, and Thai government services, while the recruitment channels and training of labor, the upstream and downstream industrial chain of the park, and the supply of materials and machinery and equipment are higher The satisfaction of the chain is not enough, showing that these two parts are not strong enough, and there is still room for development, in the future development of the park, it can be appropriately targeted for the upstream and downstream industrial chain to attract investment, expand labor recruitment channels, increase labor knowledge training, vigorously develop, strive to forge ahead, and successfully build a cradle of investment in Southeast Asian Chinese-funded enterprises and a beautiful business card of Chinese enterprises standing in overseas industrial parks.

4.4 Empirical Findings for the Satisfaction Survey Report

Opinions and suggestions on the Thai-Chinese Rayong Industrial Park：

According to statistics, the proportion of respondents to the views and suggestions of the resident enterprises on the Industrial Park was only 12.66%, mainly summarized in the following four areas:

4.4.1 TC Apartments: Want to add gym and swimming pool.

4.4.2 Traffic: the park commute traffic congestion, for the safety of traffic to consider the single lane part of the hope to expand to two lanes, improve the ability of traffic support.

4.4.3 Operational training: hope to organize regular business operations training, improve the level of enterprises, such as: taxation, personnel, production, and other knowledge training. Labor human resource supply: understand the needs of professional and technical personnel, provide more professional and technical personnel recruit menthanes, to attract more skill person to work in the park

**5. CONCLUSION**

**Hypothesis 1:** China's outward FDI is helpful for Thailand's GDP growth, through this paper analysis 4.1.4 GDP Thailand growth Rate analysis for China outward FDI in Thailand from 2003 to 2014, China outward FDI is contribution to growth rate proportion of Thailand GDP more than 11.02% during this period. and 4.1.5 GDP Thailand growth Rate analysis for China outward FDI in Thailand from 2010 to 2020, that mean China outward FDI is contribution to growth rate proportion of Thailand GDP is 0.2475%/3.935%=6.29% during this period

Therefore: the hypothesis China outward FDI keeping growth is helpful for Thailand GDP growth, the hypothesis is correct.

**Hypothesis 2:** the overall FDI Chinese companies' satisfaction level can significantly influence factors for investors' future business in Thailand, Chinese investors" satisfaction level has positive relation to their future business plan in Thailand

This paper through case study the Chinese FDI enterprise investor in Thai-Rayong industry Park, and release the satisfaction survey report, then analysis this report, the average score is 92.15 points, this high score led to more and more Chinese FDI keeping growth, the growth rate of FDI is 10.54%, that mean 3.1 hypothesis 2 is correct as well.

**Limitations and suggestions for further research**

5.2.1 Due to the Covid-19, the satisfaction Survey report just 2020 for The Thai-Chinese industry Park, based on research continuity requirement, the better way is trying to survey for three years to compare the satisfaction of Chinese outward FDI investor's level is better or worse during the three years;

5.2.2 Don't use the SPSS analysis the satisfaction survey report, just use the original data to analysis.

**Acknowledgements**

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# Student Views on the Use of Textbooks in Secondary Education

Monika MITHANS[a], Polona JANČIČ HEGEDIŠ [b*],
Milena IVANUŠ GRMEK [c]

[a] *University of Maribor, Faculty of Education, Koroška cesta 160, 2000 Maribor, Slovenia,*
*monika.mithans1@um.si*
[b] *University of Maribor, Faculty of Education, Koroška cesta 160, 2000 Maribor, Slovenia,*
*polona.jancic1@um.si*
[c] *University of Maribor, Faculty of Education, Koroška cesta 160, 2000 Maribor, Slovenia,*
*milena.grmek@um.si*

**Abstract**

The project *Improving the Quality of Slovene Textbooks* (KaUč) has been carried out in Slovenia since 2017 and is to be completed in 2022. It is financed by the Republic of Slovenia and the European Union from the European Social Fund. The project's main objective is to develop textbook quality indicators for practical use in the validation and evaluation processes. In the project's first phase, it was necessary to examine the use of textbooks in schools. The research presented in this article deals with an examination of textbook usage for particular subjects and is based on the questionnaire responses by secondary school students. We wished to explore the use of different types of textbooks, how often textbooks and workbooks are used, and students' personal preferences. The results of our research show that the use of the printed textbook is most frequently used for all subjects. Students report that in class, they most often use the textbook for foreign language 1 and at home, the textbook for geography. Additionally, students' responses show that both at home as well as in class, they most frequently use the workbook for foreign languages 1 and 2, geography, Slovenian language and chemistry. For other subjects, most students claim they never use the workbook either in class or at home. Moreover, the results show that they use the workbook more often at school than at home for Slovenian language, foreign languages 1 and 2, geography, chemistry and biology. Based on the results, we also find that the majority of students mostly prefer and use the geography textbook, which is ranked the most positively according to various criteria. When preparing for knowledge assessment, students most often use textbooks and school notebooks.

**Keywords:** textbook, secondary school, instruction, students, didactics

## 1. INTRODUCTION

The first step in choosing a career path is by entering secondary education. Secondary education enables students to acquire valuable knowledge and experience for either entering the labour market or acquiring further higher-vocational, higher or university education. Secondary education in Slovenia is divided into general, vocational and technical education. General secondary education is provided by general and technical "gimnazija" schools. Lower and upper secondary vocational education and secondary technical education are provided by vocational and technical schools, while practical training is provided in collaboration between schools and employers. Three secondary schools participated in the project *Improving the Quality of Slovene Textbooks*, namely two general and one vocational secondary school. In the pages that follow, we will introduce the use of textbooks in the educational process and present empirical research, which examines the use of textbooks in secondary schools.

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\* Corresponding author.

## 2. THE USE OF TEXTBOOKS

Ivanuš Grmek [1] defines the textbook as a significant learning book, in which science and/or a certain discipline is transformed in a way that is accessible to all students. In Slovenia, the methods and procedures for the approval of textbooks are determined by the Rules on the Approval of Textbooks. The 2nd Article of the Rules on the Approval of Textbooks (2015) defines the textbook as the basic learning material for the achievement of educational objectives and standards of knowledge, as determined in the curriculum and the catalogue of knowledge [2].

Textbooks must be written in accordance with the curriculum of the particular subject and the level of education for which they are intended. The content and scope of the problems covered in a textbook must be appropriate for the developmental level of students. The textbook's level of difficulty must be adapted to the average student of a particular developmental level [1].

Thus, textbooks have a significant impact on implementing curricular intentions [3] and consequently play a decisive role in teaching school subjects [4]. They represent a source of official knowledge that is considered relevant and objective and is therefore subject to mechanisms of social control [5].

As a fundamental instruction tool [5], the textbook can be used for both, teaching as well as learning [6]. It is a versatile and accessible resource that both students and teachers can utilize according to their needs [7]. Its content and structure must enable independent learning and acquisition of different levels and types of knowledge [2]. Moreover, the textbook is a learning resource that students utilize for independent learning and reinforcing the learnt content [5]. Simultaneously, it should motivate students to learn [8].

In Slovenian school practice, we also work with textbook sets, which include a textbook, workbook, teacher's book and other didactic material and lessons. The main purpose of textbook sets is to make the learning material more accessible to students [1]. As Jurman [9] points out, lessons without textbook sets would be abstract and verbal, and above all, significantly impoverished in terms of information structure.

While the textbook and the teacher's explanations used to be the only source of information for students in the past, nowadays, the textbook is no longer the sole provider of learning content [10]. Additionally, a number of people consider the textbook as a leftover from another time, which raises the question of whether the classic textbook is still necessary as a central source of knowledge [6].

However, the fact that the textbook continues to be the basic school book, which students use on a daily basis, should not be ignored [1,11]. This is the reason the textbook continues to play an important role in educational practice [12, 13]. Nevertheless, students should be guided through the textbook's learning content. Despite the fact that the textbook's learning content follows their prior knowledge and developmental characteristics, students would not be able to acquire the target knowledge by using the textbook independently and without guidance. In order to adapt to their students more easily and to enable more varied lessons, teachers can use modern learning technology. Additionally, teachers can select among several different textbooks available for a particular subject and choose a textbook that is suitable for both, their teaching style as well as the specific characteristics of their students [14, 15].

The role of the textbook in the educational system has been changing. Its didactic function dominated in the past, however, the textbook has become part of didactic-methodical approaches, which promote educational, informative, conative, cognitive and emotional functions [9]. In addition to imparting knowledge, textbooks enable the development of skills, abilities and values [16].

High-quality textbooks are an important factor in ensuring the quality of the entire educational process [17]. That fact serves as the motivation for selecting this topic as the focus of our research.

## 3. EMPIRICAL RESEARCH

### 3.1. Research purpose

As part of the *Improving the Quality of Slovene Textbooks* project, the purpose of this research is to examine textbook use on a sample of secondary students from the following perspectives:

1.) The use of textbooks: textbook type, frequency of textbook use in class and at home, and personal preferences.

2.) Characteristics that students assign to textbooks.

Our research includes textbooks for all general subjects in secondary schools, such as SLO, MATH, FL 1 and 2, ARTS, MUSIC, HIST, ART HIST, GEOG, SOC, PSY, PHIL, PHYS, CHEM, BIOL and INFSCI[1].

*3.2. Methodology*

The approach to empirical research adopted for this study was a non-experimental descriptive approach.

*3.3. Research Sample*

649 students from three secondary schools and from three different regions participated in the survey. The research sample includes 187 (28.9%) boys and 461 (71.7%) girls. The average age of the surveyed students is 16.46 years (MIN = 15, MAX = 19, SD = 0.99). 217 (33.5%) students are $1^{st}$-year students, 205 (31.6%) are $2^{nd}$-year students, and 226 (34.9%) are $3^{rd}$-year students. The average student achievement score in the past school year was 4.07 (MIN = 1, MAX = 5, SD = 0.84).

In order to roughly assess the socio-economic situation of participating students, we obtained additional data about the education, wealth and habits of the students' families. Student's reports about their parents' education show the following results:

- one (0.2%) student's father had not completed primary school education, while 23 (3.6%) students' mothers and 16 (2.5%) students' fathers completed primary school education;
- 129 (20.0%) students' mothers and 158 (24.7%) students' fathers completed secondary school education;
- 75 (11.6%) students' mothers and 97 (15.2%) students' fathers completed vocational education after secondary school;
- 92 (14.3%) students' mothers and 78 (12.2%) students' fathers completed higher education;
- 169 (26.2%) students' mothers and 129 (20.2%) students' fathers completed university education;
- 96 (14.9%) students' mothers and 90 (14.1%) students' fathers acquired a master's degree or doctorate;
- 61 (9.5%) students had no knowledge about their mother's and 71 (11.1%) about their father's education.

Furthermore, the majority of participating students report that they have their own room at home (87.6%), their own desk (95.9%), their own books (92.5%) and access to the internet (98.9%). 63.9% of students have their own magazines at home. 42.6% of students reported that they use a mobile phone over three hours a day; 48.7% use it from 1 to 3 hours, 8.2% for less than one hour and 0.5% claim they do not own a mobile phone. Several students also reported that they have neither a tablet (66.6%), a desktop computer (43.3%) nor a laptop computer (25.1%). From 27.3% to 50.5% of students use different types of computers for less than one hour a day; from 4.4% to 17.9% of students use them for one to three hours a day, and from 1.7% to 6.5% of students use computers more than three hours a day.

The majority of students (584 or 91.8%) report that they borrow textbooks at school, while a small percentage of students (52 or 8.2%) does not borrow textbooks at school.

*3.4. Data collection process*

The principal data source for our study was an online questionnaire, which consisted of sets of questions and rating scales.

The validity of the questionnaire is determined since it is based on current scientific knowledge and examined by practising teachers.

Additionally, the questionnaire includes precise, specific questions, and clear instructions for solving and answering probing questions.

The objectivity of the questionnaire is ensured by the fact that it was conducted electronically. The respondents completed the questionnaire individually and without the presence of the researcher. Additionally, it predominantly consists of closed-type questions that allow for an objective analysis of the answers.

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[1] Subject abbreviations: SLO – Slovenian language, MATH – mathematics, FL1 – foreign language 1, FL2 – foreign language 2, ART – arts, MUSIC – music, HIST – history, ARTHIST – art history, GEOG – geography, SOC – sociology, PSY – psychology, PHIL – philosophy, PHYS – physics, CHEM – chemistry, BIOL – biology, INFSCI – information science.

*3.5. Data processing procedures*

The data were processed by using descriptive statistical procedures, such as frequency distributions and basic descriptive statistics. To test the relationships between variables, we used certain measures of inferential statistics, such as the dependent samples t-test.

**4. RESULTS**

Our research results are presented in sub-chapters and in accordance with the aspects of the research problem. Firstly, we present the data related to the use of textbooks, such as the type of textbook, frequency of textbook use in class and at home, and students' personal preferences. Secondly, we present the data about the characteristics that students assign to textbooks.

*4.1. Textbook use by secondary students*

*4.1.1. Types of textbooks used by students in class*

Table 1 presents the students' answers to the question about what type of textbook they use for particular subjects.

Table 1. Types of textbooks students use for particular subjects

|  | printed textbook | | e-textbook | | printed and e-textbook | | no textbook | | I do not have the subject | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | f | f% | f | f% | f | f% | f | f% | f | f% | f | f% |
| SLO | 526 | 83.8 | 8 | 1.3 | 31 | 4.9 | 60 | 9.6 | 3 | 0.5 | 628 | 100 |
| MATH | 462 | 73.3 | 5 | 0.8 | 82 | 13.0 | 77 | 12.2 | 4 | 0.6 | 630 | 100 |
| FL1 | 546 | 86.7 | 4 | 0.6 | 41 | 6.5 | 32 | 5.1 | 7 | 1.1 | 630 | 100 |
| FL2 | 565 | 90.0 | 1 | 0.2 | 20 | 3.2 | 7 | 5.6 | 7 | 1.1 | 628 | 100 |
| ART | 167 | 26.5 | 5 | 0.8 | 3 | 0.5 | 279 | 44.3 | 176 | 27.9 | 630 | 100 |
| MUSIC | 337 | 53.7 | 2 | 0.3 | 1 | 0.2 | 27 | 4.3 | 261 | 41.6 | 628 | 100 |
| HIST | 325 | 51.6 | 15 | 2.4 | 24 | 3.8 | 206 | 32.7 | 60 | 9.5 | 630 | 100 |
| ARTHIST | 172 | 27.4 | 2 | 0.3 | 2 | 0.3 | 210 | 33.5 | 241 | 38.4 | 627 | 100 |
| GEOG | 523 | 83.1 | 5 | 0.8 | 15 | 2.4 | 33 | 5.2 | 53 | 8.4 | 629 | 100 |
| SOC | 159 | 25.2 | 5 | 0.8 | 1 | 0.2 | 80 | 12.7 | 386 | 61.2 | 361 | 100 |
| PSY | 87 | 14.0 | 1 | 0.2 | 2 | 0.3 | 107 | 17.2 | 425 | 68.3 | 622 | 100 |
| PHIL | 34 | 5.5 | 2 | 0.3 | 2 | 0.3 | 20 | 3.2 | 564 | 90.7 | 622 | 100 |
| PHIS | 317 | 50.6 | 16 | 2.6 | 31 | 4.9 | 181 | 28.9 | 82 | 13.1 | 627 | 100 |
| CHEM | 441 | 70.3 | 4 | 0.6 | 24 | 3.8 | 65 | 10.4 | 93 | 14.8 | 627 | 100 |
| BIOL | 479 | 76.4 | 3 | 0.5 | 16 | 2.6 | 48 | 7.7 | 81 | 12.9 | 627 | 100 |
| INFSCI | 112 | 18.0 | 17 | 2.7 | 10 | 1.6 | 135 | 21.7 | 347 | 55.9 | 621 | 100 |

As can be seen from Table 1, students mainly use printed textbooks for all subjects. A small percentage of students report that they use the e-textbook, mostly for subjects such as history, physics and information science. A slightly higher percentage of students use both printed and e-textbooks, especially for mathematics, foreign language 1 and physics. A fairly high percentage of students do not use any textbooks, mostly for subjects such as fine arts, art history, history, physics and information science.

*4.1.2. The frequency of textbook and workbook use*

The frequency of textbook use

Table 2 presents the students' answers to the question about how frequently they use textbooks for particular subjects at home and in class.

Table 2. Frequency of textbook use for particular subjects in class and at home: frequencies and descriptive statistics

| | 1 – never | | 2 – occasionally | | 3 – frequently | | 4 – always | | M | | SD | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In class f;f% | At home f; f% | In class f; f% | At home f; f% | In class f ; f% | At home f; f% | In class f ; f % | At home f; f% | In class | At home | In class | At home |
| **SLO** | 105; 16.7 | 137; 22.2 | 285; 45.5 | 252; 40.8 | 167; 26.6 | 138; 22.3 | 71; 11.3 | 91; 14.7 | 2.32 | 2.30 | 0.88 | 0.97 |
| **MATH** | 245; 39.0 | 106; 17.3 | 176; 28.0 | 188; 30.6 | 138; 22.0 | 191; 31.1 | 69; 11.0 | 129; 21.0 | 2.05 | 2.56 | 1.02 | 1.01 |
| **FL1** | 40; 6.4 | 99; 16.1 | 108; 17.2 | 175; 28.5 | 236; 37.6 | 186; 30.3 | 243; 38.8 | 154; 25.1 | 3.09 | 2.64 | 0.90 | 1.03 |
| **FL2** | 34; 5.5 | 89; 14.7 | 134; 21.6 | 177; 29.2 | 218; 35.1 | 179; 29.5 | 235; 37.8 | 162; 26.7 | 3.05 | 2.68 | 0.90 | 1.02 |
| **ART** | 300; 72.5 | 285; 71.3 | 91; 22.0 | 77; 18.8 | 15; 3.6 | 25; 6.3 | 8; 1.9 | 15; 3.8 | 1.35 | 1.43 | 0.65 | 0.77 |
| **MUSIC** | 81; 21.4 | 64; 17.3 | 181; 47.8 | 147; 39.8 | 84; 22.2 | 87; 23.6 | 33; 8.7 | 71; 19.2 | 2.18 | 2.45 | 0.87 | 0.99 |
| **HIST** | 333; 58.1 | 252; 45.7 | 144; 25.1 | 130; 23.6 | 68; 11.9 | 97; 17.6 | 28; 4.9 | 72; 13.1 | 1.64 | 1.98 | 0.87 | 1.08 |
| **ARTHIST** | 290; 75.9 | 243; 66.2 | 65; 17.0 | 72; 19.6 | 20; 5.2 | 34; 9.3 | 7; 1.8 | 18; 4.9 | 1.33 | 1.53 | 0.66 | 0.86 |
| **GEOG** | 64; 11.2 | 74; 13.6 | 160; 28.1 | 92; 16.8 | 167; 29.3 | 135; 24.7 | 178; 31.3 | 245; 44.9 | 2.81 | 3.01 | 1.00 | 1.08 |
| **SOC** | 139; 62.3 | 106; 45.9 | 56; 25.1 | 77; 33.3 | 17; 7.6 | 27; 11.7 | 11; 4.9 | 21; 9.1 | 1.55 | 1.84 | 0.84 | 0.96 |
| **PSY** | 154; 77.0 | 132; 62.6 | 29; 14.5 | 42; 19.9 | 9; 4.5 | 24; 11.4 | 8; 4.0 | 13; 6.2 | 1.36 | 1.61 | 0.75 | 0.92 |
| **PHIL** | 38; 50.7 | 50; 54.3 | 18; 24.0 | 17; 18.5 | 9; 12.0 | 18; 19.6 | 10; 13.3 | 7; 7.6 | 1.88 | 1.80 | 1.08 | 1.01 |
| **PHYS** | 307; 56.7 | 175; 33.1 | 167; 30.9 | 216; 40.8 | 49; 9.1 | 86; 16.3 | 18; 3.3 | 52; 9.8 | 1.59 | 2.03 | 0.79 | 0.94 |
| **CHEM** | 173; 32.3 | 97; 18.6 | 185; 34.6 | 154; 29.5 | 119; 22.2 | 148; 28.4 | 58; 10.8 | 123; 23.6 | 2.12 | 2.57 | 0.98 | 1.04 |
| **BIOL** | 203; 37.4 | 83; 15.6 | 200; 36.8 | 175; 33.0 | 99; 18.2 | 149; 28.1 | 41; 7.6 | 124; 23.4 | 1.96 | 2.59 | 0.93 | 1.01 |
| **INFSCI** | 175; 63.2 | 178; 60.5 | 77; 27.8 | 79; 26.9 | 15; 5.4 | 23; 7.8 | 10; 3.6 | 14; 4.8 | 1.49 | 1.57 | 0.76 | 0.83 |

As shown in Table 2, students most frequently use textbooks for foreign language 1 in class, followed by foreign language 2, geography, Slovenian language, music, chemistry, mathematics, biology, philosophy, history, physics, sociology, information science, psychology, arts and art history. On the other hand, students report that at home, they most frequently use the geography textbook, followed by textbooks for foreign language 2, foreign language 1, mathematics, biology, chemistry, music, Slovenian language, physics, history, sociology, philosophy, psychology, information science, art history and arts.

We also examined whether there are statistically significant differences in textbook use for particular subjects in class and at home. The results of the dependent samples t-test indicate that there are no statistically significant differences in the frequency of textbook use at home and in class for Slovenian language ($t_{SLO}$ = 1.033; $df_{SLO}$ = 611; $p_{SLO}$ = 0.302) and philosophy ($t_{PHIL}$ = -0.778; $df_{PHIL}$ = 46; $p_{PHIL}$ = 0.441). For both foreign languages, statistically significant differences are found as students use textbooks more frequently in class than at home ($t_{FL1}$ = 11.705; $df_{FL1}$ = 608; $p_{FL1}$ = 0.000; $t_{FL2}$ = 9.780; $df_{FL2}$ = 597; $p_{FL2}$ = 0.000). Additionally, statistically significant differences are found for all other subjects, as the students report more frequent textbook use at home than in class ($t_{MATH}$ = -10.827; $df_{MATH}$ = 609; $p_{MATH}$ = 0.000; $t_{ART}$ = -2.527; $df_{ART}$ = 370; $p_{ART}$ = 0.012; $t_{MUSIC}$ = -5.103; $df_{MUSIC}$ = 345; $p_{MUSIC}$ = 0.000; $t_{HIST}$ = -9.079; $df_{HIST}$ = 538; $p_{HIST}$ = 0.000; $t_{ARTHIST}$ = -5.373; $df_{ARTHIST}$ = 338; $p_{ARTHIST}$ = 0.000; $t_{GEOG}$ = -4.654; $df_{GEOG}$ = 531; $p_{GEOG}$ = 0.000; $t_{SOC}$ = -5.315; $df_{SOC}$ = 197; $p_{SOC}$ = 0.000; $t_{PSY}$ = -5.430; $df_{PSY}$ = 177; $p_{PSY}$ = 0.000; $t_{PHYS}$ = -11.984; $df_{PHYS}$ = 514; $p_{PHYS}$ = 0.000; $t_{CHEM}$ = -10.233; $df_{CHEM}$ = 504; $p_{CHEM}$ = 0.000; $t_{BIOL}$ = -12.402; $df_{BIOL}$ = 517; $p_{BIOL}$ = 0.000; $t_{INFSCI}$ = -2.504; $df_{INFSCI}$ = 250; $p_{INFSCI}$ = 0.013).

The frequency of workbook use

Table 3 presents students' answers to the question about how frequently they use the workbook for particular subjects in class and at home.

Table 3. Frequency of workbook use for particular subjects in class and at home: frequencies and descriptive statistics

| | 1 – never | | 2 – occasionally | | 3 – frequently | | 4 – always | | M | | SD | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In class f; f% | At home f; f% | In class f ; f% | At home f; f% | In class f ; f% | At home f; f% | In class f ; f% | At home f; f% | In class | At home | In class | At home |
| **SLO** | 176; 29.0 | 264; 45.4 | 245; 40.4 | 193; 33.2 | 143; 23.6 | 87; 14.9 | 43; 7.1 | 38; 6.5 | 2.09 | 1.83 | 0.90 | 0.91 |
| **MATH** | 489; 81.6 | 465; 80.9 | 54; 9.0 | 54; 9.4 | 35; 5.8 | 33; 5.7 | 21; 3.5 | 23; 4.0 | 1.31 | 1.33 | 0.74 | 0.76 |
| **FL1** | 61; 10.2 | 139; 24.3 | 141; 23.6 | 187; 32.6 | 235; 39.3 | 151; 26.4 | 161; 26.9 | 96; 16.8 | 2.83 | 2.36 | 0.94 | 1.02 |
| **FL2** | 151; 25.5 | 200; 35.3 | 142; 24.0 | 149; 26.3 | 182; 30.8 | 143; 25.2 | 116; 19.6 | 75; 13.2 | 2.45 | 2.16 | 1.07 | 1.05 |
| **ART** | 345; 89.6 | 348; 89.7 | 22; 5.7 | 21; 5.4 | 11; 2.9 | 21; 3.1 | 7; 1.8 | 7; 1.8 | 1.17 | 1.17 | 0.55 | 0.56 |
| **MUSIC** | 328; 88.9 | 324; 88.5 | 24; 6.5 | 26; 7.1 | 9; 2.4 | 11; 3.0 | 8; 2.2 | 5; 1.4 | 1.18 | 1.17 | 0.57 | 0.53 |
| **HIST** | 495; 90.8 | 473; 92.0 | 25; 4.6 | 21; 4.1 | 14; 2.6 | 14; 2.7 | 11; 2.0 | 6; 1.2 | 1.16 | 1.13 | 0.55 | 0.49 |
| **ARTHIST** | 344; 91.0 | 323; 89.0 | 21; 5.6 | 26; 7.2 | 7; 1.9 | 6; 1.7 | 6; 1.6 | 8; 1.2 | 1.14 | 1.17 | 0.50 | 0.56 |
| **GEOG** | 114; 20.7 | 172; 33.2 | 148; 26.9 | 173; 33.4 | 189; 34.4 | 120; 23.2 | 99; 18.0 | 53; 10.2 | 2.50 | 2.10 | 1.01 | 0.98 |
| **SOC** | 207; 88.1 | 199; 85.0 | 16; 6.8 | 18; 7.7 | 9; 3.8 | 13; 5.6 | 3; 1.3 | 4; 1.7 | 1.18 | 1.24 | 0.55 | 0.63 |
| **PSY** | 180; 86.1 | 191; 88.4 | 17; 8.1 | 12; 5.6 | 8; 3.8 | 9; 4.2 | 4; 1.9 | 4; 1.9 | 1.22 | 1.19 | 0.60 | 0.59 |
| **PHIL** | 84; 75.0 | 102; 76.7 | 15; 13.4 | 12; 9.0 | 6; 5.4 | 12; 9.0 | 7; 6.3 | 7; 5.3 | 1.43 | 1.43 | 0.86 | 0.86 |
| **PHYS** | 467; 90.7 | 451; 91.9 | 32; 6.2 | 24; 4.9 | 10; 1.9 | 12; 2.4 | 6; 1.2 | 4; 0.8 | 1.14 | 1.12 | 0.48 | 0.45 |
| **CHEM** | 203; 39.3 | 227; 46.1 | 90; 17.4 | 86; 17.5 | 142; 27.5 | 111; 22.6 | 81; 15.7 | 68; 13.8 | 2.20 | 2.04 | 1.12 | 1.11 |
| **BIOL** | 465; 89.1 | 462; 92.6 | 40; 7.7 | 20; 4.0 | 9; 1.7 | 14; 2.8 | 8; 1.5 | 3; 0.6 | 1.16 | 1.11 | 0.51 | 0.44 |
| **INFSCI** | 258; 85.7 | 259; 86.6 | 27; 9.0 | 25; 8.4 | 10; 3.3 | 8; 2.7 | 6; 2.0 | 7; 2.3 | 1.22 | 1.21 | 0.60 | 0.60 |

Table 3 presents students' reports about the frequency of workbook use for particular subjects in class and at home. As the results indicate, students most frequently use the workbook both in class and at home for both foreign languages, geography, Slovenian language and chemistry. The majority of students never use the workbook in class or at home for all other subjects.

With the dependent samples t-test, we examined whether statistically significant differences occur in the frequency of workbook use for particular subjects in class or at home. The results indicate that there are no statistically significant differences for mathematics ($t_{MATH} = -0.571$; $df_{MATH} = 561$; $p_{MATH} = 0.568$), arts ($t_{ART} = 0.000$; $df_{ART} = 349$; $p_{ART} = 1.000$), music ($t_{MUSIC} = -0.458$; $df_{MUSIC} = 333$; $p_{MUSIC} = 0.647$), history ($t_{HIST} = -0.954$; $df_{HIST} = 499$; $p_{HIST} = 0.341$), art history ($t_{ARTHIST} = -1.232$; $df_{ARTHIST} = 339$; $p_{ARTHIST} = 0.219$), sociology ($t_{SOC} = -1.978$; $df_{SOC} = 198$; $p_{SOC} = 0.051$), psychology ($t_{PSY} = -0.277$; $df_{PSY} = 182$; $p_{PSY} = 0.782$), philosophy ($t_{PHIL} = -0.000$; $df_{PHIL} = 46$; $p_{PHIL} = 1.000$), information science ($t_{INFSCI} = -0.288$; $df_{INFSCI} = 261$; $p_{INFSCI} = 0.773$) and physics ($t_{PHYS} = 0.727$; $df_{PHYS} = 473$; $p_{PHYS} = 0.467$). Statistically significant differences occur for subjects such as Slovenian language ($t_{SLO} = 8,937$; $df_{SLO} = 570$; $p_{SLO} = 0,000$), foreign language 1 ($t_{FL1} = 12,898$; $df_{FL1} = 554$; $p_{FL1} = 0,000$), foreign language 2 ($t_{FL2} = 8,772$; $df_{FL2} = $

550; $p_{FL2}$ = 0,000), geography ($t_{GEOG}$ = 9,810; $df_{GEOG}$ = 504; $p_{GEOG}$ = 0,000), chemistry ($t_{CHEM}$ = 3,840; $df_{CHEM}$ = 473; $p_{CHEM}$ = 0,000) and biology ($t_{BIOL}$ = 2,690; $df_{BIOL}$ = 479; $p_{BIOL}$ = 0,007), as students report that they more frequently use workbooks for these subjects at home than in class.

When asked which textbook they use most frequently, the majority of students answered that they most often use the geography textbook (310), followed by the mathematics textbook (108), English language (95), chemistry (43), biology (39), German language (28), Slovenian language (22), history (20), physics (8), Russian language (6), music (2), French language (1), philosophy (1) and Italian language (1) textbooks.

### 4.1.3. Students' personal preferences

When asked which textbook they prefer the most, the majority of students selected the geography textbook (207), followed by the chemistry textbook (84), English language (73), biology (51), mathematics (35), Slovenian language (27), history (24), music (21), German language (14), Spanish language (12), Russian language (12), Italian language (7), physics (5), sociology (2), French language (1), psychology (1) and arts (1) textbooks.

### 4.2. Characteristics that students assign to textbooks

Tables 4 and 5 present students' evaluation of textbooks for different subjects according to different aspects. Students evaluated whether a textbook for a certain subject corresponds to the description given in the questionnaire. Tables 4 and 5 show the frequencies and proportions of how many times a particular textbook was selected to correspond to the given description. Textbooks for all subjects were evaluated by all students, even the students who are not learning certain subjects in their classes. As expected, these students did not attribute the above-mentioned characteristics to textbooks. Thus, the percentages in these sections are lower.

Table 4. Characteristics students assign to textbooks for SLO, MATH, FL1, FL2, ART, MUSIC, HIST and ARTHIST: frequencies and percentages

| *Textbook characteristics* | SLO f; f% | MATH f; f% | FL1 f; f% | FL2 f; f% | ART f; f% | MUSIC f; f% | HIST f; f% | ARTHIST f; f % |
|---|---|---|---|---|---|---|---|---|
| The textbook is relevant to my needs and interests | 210; 41.2 | 218; 42.7 | 263; **51.5** | 220; 43.1 | 49; 9.6 | 107; 21.0 | 134; 26.3 | 48; 9.4 |
| The textbook is relevant to everyday life. | 132; 32.4 | 82; 20.1 | 216; **52.9** | 144; 35.3 | 35; 8.6 | 59; 14.5 | 49; 12.0 | 18; 4.4 |
| The textbook encourages me to find the reasons for certain phenomena and to analyse and explain them. | 64; 18.1 | 118; 33.3 | 97; 27.4 | 71; 20.1 | 44; 12.4 | 44; 12.4 | 85; 24.0 | 27; 7.6 |
| The textbook motivates me and stimulates my mental activity. | 65; 16.3 | 165; 41.4 | 143; 35.8 | 102; 25.6 | 40; 10.0 | 56; 14.0 | 74; 18.5 | 13; 3.3 |
| The textbook encourages me to look for new ideas in order to solve certain problems. | 44; 11.9 | 193; **52.3** | 82; 22.2 | 55; 14.9 | 50; 13.6 | 31; 8.4 | 48; 13.0 | 12; 3.3 |
| The textbook enables me to meaningfully connect knowledge between different subjects. | 114; 17.6 | 110; 28.2 | 141; 36.2 | 97; 24.9 | 62; 15.9 | 79; 20.3 | 103; 26.4 | 35; 9.0 |
| The textbook allows me to meaningfully connect my knowledge with new content within a particular subject. | 269; 35.2 | 180; 43.4 | 168; 40.5 | 129; 31.1 | 54; 13.0 | 82; 19.8 | 100; 24.1 | 28; 6.7 |
| I can find the necessary data and information in the textbook | 253; 41.7 | 177; 40.8 | 182; 41.9 | 150; 34.6 | 60; 13.8 | 107; 24.7 | 118; 27.2 | 44; 10.1 |
| The textbook encourages me to search for information on the internet. | 69; 10.6 | 83; 25.4 | 108; 33.0 | 97; 29.7 | 48; 14.7 | 50; 15.3 | 63; 19.3 | 24; 7.3 |
| The textbook is based on and/or follows my prior knowledge. | 181; 43.7 | 171; 41.3 | 191; 46.1 | 117; 28.3 | 54; 13.0 | 77; 18.6 | 85; 20.5 | 23; 5.6 |
| The textbook enables me to learn in different ways. | 108; 30.1 | 136; 37.9 | 155; 43.2 | 119; 33.1 | 47; 13.1 | 69; 19.2 | 66; 18.4 | 18; 5.0 |
| The textbook photos, pictures, sketches and graphics help me learn. | 139; 32.0 | 179; 41.2 | 180; 41.5 | 161; 37.1 | 89; 20.5 | 118; 27.2 | 123; 28.3 | 72; 16.6 |
| By using the textbook, I am getting used to independent learning. | 140; 36.9 | 162; 42.7 | 161; 42.5 | 129; 34.0 | 73; 19.3 | 73; 19.3 | 84; 22.2 | 42; 11.1 |
| The textbook encourages me to develop various reading strategies. | 155; 43.4 | 62; 17.4 | 136; 38.1 | 106; 29.7 | 48; 13.4 | 57; 16.0 | 66; 18.5 | 27; 7.6 |
| The textbook helps me develop different types of communication. | 121; 36.3 | 55; 16.5 | 156; 46.8 | 123; 36.9 | 47; 14.1 | 51; 15.3 | 34; 10.2 | 13; 3.9 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| The textbook improves my vocabulary. | 244; **54.8** | 72; 16.2 | 222; 49.9 | 173; 38.9 | 42; 9.4 | 62; 13.9 | 67; 15.1 | 26; 5.8 |

*Note: Percentages above 50% are marked in bold.*

Table 5. Characteristics students assign to textbooks for GEOG, PHIL, SOC, PSY, INFSCI, PHYS, CHEM, and BIOL: frequencies and percentages

| *Textbook characteristics* | GEOG f; f% | PHIL f; f% | SOC f; f% | PSY f; f% | INFSC I f; f% | PHYS f; f% | CHE M f; f% | BIOL f; f% |
|---|---|---|---|---|---|---|---|---|
| The textbook is relevant to my needs and interests | 246; **62.8** | 40; 10.2 | 42; 10.7 | 54; 13.8 | 47; 12.0 | 75; 19.1 | 156; 39.8 | 150; 38.3 |
| The textbook is relevant to everyday life. | 222; **58.3** | 32; 8.3 | 54; 14.0 | 60; 15.5 | 44; 11.4 | 84; 21.8 | 109; 28.2 | 153; 39.6 |
| The textbook encourages me to find the reasons for certain phenomena and to analyse and explain them. | 171; 48.2 | 32; 9.0 | 25; 7.0 | 44; 12.4 | 30; 8.5 | 83; 23.4 | 121; 34.1 | 126; 35.5 |
| The textbook motivates me and stimulates my mental activity. | 154; 46.2 | 33; 9.9 | 32; 9.6 | 38; 11.4 | 33; 9.9 | 74; 22.2 | 102; 30.6 | 120; 36.0 |
| The textbook encourages me to look for new ideas in order to solve certain problems. | 109; 34.8 | 30; 9.6 | 29; 9.3 | 29; 9.3 | 35; 11.2 | 88; 28.1 | 96; 30.7 | 85; 27.2 |
| The textbook enables me to meaningfully connect knowledge between different subjects. | 167; 47.6 | 26; 7.4 | 39; 11.1 | 40; 11.4 | 41; 11.7 | 79; 22.5 | 114; 32.5 | 132; 37.6 |
| The textbook allows me to meaningfully connect my knowledge with new content within a particular subject. | 193; **53.5** | 41; 11.4 | 35; 9.7 | 43; 11.9 | 28; 7.8 | 77; 21.3 | 132; 36.6 | 128; 35.5 |
| I can find the necessary data and information in the textbook | 211; **57.3** | 35; 9.5 | 30; 8.2 | 45; 12.2 | 41; 11.1 | 91; 24.7 | 134; 36.4 | 139; 37.8 |
| The textbook encourages me to search for information on the internet. | 113; 38.8 | 29; 10.0 | 30; 10.3 | 31; 10.7 | 37; 12.7 | 68; 23.4 | 73; 25.1 | 78; 26.8 |
| The textbook is based on and/or follows my prior knowledge. | 179; **50.4** | 34; 9.6 | 31; 8.7 | 31; 8.7 | 32; 9.0 | 85; 23.9 | 128; 36.1 | 113; 31.8 |
| The textbook enables me to learn in different ways. | 150; **50.0** | 29; 9.7 | 32; 10.7 | 28; 9.3 | 29; 9.7 | 69; 23.0 | 83; 27.7 | 85; 28.3 |
| The textbook photos, pictures, sketches and graphics help me learn. | 223; **58.5** | 27; 7.1 | 34; 8.9 | 40; 10.5 | 36; 5.6 | 98; 25.7 | 145; 38.1 | 166; 43.6 |
| By using the textbook, I am getting used to independent learning. | 173; **52.4** | 29; 8.8 | 33; 10.0 | 32; 9.7 | 36; 10.9 | 68; 20.6 | 110; 33.3 | 112; 33.9 |
| The textbook encourages me to develop various reading strategies. | 130; 48.5 | 23; 8.6 | 22; 8.2 | 36; 13.4 | 29; 10.8 | 42; 15.7 | 70; 26.1 | 70; 26.1 |
| The textbook helps me develop different types of communication. | 105; 44.3 | 28; 11.8 | 24; 10.1 | 32; 13.5 | 38; 16.0 | 34; 14.3 | 60; 25.3 | 53; 22.4 |
| The textbook improves my vocabulary. | 158; **52.5** | 19; 6.3 | 36; 12.0 | 50; 16.6 | 37; 12.3 | 58; 19.3 | 84; 27.9 | 108; 35.9 |

*Note: Percentages above 50% are marked in bold.*

Tables 4 and 5 indicate that the majority of students do not assign the qualities listed in the tables above to most textbooks. As the results show, students assign the most positive attributes to the geography textbook. Additionally, the majority of students positively evaluated the foreign language 1, Slovenian language and mathematics textbooks.

The last question required students to select one subject and the learning materials they use when preparing for the assessment of knowledge for this subject. Students ranked the use of learning materials by frequency, 1 meaning the least frequently and 5 meaning the most frequently. As seen in Table 6 below, we did not divide the students' answers by particular subjects in our analysis since the questionnaire required students to enter the subject's title themselves. In doing so, they named the same subject differently, while also making language errors in their responses. Thus, in several cases, a single subject is given numerous different titles.

Table 6. The frequency of using particular learning materials when preparing for knowledge assessment

| Learning material | 1 f; f% | 2 f; f% | 3 f; f% | 4 f; f% | 5 f; f% |
|---|---|---|---|---|---|
| School notebook | 104; 19.6 | 43; 8.1 | 40; 7.5 | 82; 15.4 | 262; 49.3 |
| Textbook | 30; 5.7 | 77; 14.7 | 66; 12.6 | 189; 36.0 | 163; 31.0 |

| | | | | | |
|---|---|---|---|---|---|
| Content I find on websites | 100; | 176; | 143; | 75; | 28; |
| | 19.2 | 33.7 | 27.4 | 27.4 | 5.4 |
| Learning websites | 191; | 155; | 64; | 65; | 44; |
| | 36.8 | 29.9 | 12.3 | 12.5 | 8.5 |
| Workbook (study sheets, worksheets) | 100; | 71; | 210; | 100; | 32; |
| | 19.5 | 13.8 | 40.9 | 19.5 | 6.2 |

*Note: Students ranked the learning material according to frequency from 1 (least frequent) to 5 (most frequent).*

As seen in Table 6, students most frequently use school notebooks and textbooks when preparing for the examination and assessment of knowledge.

## 5. DISCUSSION WITH CONCLUSION

We examined the use of textbooks for particular subjects by surveying secondary school students, focusing on the use of different types of textbooks, the frequency of textbook and workbook use, and students' personal preferences. Based on the analysis results, we conclude that the use of printed textbooks prevails for all subjects, while only a small percentage of students use the e-textbook, either independently or in combination with a printed textbook. Additionally, students report they do not use the textbook for certain subjects at all. However, this study should be repeated in the future, as the present research is based on the data acquired in 2018, prior to the COVID-19 pandemic, during which the use of electronic materials was increased due to distance learning. With their "Analysis of Distance Education in Slovenia during the COVID-19 Epidemic", Rupnik Vec and co-authors [18] find that students most frequently used the textbook independently (72.9%) during the time of distance education. This finding further emphasizes the importance of the textbook for teaching and learning. Furthermore, in his research, Knight [19] notes that teachers in the current digital age still recognize textbooks as a reliable tool for students to access authentic information, broaden their understanding and develop critical thinking. However, the obtained research results also remind us that the use of textbooks has been changing and adapting according to current social conditions.

Results indicate that students most frequently use the textbook for foreign language 1 in class, and the textbook for geography at home. They use the workbook for both foreign languages, geography, Slovenian language and chemistry both in class as well as at home. Most students also report they never use the workbook for other subjects, neither in class nor at home. Our findings also revealed that there are no statistically significant differences in the frequency of textbook use in class or at home for Slovenian language and philosophy. Furthermore, there are statistically significant differences in the use of textbooks for both foreign languages in class and at home, as students report that they more frequently use the textbook in class than at home. For all other subjects, there are statistically significant differences in the use of textbooks in class or at home since students report that they more frequently use the textbooks at home than in class. Additionally, students more frequently use the workbook for Slovenian language, foreign language 1, foreign language 2, geography, chemistry and biology in class than at home. For other subjects, there are no statistically significant differences in the frequency of workbook use in class and at home. The majority of students report that they prefer and use the geography textbook the most. According to different criteria, the geography textbook is also the most positively rated. In a study conducted in Australia [20] authors found that most educational institutions prescribed textbooks as compulsory and important for subjects such as science, mathematics and education.

The results of our research further show that when preparing for knowledge assessment, students most frequently use the textbook and school notebook. In the Slovenian research conducted among secondary school students in 2015 [21], the authors examined what materials students use when preparing for the examination and assessment of knowledge for one subject, namely the Slovenian language. They found that when preparing for the oral examination of grammar and literature, the majority of students use the school notebook, while the majority of students use the textbook when preparing for a written test of grammar and literature. The frequency of using online resources and electronic media increases with age and the level of difficulty. The use of the school notebook is most common among students of vocational secondary schools, while the use of the textbook is most common among students of technical and general secondary schools.

The education process has been constantly developing and adapting to current social conditions, consequently altering the scope and methods of teaching materials, which certainly include textbooks. As previously mentioned above [18], an analysis was carried out for the Republic of Slovenia, which was related to textbook use during the first wave of distance learning due to the COVID-19 pandemic. Even after two years since the beginning of the COVID-19 pandemic, the results of this analysis have not been given, which is why we lack concrete data about the textbook type, the frequency of textbook use and students' textbook preferences. As a result, we shall repeat our research on the use of textbooks in the school year 2022/2023.

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# DEMATEL Technique for Agile Outsourcing Provider Evaluation in Information Technologies

Nazli GOKER[a*], Mehtap DURSUN [b]

[a] *Galatasaray University, Industrial Engineering Department, Ortakoy, Istanbul, Turkey, nagoker@gsu.edu.tr*
[b] *Galatasaray University, Industrial Engineering Department, Ortakoy, Istanbul, Turkey, mdursun@gsu.edu.tr*

**Abstract**

In project management, agility has been to deal with the shortcomings of traditional methodologies that are linear and sequential. An agile project contains both planned processes and iterations. In global competition, obtaining agile processes in outsourcing procedures allows the firms to keep up with the changes and dynamic issues. In this work, the factors that influence agile provider selection decision are evaluated, and their importance weights are determined through Decision Making Trial and Evaluation Laboratory (DEMATEL) technique. The application is illustrated through a case study, which is conducted in a white goods manufacturer that performs in Turkey.

**Keywords:** Agility, agile provider selection, DEMATEL, project management.

## 1. INTRODUCTION

Agile project management notion is launched in 2001 to deal with ineffectiveness in describing customer needs, managing the changes of the project requirements, and cost saving. It has been emerged from unpredictable properties of customer requirements, technologic progresses, and unstability of business problems [1]. At first, Waterfall project management methodology, which is linear and sequential, was used in managing the projects. Agile project management methodology has emerged to eliminate the shortcomings of Waterfall project management methodology. In an agile project, processes are planned and then managed in iterative manner. The outcomes achieved from an iteration lead to construct the following project stage [2].

In competitive global markets, agility concept has become more and more crucial in managerial processes. Correspondingly, agility in outsourcing processes has emerged in order to cope with changes and dynamic environment. Outsourcing process disintegrates the jobs by collaborating with a provider in lieu of insourcing an activity [3,4]. Recently, outsourcing has been a part of strategic management and operations management, although it was firstly employed in the early 1990s in information technologies (IT) to achieve cost savings and technical efficiency [5].

This work introduces a Decision-Making Trial and Evaluation Laboratory (DEMATEL) technique to determine the importance degrees of agile provider selection criteria. The presence of interrelationships among evaluation criteria in data led us to employ DEMATEL methodology as an appropriate tool.

The remaining sections of the paper are organized as follows. Section 2 explains briefly DEMATEL methodology. The following section illustrates the application via a case study conducted in white goods industry. Final section delineates conclusions and future research directions.

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\* Corresponding author.

**2. DEMATEL TECHNIQUE**

The DEMATEL methodology developed by the Science and Human Affairs Program of the Battelle Memorial Institute of Geneva between 1972 and 1976 [6,7]. Based on the graph theory, the DEMATEL method can divide multiple factors into a cause-effect group, and it enables the decision maker to visualize influences between criteria with a network relationship map [8].

The method begins by generating the initial direct influence matrix $A$. The elements $a_{ij}$ of the matrix $A$ represent the direct influence of each factor $i$ exerts on each factor j, evaluated by a decision maker. The matrix $A$ is normalized by using (1) and it is named as the matrix $D$ [9].

$$D = s.A, \tag{1}$$

where

$$s = \min \left[ \frac{1}{\max_{1 \le i \le n} \sum_{j=1}^{n} |a_{ij}|}, \frac{1}{\max_{1 \le i \le n} \sum_{i=1}^{n} |a_{ij}|} \right] \tag{2}$$

The total relation matrix $T$ is defined as $T = D(I - D)^{-1}$ where $I$ is the identity matrix. Define $r$ and $c$ be $n$ x 1 and 1 x $n$ vectors representing the sum of rows and sum of columns of the total relation matrix $T$, respectively. Suppose $r_i$ be the sum of $i^{th}$ row in matrix $T$, then $r_i$ shows both direct and indirect effects given by factor $i$ to the other factors. If $c_j$ denotes the sum of $j^{th}$ column in matrix T, then $c_j$ shows both direct and indirect effects by factor $j$ from the other factors [8].

When solving a decision-making problem, the use of DEMATEL method enables also the decision maker to obtain the importance weights of the criteria, in addition to its ability to visualize the interactions between them.

The degree of importance for a factor $i$ is considered as equals to the sum $(r_i + c_j)$ when $j = i$. A network relationship map which explains the structural relations among factors can be obtained by setting up a threshold value which is determined by the decision makers. Additionally, the difference $(r_i - c_j)$ represents the net effect that factor $i$ contributes to the system. A factor $i$ is a net causer if $(r_i - c_j)$ is positive, and when $(r_i - c_j)$ is negative, factor $i$ is a net receiver [8].

**3. CASE STUDY**

This work presents a DEMATEL approach for evaluating agile provider selection criteria in Turkish white goods sector. The best performing provider alternative will provide an IT-based project to the case company. The case study is conducted through three experts' opinions. Initially, the evaluation criteria which are given in Table 1, are identified by interviewing the project managers of the case firm.

This work presents an IFCM approach for evaluating success factors of home office in pandemic period. The case study is conducted in a consulting firm performing in Turkey through three experts' opinions. Initially, success factors that are determined by interviewing the project managers of the case company, are delineated in Table 1.

Table 1: Success factors of home office

| Label | Concept |
|-------|---------|
| $C_1$ | Cost |
| $C_2$ | Lead time |
| $C_3$ | Customer participation |
| $C_4$ | Ability to react to change |
| $C_5$ | Self-organization |
| $C_6$ | Responsiveness |
| $C_7$ | Innovative skills |

In order to apply DEMATEL method, a team of three experts indicates the influence of each criterion *i* exerts on each factor *j* of the others, using an integer scale which is generally going from "0" (no influence) to "4" (very high influence) represented in Table 2.

Table 2: Linguistic Scale

| | |
|---|---|
| No influence | 0 |
| Very low influence | 1 |
| Low influence | 2 |
| High influence | 3 |
| Very high influence | 4 |

The obtained initial direct influence matrix is shown in Table 3.

Table 3. Initial direct influence matrix

| | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ | $C_6$ | $C_7$ |
|---|---|---|---|---|---|---|---|
| $C_1$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $C_2$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $C_3$ | 0 | 3 | 0 | 4 | 0 | 4 | 0 |
| $C_4$ | 0 | 2 | 0 | 0 | 0 | 4 | 0 |
| $C_5$ | 0 | 3 | 0 | 2 | 0 | 2 | 1 |
| $C_6$ | 0 | 0 | 4 | 3 | 1 | 0 | 0 |
| $C_7$ | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

The weights of agile outsourcing provider selection factors are calculated as in Table 4.

Table 7: Importance weights

| Label | Concept | Weight |
|---|---|---|
| $C_1$ | Cost | 0.0007 |
| $C_2$ | Lead time | 0.1050 |
| $C_3$ | Customer participation | 0.2408 |
| $C_4$ | Ability to react to change | 0.2264 |
| $C_5$ | Self-organization | 0.1175 |
| $C_6$ | Responsiveness | 0.2940 |
| $C_7$ | Innovative skills | 0.0151 |

## 4. CONCLUSIONS

To obtain the importance weights of agile provider selection criteria for an IT-based project conducted in white goods industry, evaluation factors are determined through expert opinions and then algorithm of the work is reported by considering DEMATEL technique. Importance weights of concepts are assigned by applying DEMATEL methodology, responsiveness is the most significant factor however cost and innovative skills are the least effective

ones. Future research directions will focus on proposing group decision making approach for evaluating the criteria of agile provider evaluation in various sectors.

**Acknowledgements**

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# Flow Control and Energy Efficiency Improvement for the VVVF Driven Parallel Pump Mechatronic System

Bojan Z. KNEZEVIC[a*], Zeljko KLINCOV [b], Dragan ERCEG [c]

[a] *University of Banja Luka, Faculty of Mechanical Engineering, B&H, bojan.knezevic@mf.unibl.org*
[b] *ASCO BH d.o.o., Mahovljani, Bosnia and Herzegovina, z.klincov97@hotmail.com*
[c] *University of Banja Luka, Faculty of Mechanical Engineering, B&H, dragan.erceg@mf.unibl.org*

**Abstract**

The aim of this paper is to prove that frequency converters can replace PLCs in smaller automated mechatronic systems with capabilities for reduce energy consumption. For the implementation of this research, an experimental setup was used, which consists of two separate systems based on: pump, frequency converter, valves and sensors. The first part of the paper describes the proposed procedure of setting the parameters of the PI controllers. Programming and setting of parameters were performed with only one control loop, which was implemented in only one frequency converter, while the second frequency converter was in closed loop with the first converter. Second part of this paper show how proper power drive control mode can increase the energy efficiency of the overall system. A comparison of the efficiency of different control types of both converters was performed, and Schneider Electric Altivar ATV630 and ATV320 frequency converters were used. Measurements of electricity consumption were performed for several cases of system settings for U/F Standard, U/F Quadratic, U/F Energy Saving and Sensorless Vector Control mode of electric motor control. At the end, the measurement results were presented and as well as comparisons of the efficiency between two converters.

**Keywords:** PI controller, Frequency converters, Energy efficiency, Flow control loop

## 1. INTRODUCTION

Frequency converters are devices used to control the speed of an electric motors. Beside this basic function, modern frequency converters have a lot of other integrated functions that allows them to be the executive and the control part of an automated system. Thanks to that, frequency converters came so close to the programmable logic controllers that in some cases they can even replace them. In addition to the digital inputs and outputs, analog inputs and outputs and fast digital inputs, frequency converters have the possibility of closed-loop control through several control loops with integrated PID controllers, a wide range of communication protocols and possibility of programming in PLC programming languages. In addition, we can add the ability to program, not just to adjust the parameters, through specialized software that allows you to record, monitor and visualize parameters of the system, as well as diagnostic functions of the entire system.

Electric motor systems in industrial and infrastructural applications with pumps, fans and compressors in buildings are responsible for 53% of total world electricity consumption [1,2]. Electric motor consumption can be reduced by up to 60% by using frequency converters [3,4]. In addition to reduce electricity consumption, the use of frequency converters reduces maintenance costs and improves control and reliability of the process [5,6].

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\* Corresponding author.

The aim of this paper is to determine whether and how it is possible to control a system with multiple centrifugal pumps that are hydraulically connected to each other in parallel. At the same time, to achieve precise and reliable regulation of pressure and flow in all operating modes, as well as to confirm the assumption that frequency converters can replace PLC's in smaller automated systems.

System control was successfully done by using only one control loop which was implemented in only one frequency converter, while the second frequency converter was controlled by a loop signal from the first converter. By using PI regulators, precise and reliable regulation of pressure and flow was achieved. Converters sends information to each other and in that way their synchronization in operation was created. Thanks to the synchronization, the pumps always run at the same speeds and achieve the same pressure or flow values in the system at all times. The PLC function of the frequency converters was used during programming.

The paper is structured so that the second chapter describes the experimental equipment used for research. The hydraulic installation is described as well as the characteristics of independent hydraulic systems and also their parallel connections. In addition, the procedure of connecting two independent systems into parallel is explained.

The third chapter describes the proposed process of adjusting the parameters of the flow PI controller as well as the results of the system response when the systems are in parallel connection. Also, the procedure of programming frequency controllers, which was performed using SoMove software, is described.

The fourth chapter describes the results of energy consumption and comparison of the efficiency of different control modes of both frequency converters. Measurements were performed for three cases of system setup for U/F Standard, U/F Quadratic, U/F Energy Saving and Sensorless Vector Control modes of electric motor control. In each of the three cases, the most efficient mode of controlling of each frequency converter was determined and a comparison of the efficiency of the control modes between two used converters were performed.

## 2. DESCRIPTION OF THE EXPERIMENTAL SETUP

For the realization of this research, an experimental setup was used, which consists of two separate systems, and each system consists of: a pump, a frequency converter, a command table, pressure and flow sensors, rotameter and manometer (Fig. 1). The command tables are used to control the frequency converters, and it is possible to maintain the defined pressure or flow value in the system.
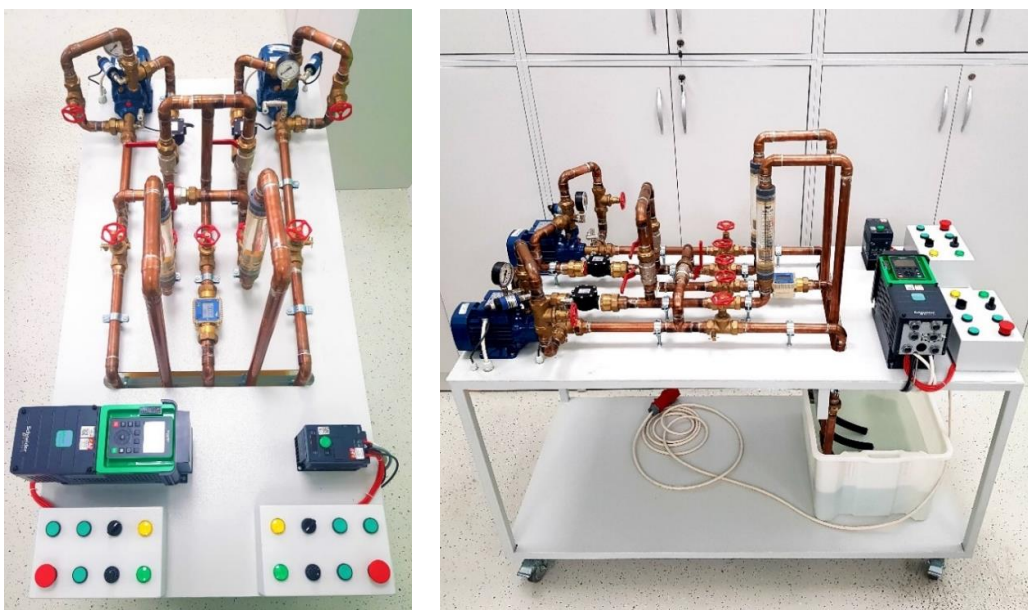


Fig. 1. Experimental setup

The components in experimental setup shown on Fig. 1 are:
- frequency converter Schneider Electric Altivar ATV630,

- frequency converter Schneider Electric Altivar ATV320,

- Pedrollo centrifugal water pump marked PK65, two pieces,

- Schneider Electric pressure sensor marked XMLK006B2D21 and XMLK010B2D21,

- Sea DN32 flow sensor, two pieces,

- digital flow sensor K24 (JH-M01),

- rotameter Z4004, two pieces,

- Wika manometer, 100.10, 16 bar, two pieces, and

- command table for each frequency converter.

Using manual valves, marked as V1, V2, V3 and V4, (Fig. 2), two systems can be connected into series or in parallel, in order to achieve higher pressure or flow, respectively. Each system has 3 manual valves, in system A these valves are V1A, V2A и V3A, and in system B V1B, V2B и V3B.

Valves V2A and V2B are bypass valves and their opening achieve recirculation of pump PA and of pump PB, respectively.

When valves V1, V2 and V4 are closed, then independent operation of systems A and B is achieved, changes of the operating conditions of one system will not affect the changes of the operating conditions of another system. On one side are the pump PA and the valves V1A, V2A and V3A, and on the other side are PB and valves V1B, V2B and V3B. Valves V1A and V3A simulates the increase of the suction depth and change of the head of PA pump, respectively, and valves V1B and V3B achieves the same in system B.

When valves V3A, V3B and V4 are closed, and valves V1 и V2 are opened, then systems A and B are connected in parallel, Fig. 2.

If two identical pumps are used in the system, as is in this case, the total Q-H characteristic of the pumps in parallel connection is shown on Fig. 3.
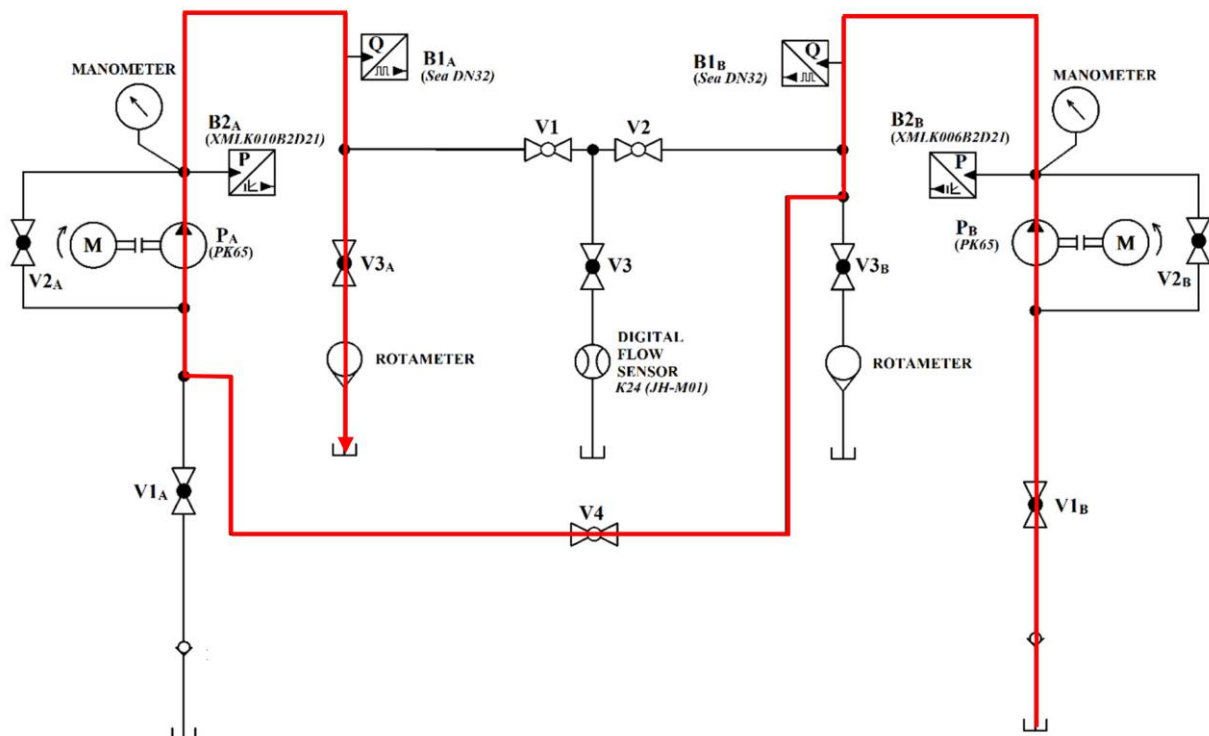


Fig. 2. Hydraulic scheme of the experimental setup when systems A and B are connected in series

From Fig. 3, the maximum head of systems connected in parallel remains equal to the maximum head of one pump: $H_{max} = H_{Amax} = H_{Bmax}$, and the maximum flow of the parallel system is equal to the sum of the maximum flows of the both pumps: $Q = Q_A + Q_B = 2Q_A = 2Q_B$.
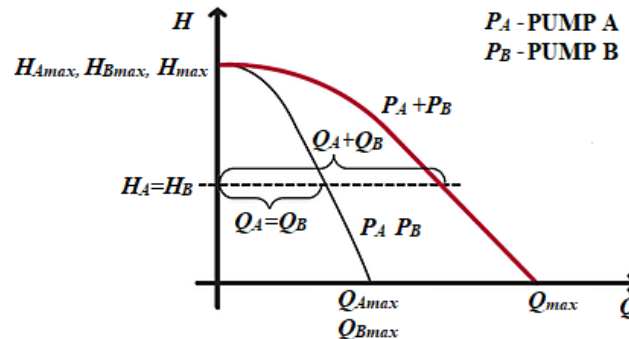


Fig. 3. Total Q-H characteristics of A and B systems connected in parallel [6]

At any point of the total Q-H characteristics of the parallel system connection (Fig. 3), if the pumps run at the same speeds:

$$H = H_A = H_B \text{ and} \tag{1}$$

$$Q = Q_A + Q_B = 2Q_A = 2Q_B. \tag{2}$$

Pumps PA and PB takes a water from the tank through valves V1A and V1B, respectively, and then sends it to the tank through valve V3 and digital flow sensor, Fig. 4. As the valves V1 and V2 are opened, and valves V3A, V4 and V3B closed, the flows of both pumps will sum up in the pipeline where valve V3 and the sensor are located. In this way, it is possible to achieve double the flow value in the system than the flow value that one pump could achieve. Closing the V3 valve simulates the change of the parallel system head, and valves V1A and V1B simulates the change of the suction depth [7, 8].

## 3. FLOW CONTROL IN THE SYSTEM WHERE PUMPS PA AND PB ARE CONNECTED IN PARALLEL

Control of the hydraulic system when the systems A and B are connected in parallel, will be performed, using the frequency converter ATV320. In the case of a parallel connection between two systems, flow regulation is of the interest. The flow is measured by the B1B valve (Fig. 2) because it is connected to the ATV320 frequency converter. Regulation is performed by a PI controller, and flow reference value in the system can be 5-80 L/min.

The pump PB will operate alone when the flow reference value in the system is less than 40 L/min, and for the higher reference values both pumps will operate together.

Using the analog output of the ATV320 frequency controller, the reference value of the supply voltage frequency of the PB is sent as an analog signal, which is then used as the reference frequency of the pump PA. In this way, pump PA and pump PB have the same supply frequency, synchronization is achieved. Synchronization is done with the aim that the pumps achieve the same values of flow into the system when the reference is greater than 40 L/min (when the reference is 50 L/min pumps will achieve 25 L/min each).

In order to achieve a parallel connection of the systems A and B, it is necessary, beside the setting the parameters of the flow regulator, to use the programming functions in the programming language of the function block diagram, which the ATV320 has as the part of the SoMove software.

*3.1. Adjustment of flow regulator parameters*

It is not possible to adjust the parameters of the PI flow regulator by some of exact methods. The reason is the sluggishness in the response of the used turbine flow sensor, and because of that sensor would not be able to register undamped oscillations at the stability limit [9, 10].

A less exact method based on the trial and error method, followed with the visually recorded flow responses, will be used to adjust the parameters of the PI flow controller. Proportional gain is set to the minimum value, and integral term is excluded. Then gradually increase proportional gain until the response of the system achieves the desired shape without overshoot. If the reference value cannot be reached by adjusting the proportional gain, an integral term must be activated. Increase value of the integral term until the steady state error is eliminated.

The impulse reference has an amplitude of 40 L/min and valves V1A and V3A are opened, Fig. 2. The value of the proportional gain, at which the system reaches the desired shape (Fig. 4), is equal to 0.15. The achieved shape has a large steady state error. In order to eliminate the error, while maintaining the response form, the integral term is increased until the error is completely eliminated.
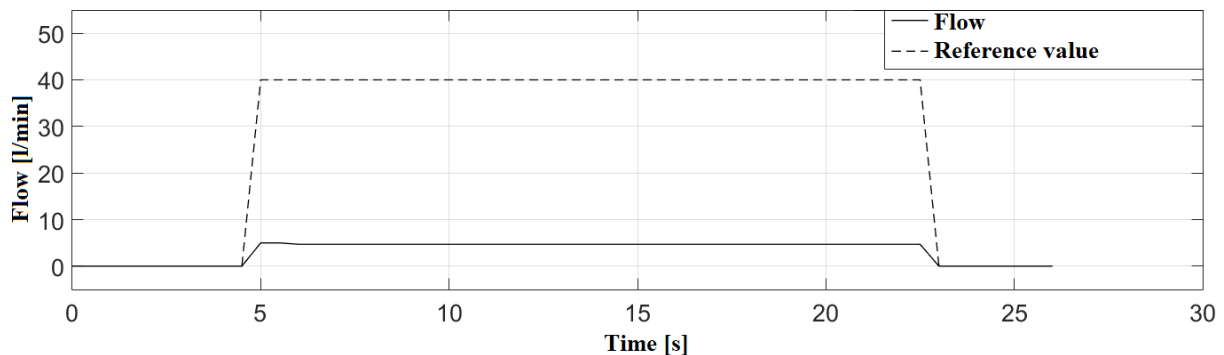
Fig. 4. Form of the change of flow for the value of proportional gain equal to 0.15 and for off integral term of PI flow controller

The result of the described method is shown on Fig. 5. The minimum value of the pressure reference is set to a 7 L/min, so that the system passes through the area below the minimum flow value during startup, and the maximum value of the reference is set to 40 L/min.
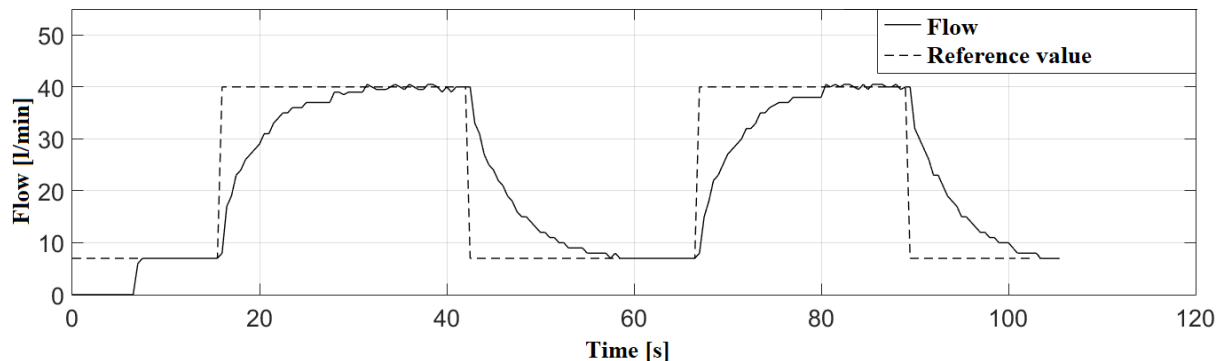
Fig. 5. System response on the impulse change of flow reference

As can be seen from the diagram on Fig. 5, the system passes the area below the minimum value of the flow without oscillations. The system follows the change of the reference value to 40 L/min without overshoot and without steady state error. The presented behavior of the system is achieved with a PI controller whose parameters are: kp = 0.15 and Ti = 0.15.
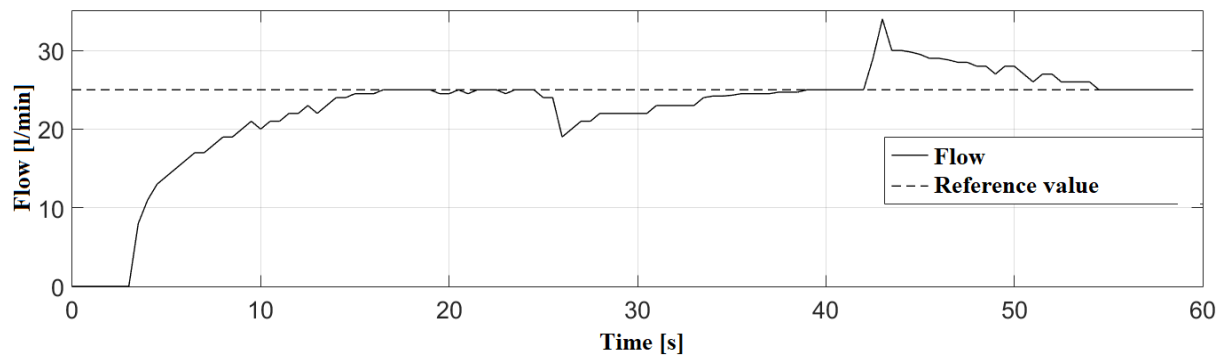
Fig. 6. System response on the load change

The robustness of the flow regulator, the resistance on a load change, is checked by closing and opening the valve V3A, Fig. 2. The flow reference value is set to a constant value of 25 L/min and the system response is shown on Fig. 6.

As can be seen from the diagram on Fig. 6, the set PI flow controller responds to the load change and returns the regulated value to the reference value, which confirms that the controller with the parameters kp = 0.15 and Ti = 0.15 is robust as its shout be.

*3.2. Synchronization control algorithm for the parallel pump operation*

In parallel pump mode, the PI flow controller is implemented on the ATV320. The ATV630 is synchronized by obtaining a frequency reference value from ATV320 via an analog input. On the other hand, the ATV630 sends a flow value, measured via V1A sensor, to the ATV320 via an analog output.

System parameters for A and B systems are set for flows from 5 to 40 L/min. When systems A and B are connected in parallel, the total system operates in the range of 5 to 80 L/min. In order to satisfy the required requirement, the control algorithm is implemented so that only the pump PB works up to 40 L/min, and from 40 to 80 L/min both pumps work synchronously, so they implement the same flows and total flow is equal to reference. The described control method can be realized only with the help of using the PLC function in the SoMove software, described as [11, 12]:

- As long as the voltage at the analog input of the ATV320 frequency converter is less than 5 V, it is multiplied by 2 and sent to the reference channel. For a voltage of 4 V, a reference value of 8 V is obtained and the PB then will achieve 37 L/min in the system. While the voltage at the analog input of the frequency regulator is less than 5 V, 0 is sent from the analog output. Reference frequency of pump PA, in that case, will be 0 Hz.

- When the voltage at the analog input of the ATV320 frequency regulator is higher than 5 V, it is sent as it is to the reference channel. For a voltage of 8 V, a reference value of 8 V is obtained and the pump PB then will achieve 37 L/min in the system. At the same time, the value of the referent frequency of the motor of the PB pump is sent from the analog output in the form of a voltage signal 0-10 V. In this way, the PA pump will have the same reference frequency of the motor voltage as the PB, so it will also achieve 37 L/min in the system, synchronization is achieved. The total flow in the system will be 74 L/min.

- As the analog input is set in the range 0-10 V, values from 0 to 8192 will be entered in the analog input register. For 5 V, the value 4096 will be entered in the register input. This information is used for PLC programming.

- Register 3202 contains information of the frequency of operation of the motor of pump PB. The operating frequency is 0-50 Hz, and values 0-500 are entered in the register. The register frequency value 3202 is sent via the analog output to the ATV630 for synchronization. The analog output is voltage, 0-10 V, and its register is 13-bit, which means that in order to send a value of 10 V, the value 8192 must be

entered in it. For the operating frequency of 50 Hz, the value 500 is entered in the analog output register, which would correspond to the voltage values below 1 V and synchronization would fail. The solution is to scale the value of register 3202 before writing it to the analog output register. The value of register 3202 should be multiplied by 16 and added by 192 (500·16+192=8192). Because of scaling, for an operating frequency of 50 Hz, the value 8192 would be entered in the analog output register, which corresponds to a voltage of 10 V.

The full PLC program written in the functional block diagram language, for the case when systems A and B are connected in parallel, is shown on Fig. 7.
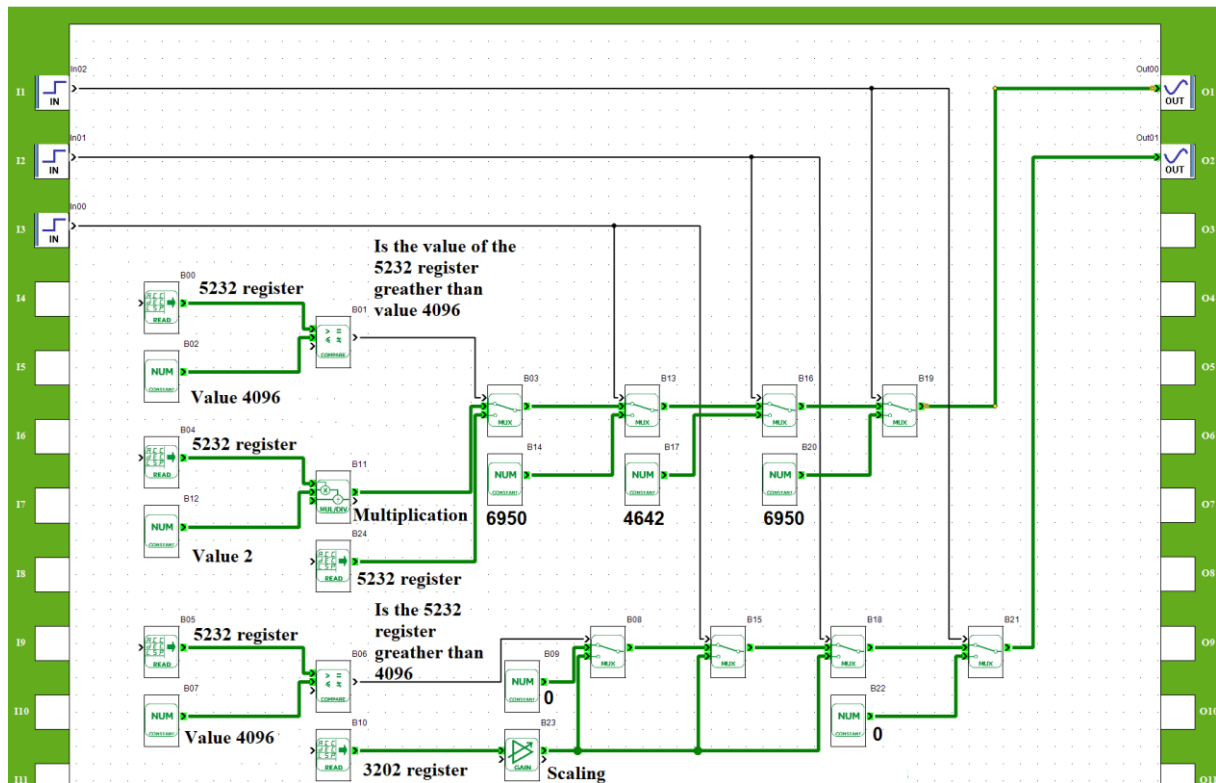


Fig. 7. PLC program for parallel mode of operation of systems A and B

*3.3. Testing of the characteristics of the systems A and B connected in parallel*

After determining the parameters and programming, it is necessary to connect the systems hydraulically in parallel and test the overall system. The minimum value of the flow reference is set to 5 L/min, so that the system passes through the area below the minimum flow value during startup. Valves V1A, V1B and V3 are opened, Fig. 2. The flow reference values are 35 L/min and 50 L/min.

The response of systems A and B connected in parallel on the impulse change of the pressure reference value is shown in Fig. 8.
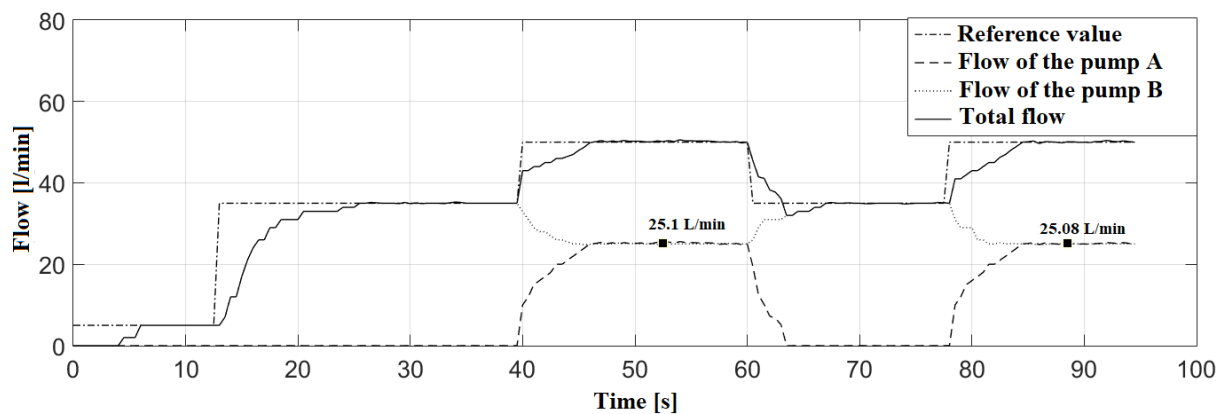
Fig. 8. Response of systems A and B connected in parallel on the impulse change of the flow reference value

As can be seen from the diagram on Fig. 8, the system passes the area below the minimum flow value without oscillations. The system follows the change of the flow reference value, to 35 L/min and 50 L/min, without overshoot and without steady state error. When changing the reference from 50 L/min to 35 L/min, pump A suddenly stops and due to the high sluggishness of the used flow sensor, the system cannot increase the flow of pump B fast enough. The result is a undershoot.

Based on several control points of the diagram, it is concluded that the synchronization was done successfully and that the loads between the pumps were equally distributed.

The behavior of the system on a change of the load at constant flow reference of 50 L/min is shown on Fig. 9. The load change is simulated by closing or opening valve V3, Fig. 2.
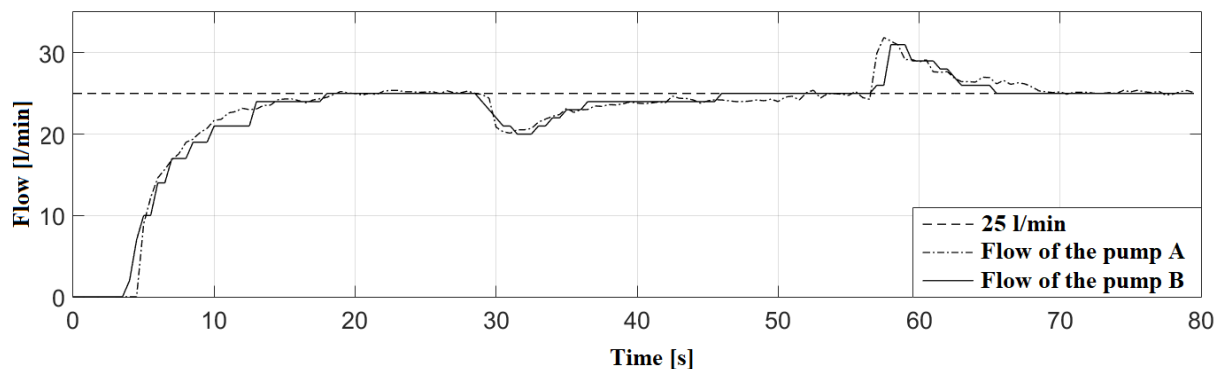


Fig. 9. Response of systems A and B connected in parallel on the load change

As can be seen from the diagram on Fig. 9, the system follows the flow reference value at constant load. When the load changes, increases and decreases, there is a shorter deviation from the flow reference value, which the controller compensates and returns to the reference value. Also, based on the control points of the diagram, conclusion is that the loads between the pumps are equally distributed and that their responses are consistent.

Parallel system was also tested on the slope function of the flow reference change to test the synchronization sensitivity. From the diagram on Fig. 10, it can be seen that the overall system successfully follows the increase of the flow reference value without error, without oscillations or hydraulic shocks and with even participation of both pumps as predicted by the control algorithm.
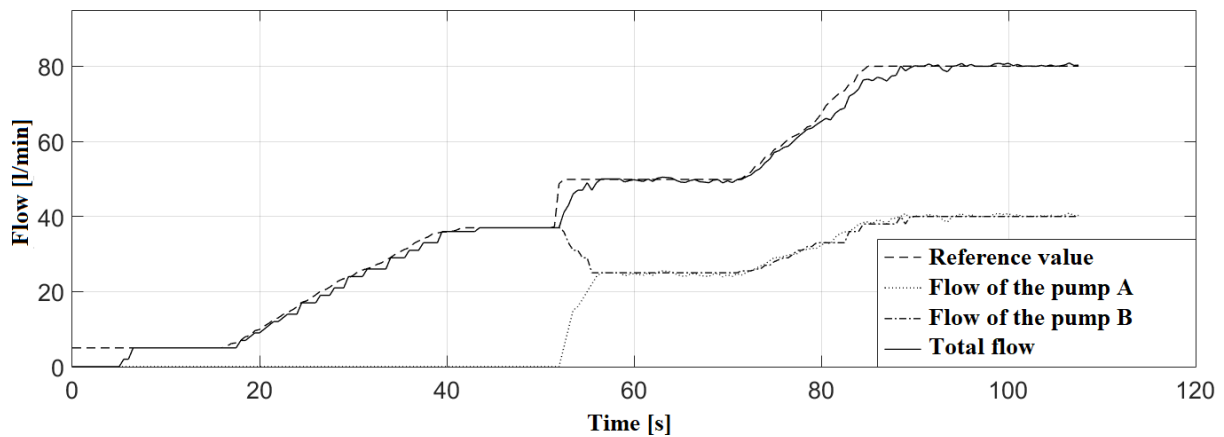
Fig. 10. Response of systems A and B connected in parallel during inclined increase of the flow reference

## 4. ANALYSIS OF DIFFERENT CONTROL MODES OF CENTRIFUGAL PUMPS FROM THE ASPECT OF ENERGY EFFICIENCY

ATV630 has three modes of electric motor control (U/F Standard, U/F Quadratic and U/F Energy Saving) while ATV320 in addition has a vector mode of electric motor control without the use of sensors (Sensorless Vector Control, SVC).

The research begins by measuring the electric energy consumption of the pump motors, for all control modes of both frequency converters, for a certain time interval.

Closing the valve simulates an increase of pump head (simulates the change of load in the system).

Measurements of electric energy consumption of all control modes were performed for three system setup cases:

- for case of low flow and very low pressure in the system (case of idling with low speed),

- for case of high flow and very low pressure in the system (case of idling with high speed),

- for case of high pressure and high flow in the system (load close to nominal at high speed).

On the described way, a total of 7 measurements of electricity consumption were performed for one system adjustment.

Active electric power for both motors is calculated according to:

$$P_{el}[\text{W}] = \sqrt{3}UI \cdot 0.76, \tag{3}$$

where are: U pump motor supply voltage, I electric current of the pump motor and 0.76 power factor.

Current and voltage of pump motor were measured during the entire measurement interval. Based on the measured values and with the help of (3), the active electrical power of the pump motor is calculated.

Based on the calculated active electric power of the motor, the electric energy consumed by the motor during the operation of ten minutes is calculated according to:

$$E_n[\text{Wh}] = \sum_0^{600} P_{el,n}, \tag{4}$$

where are: En the amount of energy consumed by the engine during operation of n seconds and Pel, n electrical power of the motor in the n-th second.

The hydraulic power of the system is calculated according to:

$$N[\text{W}] = p[\text{bar}] \cdot 10^5 \cdot Q[\text{L/min}] \cdot \frac{10^{-3}}{60}, \tag{5}$$

where are: p for pressure and Q for flow.

*4.1. Case of low flow and very low pressure in the system*

In the case of low flow and very low pressure, the value of the pressure in the system is set to 0.21 bar, and the flow in the system is set to 12 L/min using a valve.

Based on the measured pressure and flow, using (5), the hydraulic power in the system was calculated and it is 4.2 W. The values of pressure, flow and hydraulic power of the pump are the same for all 7 consumption measurements.

Ten minutes measurement of the motor consumption of the pump controlled with the ATV630 frequency converter in U/F Standard control mode was performed. A current overshoot is observed during start up, after which the current stabilizes and remains constant until the end of the measurement. The value of the current in the steady state is 0.64 A. The voltage value is 143 V, frequency of 19.2 Hz. Based on the current and voltage, the active electric power is calculated, according to (3). Based on the calculated power, using (4), the energy consumed by the engine during the ten minutes operation was calculated. Results of measurements of electrical quantities of ATV630 driven pump drive are given in Tab. 1.

During 10 minutes of operation, the pump motor controlled by the ATV630 frequency converter in U/F Standard control mode consumed 19.95 Wh of electric energy in case of low flow and very low pressure.

Table 1. Results of measurements of electrical quantities of ATV630 driven pump drive

| Control mode | Current [A] | Voltage [V] | Freq. [Hz] | Current overshoot | El. energy [Wh] |
|---|---|---|---|---|---|
| U/F Standard | 1.1 | 143 | 19.2 | yes | 19.95 |
| U/F Quadratic | 0.34 | 83 | 19.4 | no | 5.93 |
| U/F Energy Saving | 0.32 | 77 | 20.1 | no | 5.34 |

Of all three ATV630 frequency converter control modes for low flow and very low pressure, the pump motor consumed the least electric energy in U/F Energy Saving control mode.

As seen from Table 1, the pump motor current was lowest in U/F Energy Saving control mode (0.32 A) and highest in U/F Standard control mode (0.64 A). When operating in U/F Standard control mode, overshoot occurs at start up, while in other control modes this was not the case. The electric current of the pump motor in U/F Quadratic control mode is almost the same as for U/F Energy Saving (0.34 A).

Table 1 shows that the pump motor voltage was lowest in U/F Energy Saving control mode (77 V), then in U/F Quadratic (83 V), and highest in U/F Standard control mode (173 V). In none of the three control modes a voltage overshoot during start up did not occur.

The electric energy consumption values of the pump motor are highest for U/F Standard control mode (19.95 Wh), followed by U/F Quadratic (5.93 Wh) and lowest for U/F Energy Saving (5.34 Wh).

As was done for the ATV630, the same ten minutes measurement of pump motor consumption in U/F Standard control mode was done for the ATV320. In addition, measurements were performed for the SVC control mode that the ATV630 does not have. Results of measurements of electrical quantities of ATV320 driven pump drive are given in Tab. 2.

Table 2. Results of measurements of electrical quantities of ATV320 driven pump drive

| Control mode | Current [A] | Voltage [V] | Freq. [Hz] | Current overshoot | El. energy [Wh] |
|---|---|---|---|---|---|
| U/F Standard | 1.1 | 85 | 20 | yes | 20.28 |
| U/F Quadratic | 0.6 | 48 | 21 | no | 6.2 |
| U/F Energy Saving | 0.6 | 46 | 20.9 | no | 5.95 |
| Sensorless Vector Control | 1.1 | 85 | 20 | yes | 20.29 |

Of all four modes of control of the ATV320 frequency regulator in case of low flow and very low pressure, the pump motor consumed the least electric energy in U/F Energy Saving control mode.

As seen from Tab. 2, the electric current of the pump motor was the lowest in U/F Energy Saving and in U/F Quadratic control mode, and in both cases the current was equal (0.6 A). When operating in U/F Standard and SVC

control modes, an overshoot occurs at startup. The U/F Standard and SVC control modes also had the same currents, but higher than the other two control modes (1.1 A).

Tab. 2 shows that the pump motor voltage was lowest in U/F Energy Saving control mode (46 V), then in U/F Quadratic (48 V), and highest in U/F Standard and SVC control mode. There was no voltage overshoot during the start up in any case. In case of low flow and very low pressure U/F Standard and SVC control modes had identical voltage values (85 V).

Pump motor electric energy consumption values are highest for U/F Standard and SVC control modes (20.28 and 20.29 Wh, respectively), followed by U/F Quadratic (6.2 Wh) and lowest for U/F Energy Saving (5.95 Wh).

*4.2. Case of high flow and very low pressure in the system*

In the case of high flow and very low pressure, the reference value of the pressure in the system is set to 0.2 bar, and the flow in the system is set to 39 L/min using a valve. Based on the measured pressure and flow, the hydraulic power of the pump in the system was calculated and it is 13 W. The values of pressure, flow and hydraulic power of the pump are the same for all 7 consumption measurements.

Of all the three modes of control of the ATV630 frequency converter in case of high flow and very low pressure, the pump motor consumed the least electric energy in U/F Energy Saving control mode. Results of measurements of electrical quantities of ATV630 driven pump drive are given in Tab. 3.

Table 3. Results of measurements of electrical quantities of ATV630 driven pump drive

| Control mode | Current [A] | Voltage [V] | Freq. [Hz] | Current overshoot | El. energy [Wh] |
|---|---|---|---|---|---|
| U/F Standard | 0.64 | 285 | 39.5 | yes | 39 |
| U/F Quadratic | 0.53 | 247 | 40 | no | 27.63 |
| U/F Energy Saving | 0.48 | 154 | 41.3 | no | 15.68 |

From Tab. 3 it can be seen that the electric current of the pump motor was the lowest in the U/F Energy Saving control mode (0.48 A) and the highest in the U/F Standard control mode (0.64 A). Of all three control modes, only U/F Standard control mode had a current overshoot at startup.

The pump motor voltage was the lowest in U/F Energy Saving control mode (154 V), then in U/F Quadratic (246 V), and the highest was in U/F Standard control mode (246 V), Tab. 3. In none of the three control modes a voltage overshoot during start up did not occur. Pump motor electric energy consumption values are highest for U/F Standard control mode (39 Wh), followed by U/F Quadratic (27.63 Wh) and lowest for U/F Energy Saving (15.68 Wh).

Results of measurements of electrical quantities of ATV320 driven pump drive are given in Tab. 4. Of all the four control modes of the ATV320 frequency converter in case of high flow and very low pressure, the pump motor consumed the least electric energy in U/F Energy Saving control mode.

Table 4. Results of measurements of electrical quantities of ATV320 driven pump drive

| Control mode | Current [A] | Voltage [V] | Freq. [Hz] | Current overshoot | El. енergy [Wh] |
|---|---|---|---|---|---|
| U/F Standard | 1.1 | 172 | 41.2 | yes | 40.44 |
| U/F Quadratic | 1 | 150 | 41.7 | no | 31.47 |
| U/F Energy Saving | 0.9 | 93 | 43.7 | no | 17.67 |
| Sensorless Vector Control | 1.1 | 171 | 41.2 | no | 40.26 |

As seen from Tab. 4, the pump motor current was lowest in U/F Energy Saving (0.9 A) and in U/F Quadratic control mode (1 A). The U/F Standard and SVC control modes had the same currents but higher than the other two control modes (1.1 A). During operation in U/F Standard and in SVC control modes, an overshoot occurred at the start up.

From Tab. 4 shows that the pump motor voltage was lowest in U/F Energy Saving control mode (93 V), then in U/F Quadratic (150 V), and highest in U/F Standard and SVC control mode (172 and 171 V). The values of the electric

energy consumption of the pump motor are the highest for U/F Standard (40.44 Wh) and SVC control modes (40.26 Wh), followed by U/F Quadratic (31.47 Wh), and the lowest for U/F Energy Saving (17.67 Wh).

*4.3. Case of high pressure and high flow in the system*

In the case of high pressure and high flow, the pressure reference value in the system is set to 3 bar, and the flow in the system is set to 11 L/min using a valve. Based on the measured pressure and flow, the hydraulic power in the system was calculated and it is 55.2 W. The values of pressure, flow and hydraulic power of the pump are the same for all 7 consumption measurements.

Results of measurements of electrical quantities of ATV630 driven pump drive are given in Tab. 5. Of all three modes of control of the Altivar ATV630 frequency converter in a case of high pressure and high flow in the system, the pump motor consumed the least electric energy in U/F Quadratic control mode.

Table 5. Results of measurements of electrical quantities of ATV630 driven pump drive

| Control mode | Current [A] | Voltage [V] | Freq. [Hz] | Current oveshoot | El. енergy [Wh] |
|---|---|---|---|---|---|
| U/F Standard | 0.95 | 320 | 43.2 | no | 66.35 |
| U/F Quadratic | 0.97 | 299 | 44.4 | no | 63.37 |
| U/F Energy Saving | 0.96 | 310 | 43.4 | no | 65 |

From Tab. 5 it can be seen that the electric current of the pump motor was the lowest in the U/F Standard control mode (0.95 A) and the highest in the U/F Quadratic control mode (0.97 A). No overshoots occurred during the startup.

Table 5 shows that the pump motor voltage was lowest in U/F Quadratic control mode (302 V), then in U/F Energy Saving (310 V), and highest in U/F Standard control mode (320 V). In none of the three control modes did an overshoot occur during a startup. Electric energy consumption values are highest for U/F Standard control mode (66.35 Wh), followed by U/F Energy Saving (65 Wh) and lowest for U/F Quadratic (63.37 Wh).

Results of measurements of electrical quantities of ATV320 driven pump drive are given in Tab. 6. Of all the four modes of control of the ATV320 frequency converter in case of high flow and high pressure, the pump motor consumed the least electric energy in U/F Quadratic control mode.

From Tab. 6 it can be seen that the electric current of the pump motor was the lowest in U/F Standard, in SVC and in U/F Quadratic, which had the same values of electric current (1.7 A). The electric current in U/F Energy Saving was the highest (2 A). Overshoots did not occur.

Tab. 6 shows that the pump motor voltage was lowest in U/F Energy Saving control mode (158 V), then in U/F Quadratic (180 V), and highest in U/F Standard (189 V) and SVC control mode (192 V). In no case does an overshoot occur. Electric energy consumption values are highest for U/F Standard (70.14 Wh) and SVC control modes (71 Wh), followed by U/F Energy Saving (68.67 Wh) and lowest for U/F Quadratic (66.92 Wh)

Table 6. Results of measurements of electrical quantities of ATV320 driven pump drive

| Control mode | Current [A] | Voltage [V] | Freq. [Hz] | Current overshoot | El. energy [Wh] |
|---|---|---|---|---|---|
| U/F Standard | 1.7 | 189 | 44.3 | no | 70.14 |
| U/F Quadratic | 1.7 | 180 | 45.9 | no | 66.92 |
| U/F Energy Saving | 2 | 158 | 47.4 | no | 68.67 |
| Sensorless Vector Control | 1.7 | 192 | 44.9 | no | 71.19 |

## 5. ENERGY EFFICIENCY IMPROVEMENT ANALYSIS

After the measurements for all three cases were completed, the results of electricity consumptions for both frequency converters were obtained, which were presented in the previous chapter.

Based on the measurements it can be concluded that the pump motors, in case of low flow and very low pressure and in case of high flow and very low pressure in the system, were the lowest consumers while they were controlled by frequency converters in U/F Energy Saving mode. The U/F Energy Saving control mode is used as an energy

saving mode with U/f2 ratio control. A mode that reduces motor current in cases when motor load is reduced and preserves drive performance up to full load.

In the case of low flow and very low pressure and in the case of high flow and very low pressure in the system, the load was reduced to a minimum and the efficiency of the U/F Energy Saving mode came to the fore.

The comparison of the consumed electric energies of the control modes of both frequency converters in the case of low flow and very low pressure are shown on Fig. 11.

As can be seen on the diagram on Fig. 11, the second most efficient control mode of both frequency converters is U/F Quadratic, which is almost similar to U/F Energy Saving control mode, while U/F Standard and Sensorless Vector Control are the most inefficient modes. The diagram shows that the control modes of the ATV630 frequency controller are the lower electric energy consumers than the same modes of the ATV320 frequency converter.

The comparison of the consumed electric energies of the control modes of both frequency converters in the case of high flow and very low pressure are shown on Fig. 12.

On the diagram on Fig. 12, the most efficient is the U/F Energy Saving control mode, followed by the U/F Quadratic, while the U/F Standard and Sensorless Vector Control are the most inefficient control modes. The diagram shows, in this case as well, that the control modes of the ATV630 frequency converter are lower electric consumers than the same ATV320 modes.
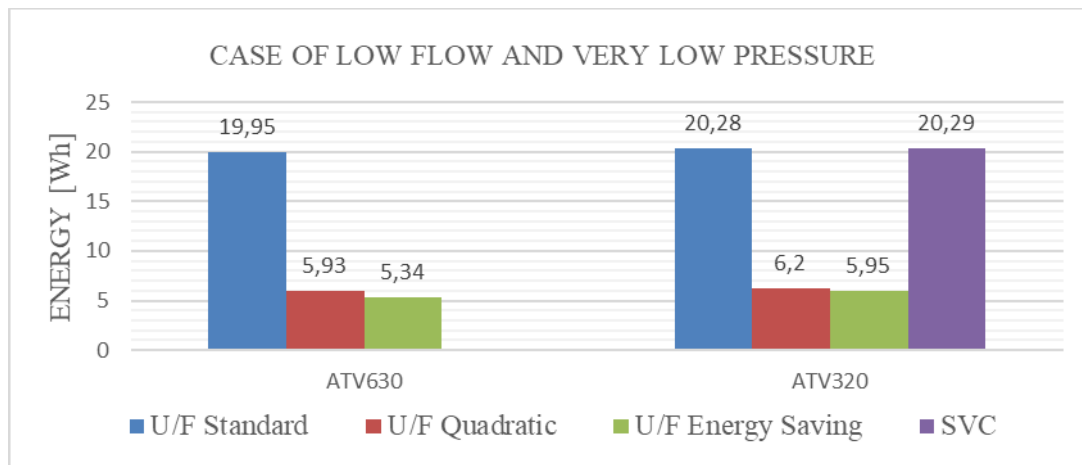


Fig. 11. Electric energy consumption of the control modes of both regulators in case of low flow and very low pressure in the system
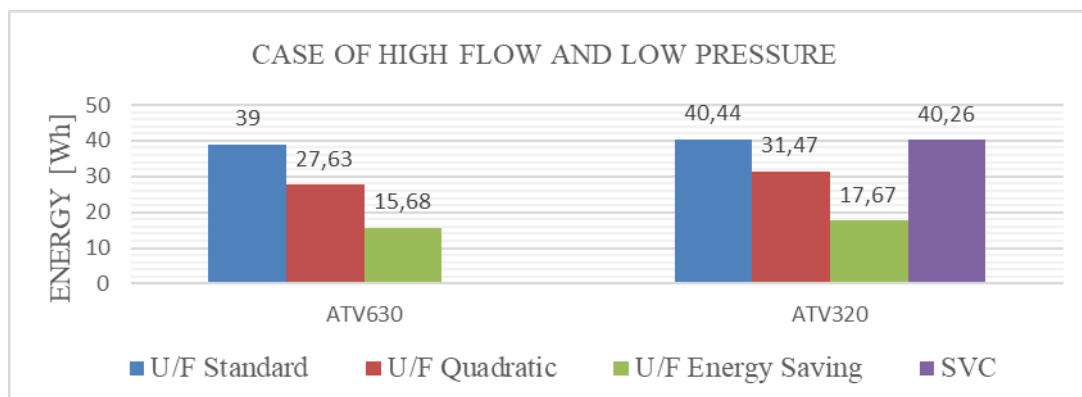


Fig. 12. Electric energy consumption of the control modes of both regulators in case of high flow and very low pressure in the system

The low electric consumption of the U/F Energy Saving control mode has come to the fore in the previous two cases of system setup, due to the low load. But when the load in the system is much higher, when the operating conditions of the system are close to the nominal, then the U/F Quadratic control mode comes to the fore.

In the U/F Quadratic control mode, the voltage-frequency ratio is not linear, as in standard mode (U/f), but U/f2 ratio. Control mode intended for variable torque applications and commonly used for pumps and fans. The comparison of the consumed electric energies of the control modes of both frequency converters in the case of high pressure and high flow in the system are on Fig. 13.

As can be seen on the diagram on Fig. 13, the lowest consumer is U/F Quadratic control mode, followed by U/F Energy Saving, while U/F Standard and Sensorless Vector Control are the largest consumers of electricity. The diagram shows, in this case as well, that the control modes of the ATV630 frequency converter are more efficient than the same modes of the ATV320 frequency converter.

For cases of system operation without heavy loads, the most efficient control mode is U/F Energy Saving. As the load in the system increases, the efficiency of the U/F Energy Saving control mode decreases, and in these cases the U/F Quadratic control mode should be used for lower electric consumption. For cases where the load is not known the optimal control mode is U/F Quadratic. Mode that can provide efficiency because it uses U/f2 ratio, as well as U/F Energy Saving, but also a mode that can answer to the requirements of variable torque, as according to the manufacturer's catalog.
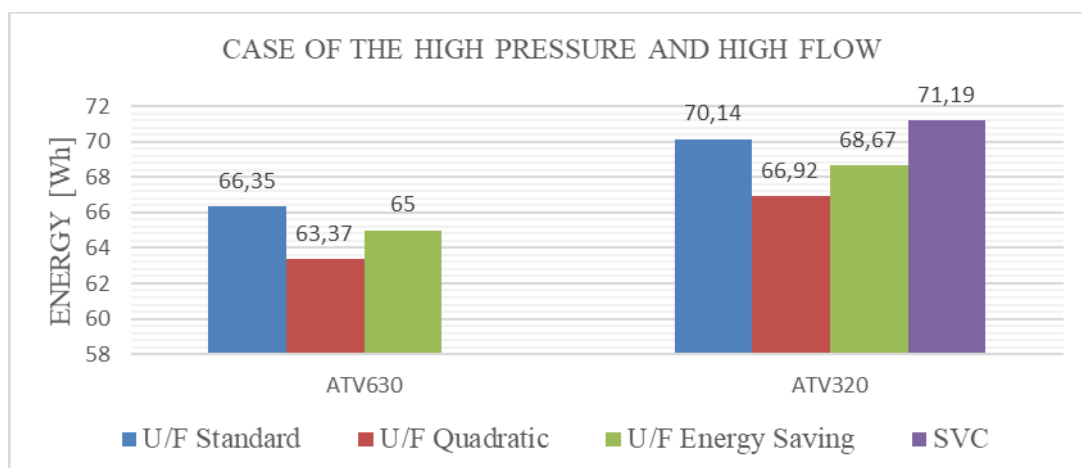


Fig. 13. Electric energy consumption of the control modes of both regulators in case of high pressure and high flow in the system

## 6. CONCLUSION

The research conducted in this paper aimed to determine whether and how it is possible to control a system of centrifugal pumps, especially in cases where the pumps are hydraulically connected. Also, the goal was to achieve precise and reliable regulation as well as energy efficiency in parallel pumping system.

After programming was completed for the case when systems A and B are connected in parallel, it has been shown that it is possible to control a centrifugal pump system, when the pumps are hydraulically connected, with two frequency converters which are passing information to each other. Control, for the case when the systems A and B are connected in parallel, was successfully done only with one control loop which was realized in one frequency converter and which gave a control signal for another frequency converter.

Frequency converters sends information to each other and because of this their synchronization in operation was achieved. Synchronization is done with the aim that the pumps achieve the same values of flow into the system when the reference is greater than 40 L/min. Parallel connection of the two systems achieved doubling the flow in the system. In addition to a large number of functions of both frequency converters, ATV320 has the possibility of PLC programming using function block diagram programming language, which was necessary for the case when the systems A and B were connected in a parallel. This shows that frequency converters can be used for simpler automation systems instead of a PLCs.

The disadvantage of hydraulic systems, such as the one described in this paper, is the use of turbine flow sensors which are sluggish and which react slowly to a change in the system. This disadvantage is best seen when there is an impulse change of reference from higher to lower value. In that case, when the systems are in parallel mode of

operation, when pump A suddenly stops and because of the high sluggishness of the used flow sensor, the system cannot increase the flow of pump B fast enough. The result is a undershoot.

Using proposed control strategy there are no oscillations, and after reaching the steady state, the values remain constant until the reference changes. When the pumps pass through the area below the minimum flow value, there are no oscillations or operating problems in any case of system operation.

In the case of low flow and very low pressure and in the case of high flow and very low pressure in the system, the load was reduced to a minimum and the most efficient control mode of both frequency converters was U/F Energy Saving. The second most efficient mode of both frequency converters was U/F Quadratic, and U/F Standard and Sensorless Vector Control modes were less efficient modes.

In a case of high pressure and high flow, the most efficient control mode of both frequency converters was U/F Quadratic, then U/F Energy Saving, while U/F Standard and Sensorless Vector Control modes were the highest consumers of electricity.

The control modes of the ATV630 frequency converter were lower electric consumers than the same ATV320 frequency converter modes. The reason is partly that the ATV630 is three phase, so the currents for the same powers are lower. With the ATV320, the currents are higher, so the losses in the converter are higher. In addition to the above, the ATV630 is adapted for use in the process industry, for driving pumps and fans that have exponential load characteristics, while the ATV320 is intended for the machine segment where constant loads with higher starting moments are generally expected.

Conclusion is that the U/F Energy Saving control mode is the most efficient for the operation of the system in the case of no heavy loads. As the load in the system increases, the efficiency of the U/F Energy Saving control mode decreases and the efficiency of the U/F Quadratic control mode increases. However, the load in the system will often not be known and then the U/F Quadratic control mode should be used, which would be the optimal mode. A mode that can meet the requirements with variable torque but also can provide energy efficiency because it uses the U/f2 ratio, as well as U/F Energy Saving. This shows that the choice of control mode, in certain operating conditions, is very important from the aspect of energy efficiency.

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# The Importance of Mother Tongue in SLA Process in Lower Secondary Education (Albanian Case)

## Miranda ENESI[a]*, Renata LEGISI [b]

[a] *Polytechnic University Of Tirana, Albania , Faculty of Mathematics &Physics Engineering, Center of Foreign Languages, m.enesi@ fimif.  edu .al*
[b] *English Language teacher, Higher Learning Group, renalegisi2@gmail.com*

**Abstract**

First language serves as a bridge, which bonds a learner with every other language. Learners must be aware of it's peculiarities and use them to facilitate their second language learning. First language influence and usage are important issues as they affect learners' second language development. This study represents the way Albanian learners use their first language when they deal with the second language and how teachers interpret this usage. This study combines theoretical information with concrete examples and ideas given by teachers themselves.  The purpose of this paper is to identify the usage of mother tongue during English language classes. This issue was investigated through quantitative research. The instrument used for the measurement of this phenomenon is a questionnaire, which focuses on asking teachers about the usage of their first language in the second language lesson. It also focuses on establishing the instances of this usage, teachers' attitude toward translation and the effects of this on their students' second language communicative skills. This study was conducted in secondary schools, consisting in a sample of 40 teachers. Participants in this research are teachers of 9th grade because their everyday use of English allows instances of investigation.

**Keywords:** First language, transferences, communicative abilities learners' reactions.

## 1. INTRODUCTION

The first language influences the learning of the other languages. In certain instances, it serves as a facilitator and in others; it prohibits proper development of the second language. Albanian language being the mother tongue is more accessible for learners, for this reason learners usually think in this language when trying to reproduce the second language. Learners must be aware of the danger and the potential of the first language impact throughout their learning.

This study seeks to find out the impact the first language has on the second language learning and development. Moreover it tries to discover the ways one uses this language to facilitate the target language learning through analysing teachers' attitudes toward this usage. By discovering these impact, a researcher can distinguish between the positive and negative instances of transference which cause the fossilisation of the mistakes. This will lead to better ways of learning the second language, a more suitable and effective usage of the first language in the classroom and a better understanding of the nature of both languages. In addition the paper treats certain ways to encourage the usage and the avoidance of the first language. Evidence is provided from the empirical results taken from the questionnaire which consist on data analyses and interpretation as well as concrete examples and situations given by the teachers participating in this research.

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* Corresponding author.

## 2. LITERATURE REVIEW

With the development of English as a foreign or second language teaching approaches, considerable attention was given by applied linguists to using or not using mother tongue (MT) as a basic principle (Larsen-Freeman, 2000).

Garcia and Sylvan (2011) cf. Burdujan (2020:34) consider outdated the monolingual education in the 'globalized' world we live nowadays and the practice of imposing only one language is discouraged. Timucin and Baytar (2015)cf. Pakera& Karaagaç(:115) found out that teachers exploit L1 to translate when students do not understand, to check understanding, to explain procedures, to give directions, to explain grammar and to manage the class.

Saliu (2017:178)I says that using L2 most of the time is a good idea; however, he suggests that Foreign language teachers should not feel at fault while using L1 when it is really required.

Nguyen An Giang    2022:20) states that English skills can be improved if they are taught in an only English environment.

Oihana et al.(2020) & Omidire (2019 b) have highlighted the importance of the L1 as a resource for learning and a good way to compensate for the challenges of  multilingual learners. Researchers as (Cenoz & Gorter, 2017; Hult, 2017; Seltzer, 2019)  cf.  Brevik &Rindal(2020:925-926) have raised concerns on the use of English at the expense of other languages as well as the lack of inclusion of students' existing language resources in the classroom

Scholars present different perspectives related to this issue; some contradict the usage of the first language while some others support it (Metruk 2017).

Utomo, B.P & Suwartono, T. (2020:10) consider using of English as essential for teachers during the classroom, since for them learning a foreign language is not just a translation act and shifting a word to the mother tongue implies the teacher's incapability.

Al-Zayed (2019) cf. Tubayqi & Al Tale'(2021:352) stated that although the Jordanian teachers used MT to teach English, they believed that this led to teaching quality reduction.

This shows that there is a controversy in this usage, and it is necessary to discover learners' reaction toward it and their benefits or negative impacts from it.

*2.1 The advantages of using the MT*

The analysis and the discussion of the data revealed that most of the teachers believe that it is necessary and acceptable to use native language in teaching. The usage of the native language saves time and helps to clarify the meaning of difficult words easier. In addition, it prevents misunderstanding of the meaning. Learners feel more confident when they hear their language and they understand the instructions better. They themselves claim that using their language makes them feel less confused. They feel more confident if they express their thoughts in both languages. Translation helps them with difficult words. They prefer grammar explanation is done in the first language.

In Albanian schools, the distinction between more and less proficient learners is found. This may seem as a type of mainstream where less capable writers are isolated or handed low quality tasks. Proficient learners hold the majority of class interaction between teacher and learners.

The focus today has shifted toward the usage of the F1 language. There are certain teaching methods, which encourage the usage of the first language as a mediator and facilitator in the learning of the second language. Communicative language teaching classes portrays the idea that we can use the first language to give instructions. Robert Buckmaster (2000) highlighted some of the usages of the first language in the classroom. According to him, students benefit more if the teachers translate for them especially concrete nouns because it would be difficult to give long explanations. Another point is the comparison between the two languages. One important and confusing part of the language are false friends. The usage of the first language would facilitate the teacher to help the learners distinguish between the words because a definition will not be effective in this case. He also elaborates on the instances where the usage of the first language would influence negatively. He points that over usage of the first language can make the learners depended on this language. In addition, translation is a literal representation of the meaning and by doing it we can restrict the possibilities of interpretation of that word. It can also reduce the amount of practice in the second language. Based on Krashen's idea (1981) cf. Bailey & Fahad (2021) pg: 540 learners learn the language better if they are exposed to comprehensible input. One of the most comprehensible inputs is the first language. According to him if learners are exposed to inputs with which they are not familiar, they will not be able to understand. Mother tongue serves as a bridge between the known and the unknown, which

in this case is the second language. Teachers can use the first language to give background information. In those cases where learners do not have previous knowledge about a specific text or sentence, teachers' can add information using the first language. This will make it easier and more comprehensible.

*2.2 Strategies used to enhance SLA with the first language*

BDI model is a model that reminds teachers to use all the possible tools to help their learners' second language acquisition. The model is primarily based on Krashen's Input Hypothesis (IH) and Vygotsky's Zone of Proximal Development (ZPD).  Krashen (2003) suggests that pupils learn a language only when the new information is near to their actual understanding. Vygotsky's ZPD shows the difference between what learners can do with help or what they are capable of doing on their own without their teachers or peers interaction. According to Herrea ( 2010) as stated by Montaño-González(2017) Vygotsky's ZPD and Krashen Hypothesis are equivalent.

BDI suggests the usage of strategies that connect what learners know with the new information they encounter. Scholars perceive BDI strategies as social / affective, cognitive and metacognitive tools because they produce independent learners who scaffold their own knowledge step by step until they produce the right utterances (Herrera et al 2011). By using this, strategy teachers' help learners scaffold themselves but it is necessary for them to know their learners' learning styles or strategies, their L1 language proficiency. Moreover they must know their stage of second language development because they may insist too much and force their learners to struggle while dealing with the assigned tasks.

This strategy has three phases:

1.  Activation, the phase where learners brainstorm about the assigned task. They are allowed to collaborate with each other and as well as they can use their first language whenever they need it. In this way, they are making the connection between their actual knowledge and the new information about the new topic.

2.  Connection, the phase where teachers interpret the lesson for their students in different forms trying to make it more accessible for them.

3.  Affirmation, the phase learners affirm what they have previously learnt by producing the new information through examples or communication between each other (Herrera et al, .2011).

## 3. METHODOLOGY

*3.1. Subjects*

The study was conducted at the 9-th grade school of Durres and Tirana Districts. The subjects of the study consisted of teachers who taught English language in these schools. More specifically, the sample of the study consisted of 40 teachers chosen randomly. Their participation in the survey was anonymous and voluntary. Of the subject, 70% were female and 30 % were male. The study was conducted during the second semester of the academic year 2021-2022. It was noticed that the teachers who participated in the survey demonstrated a positive attitude towards the instruction for the survey completion.

*3.2. Research procedure*

For the realization of this research, a questionnaire was distributed. Teachers completed the answers individually. They replied online to the questionnaire, which was sent to them via email. It was estimated that it took 10 minutes to complete the questionnaire because certain questions required argumentation and examples. Since this study tries to represent the role and frequency of first language usage, it's a quantitative study in nature. The data collected and its' analysis are represented by means of graphs.

*3.3. Research questions:*

1.  Which aspects of the second language does the first language influence?

2. When do Albanian learners use their first language and how do they and their teachers react toward this usage?

3. How can we use the first language to develop the target language?

*3.4. Instruments*

The instrument used for this research is the questionnaire. More specifically, data is generated through the distribution of the questionnaire to the teachers. It consists of two main parts. The first one includes background information about the teachers involved in the study such as gender, age-group etc. The second part of the questionnaire contains questions formulated in two different forms, considering the purpose of the research as well as the categories they are addressed to. A number of them are closed-ended questions that require the respondent to provide only short answers, while the rest focus on presenting teachers' ideas and their interpretation of the usage of the first language in the classroom. In this research there are used several types of questions. Firstly, open-ended questions are used to collect teachers' opinions on the usage of the language, its' impacts and situations in which the usage of the first language has helped their students or has been an obstacle for them. As well, they were used to show teachers' ideas toward the usage of the language, it's effectivity and their perception of learners' preferences and reactions toward the usage of the first language in the classroom. Close-ended questions are used for picking up information about the frequency of this usage, the level of the usage. They are used as well to collect information about the teachers. As well to collect information about the agreement of the learners and teachers with the usage of Albanian language in the classroom. A special part of this research focuses on the analyses of the examples and the situations the learners and teachers gave about their life experiences in the classroom.

## 4. ANALYSES OF DATA

The data collected in this research is represented in the form of graphs. Each graph will show the percentage of the answers of the participants. The date collected portrays the perspective of 40 9-th grade school teachers. Despite short answers which, as mentioned will be given in percentage, there will be a section which includes situations or examples given by the teachers.
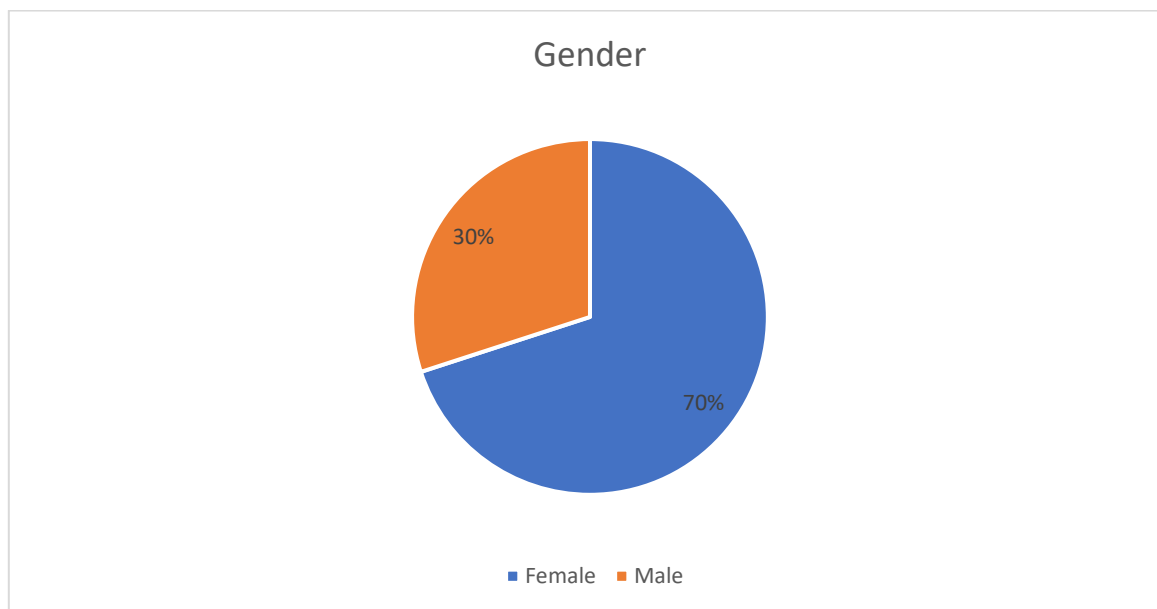
**Teacher's questionnaire**



*Fig. 1.*

The majority of the participants were female while only 30% of them were male. This is a typical characteristic of Albanian schools since the majority of the teachers are females and only a minority of them are males.
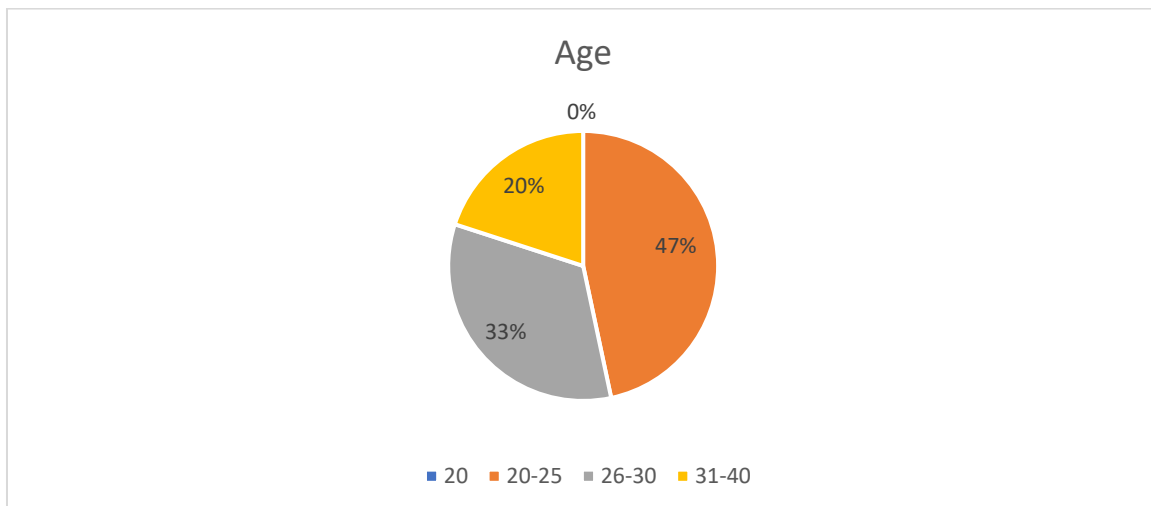
## Age



*Fig. 2.*

The participating teachers had different ages. 20% of them were young teachers between 20 to 25 years old. 47% of them were older than 30 years old. 33% of them are between the ages 26-30
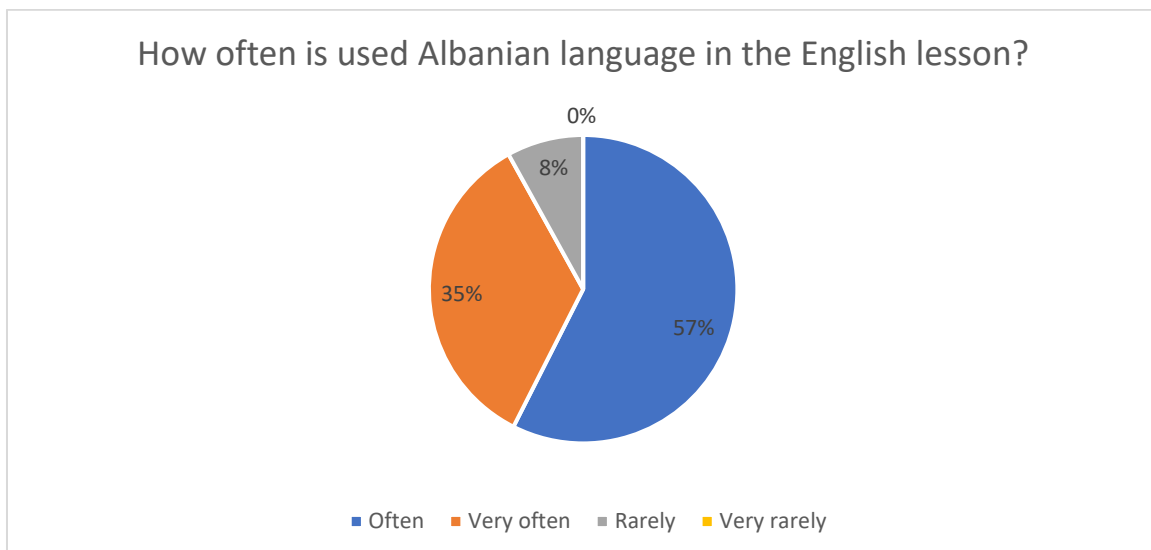
## How often is used Albanian language in the English lesson?



*Fig. 3.*

57% of the participant claimed that Albanian language is used often in their classes. Teachers agreed that Albanian language is used in a considerable amount in their classrooms. 35% of them claimed that the language is used very often while 8% of them stated that Albanian language is not used very much in the classroom. None of the participants claimed to use the language very rarely. This shows once more the importance of the first language as a source, a negotiator between the two languages and the unknown information for the learners.
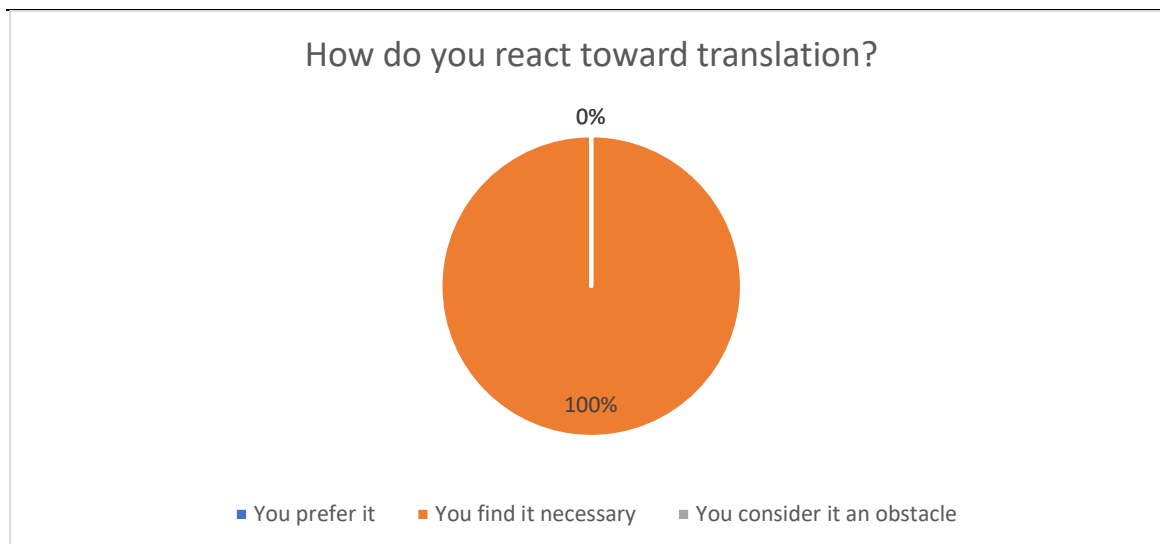
How do you react toward translation?

0%

100%

■ You prefer it   ■ You find it necessary   ■ You consider it an obstacle

*Fig. 4.*

All the teachers find translation necessary and an import element in the learning of the first language. Teachers see this aspect as most important because some of the learners disagree with the usage of the first language. This attitude is a positive aspect supported by several scholars because in this way teachers allow learners to explore and negotiate between the two languages but is very important for them to be aware of negative transferences and to avoid them form happening because this may lead to bad learning.



You would choose

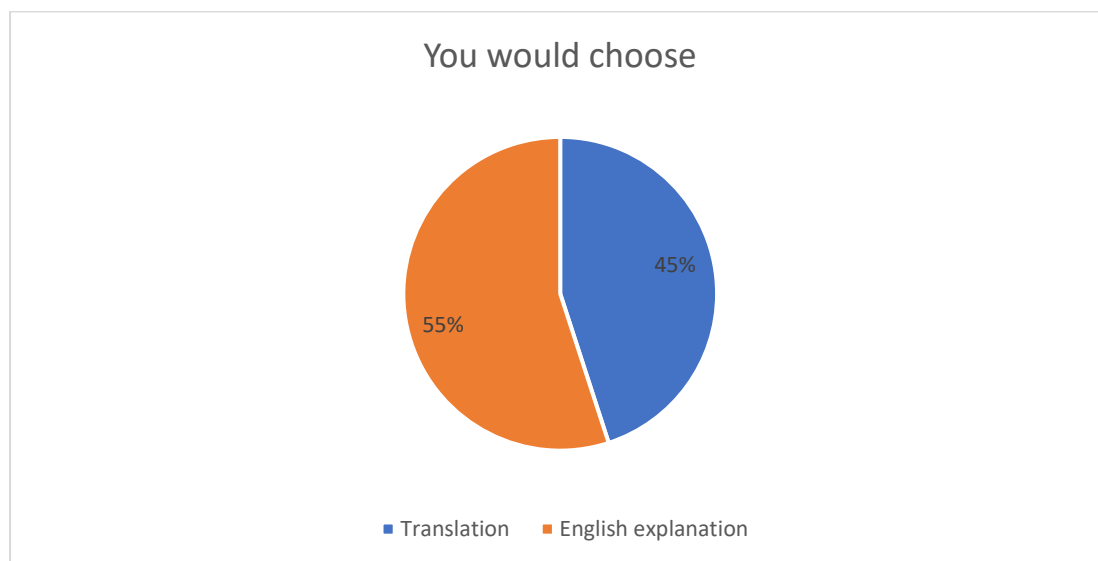45%

55%

■ Translation   ■ English explanation

*Fig. 5.*

The majority of the teachers tend to use English language whenever it is necessary by putting their focus in the second language as a way of learning it faster and memorising better. Some stated that they use the second language because it allows the learners to practice more the learnt language. 45% of them favour translation because they want all their learners to understand them and not only those who are capable in the second language. They state that is easier to show the main idea in this way. Some even state that learners need to understand the phenomenon in their language firstly and then make a connection with the second language.
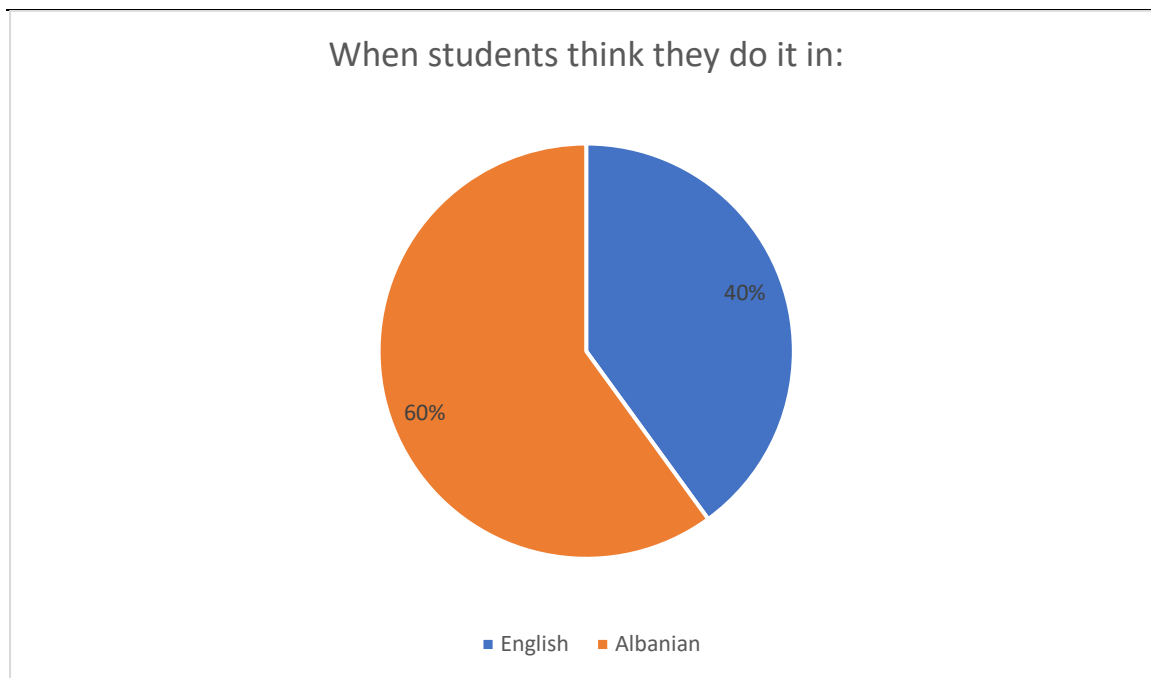
## When students think they do it in:

40%

60%

■ English  ■ Albanian

*Fig. 6.*

60% of the teachers claim that their learners think in Albanian language when they speak in English language. Only 40% of them state that their learners have achieved the necessary proficiency to differentiate between the two languages. Despite the necessity of the first language usage teachers need to help their learners understand the basic differences between the two languages and the effectivity of using the fist language so that learners do not become dependent on it. Thinking in Albanian language is the first step to an irregular development of English language, which will be very difficult to change later on because it is a close usage of the two,which will build thinking schemes that learners will apply in all the possible contexts of usage.

## Do learners use Albanian language structure when they communicate in English?

25%

45%

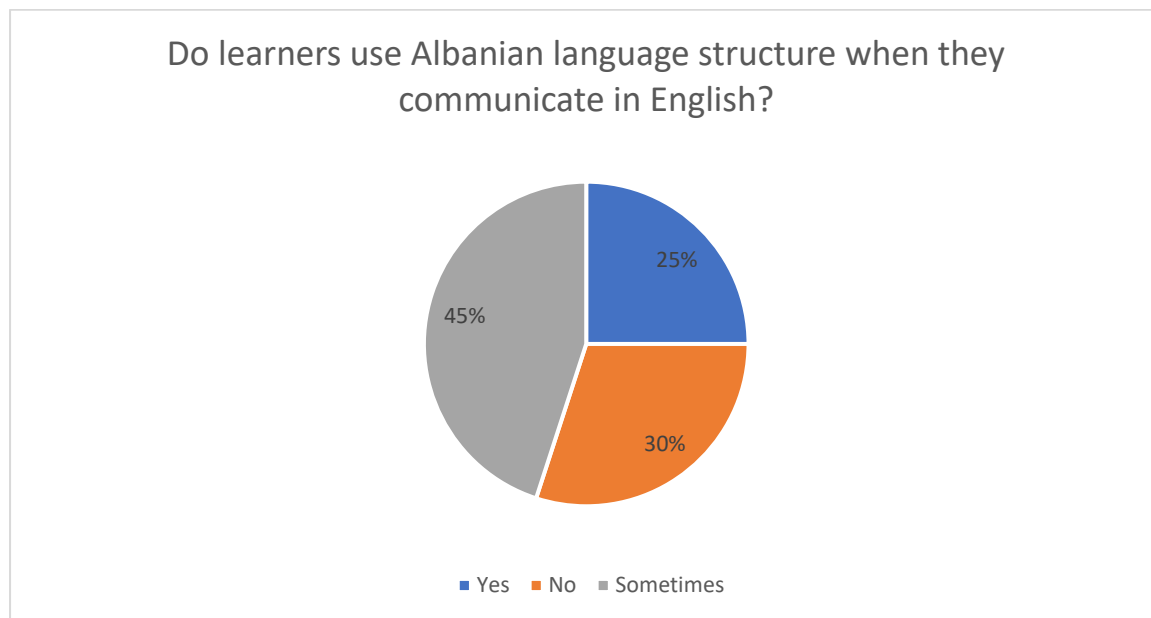30%

■ Yes  ■ No  ■ Sometimes

*Fig. 7.*

45% of the participating teachers claimed that their learners use Albanian language structure when they communicate in English. In this way, they make negative transferences causing problems in their fluency and accuracy. 25% of them state that their learners think and use the same structures in both languages. While 30% of

the teachers have learners, who are good in both languages and know the differences between the two reducing the amount of negative transferences and using their first language only as a support in specific occasions.
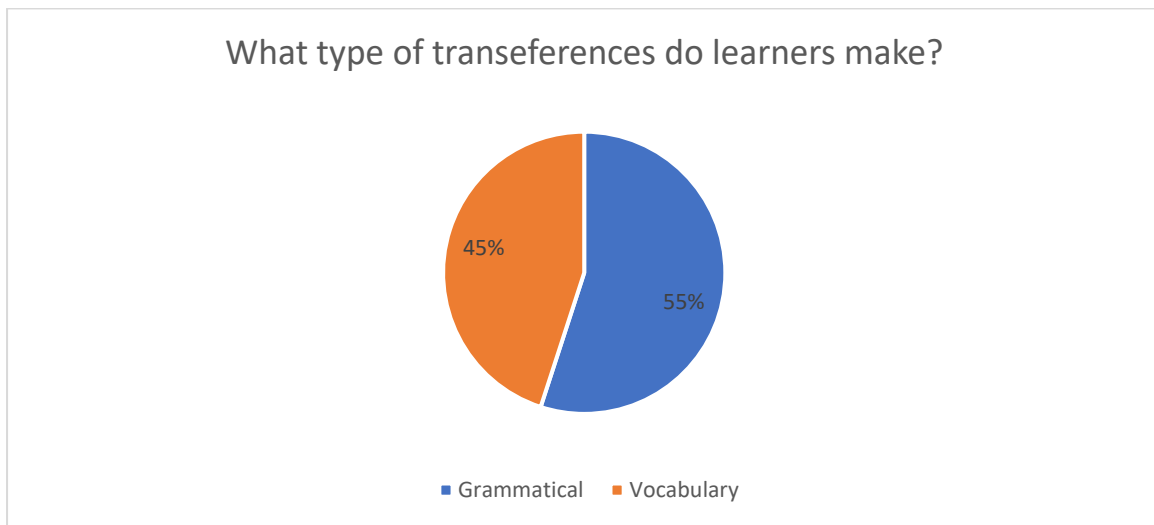


## What type of transeferences do learners make?

45%
55%

■ Grammatical  ■ Vocabulary

*Fig. 1.8.*

Structural differences between the languages seem to be the main problem for the learners. Teachers claimed that learners make sentences same as they would make them in Albanian language. Learners are affected by as well a large amount of vocabulary transferences seem to occur in the classrooms because learners are affected by false friends and not only this but some of them even use Albanian words knowing that these words are not in English language.



## Do you think Albanian language should be used in the classroom?

21%

79%

■ Yes  ■ No
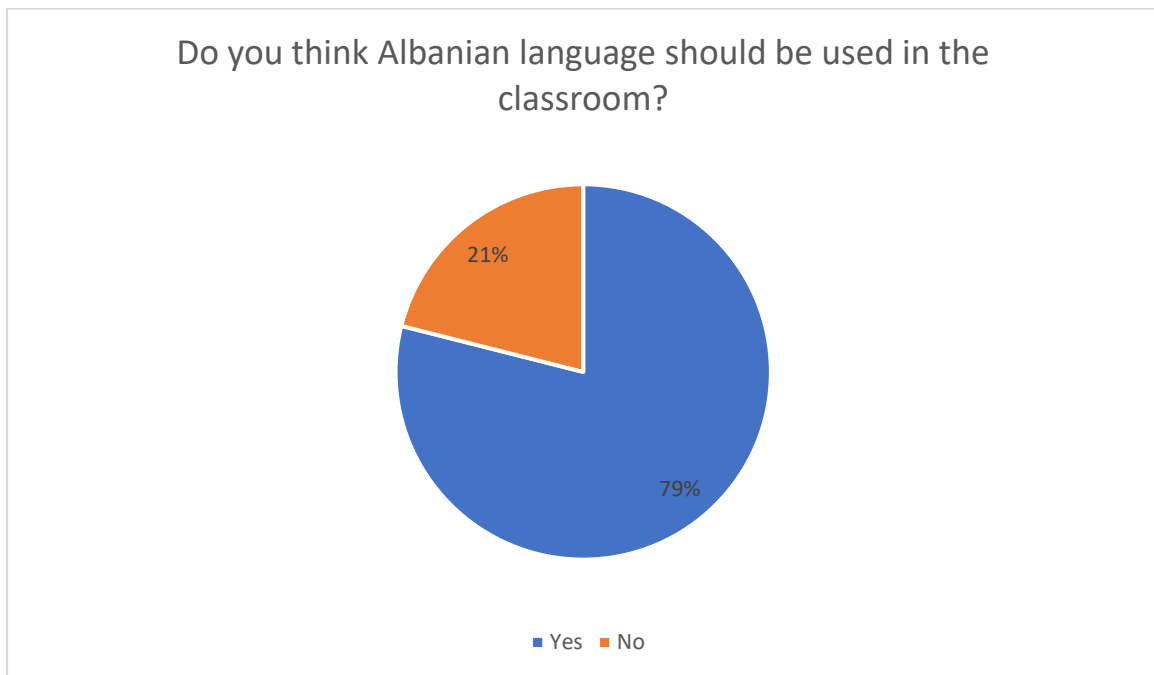
*Fig. 8*

Based on the results Albanian teacher favour the usage of Albanian language in the classroom. We see an agreement between the previous question where they claimed to favour literal translation instead of English explanations or definitions. They stated that is better for learners to make a connection with their first language. While 21% of them disagree with this usage because it is an obstacle of the second language development, and it

may confuse learners' thoughts. Others state that reduction of the first language increases the production of the second language seeing it as a factor, which should be banned from the classrooms.
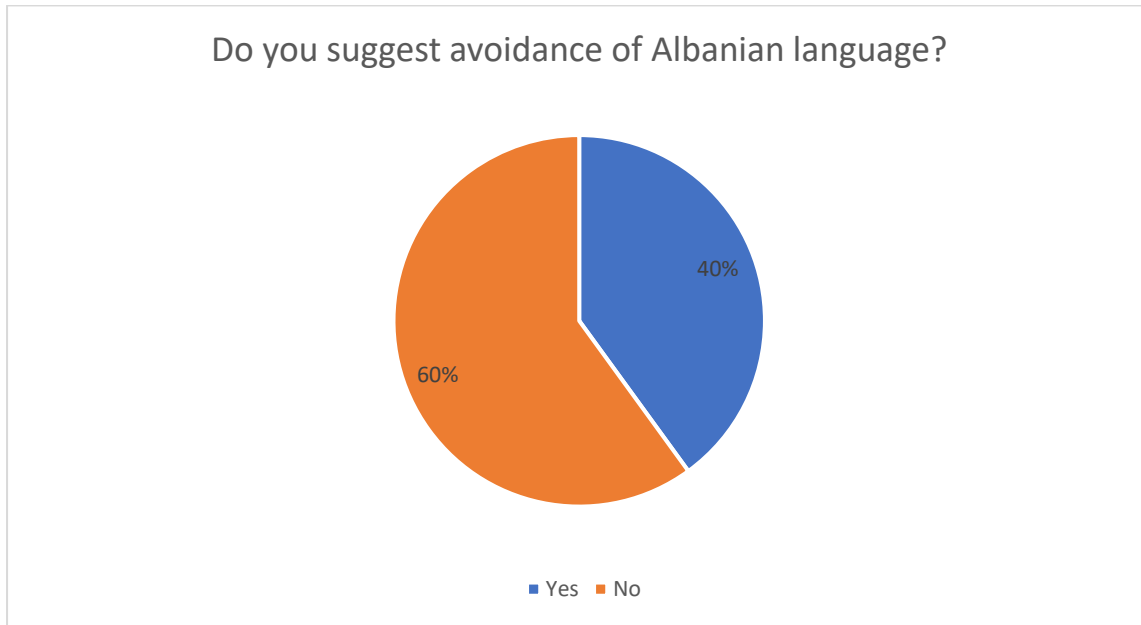


*Fig. 9.*

The majority of the teachers do not suggest their learners to avoid using Albanian language while 40% of them suggest this avoidance and insist on the usage of only English language in the classrooms. Teachers seem to use the first language as a resource in difficult parts of the language. While those teachers who do not allow the usage of Albanian language state that their learners feel already confused with the structure of the second language and using in the same time with Albanian language or at most difficult cases will lead to negative transference of the language.

Reasons are given in the situation and example section below.



*Fig. 10.*

The majority of the teachers claimed that their learners are familiar with words, which sound or look the same in both languages but have different meanings. This fact does not seem to prevent them from making negative transferences as seen in the previous question.

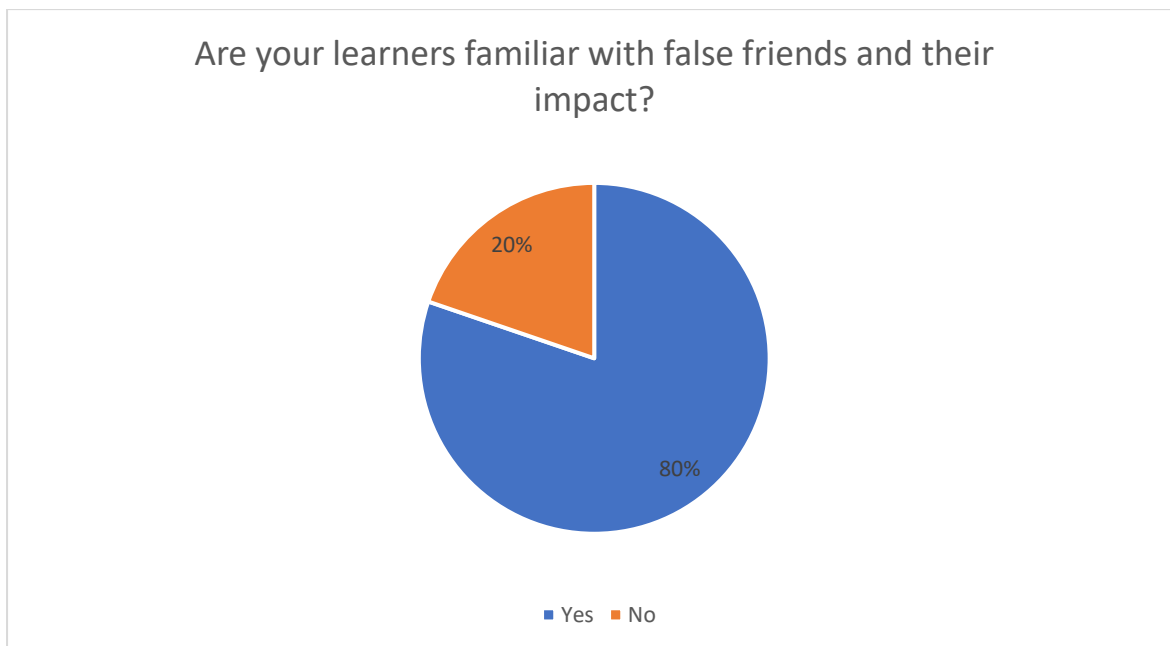While only 20% of them stated that, their leaners are not familiar with this concept and their impacts in misusing the language

**Situation and example section**

**When do learners and teachers use Albanian language in the classroom?**

Teacher state that learners use it when:

They cannot find a word in English
In grammatical sections of the lesson
When they ask something about the new lesson or when they do not understand something, they usually ask in Albanian language.
Teachers as well state that they use Albanian language when they deal with phrasal verbs or idioms, which need translation and explanation.
Moreover, they use it when they explain grammar or give instruction to learners about the tasks they have to perform.

*Strategies teachers use to make learners use English language more:*

Teachers state that they tend to motivate and persuade their learners use English by using easy language and methods of teaching.
Showing them acceptance of mistakes and persuade them to speak despite the mistakes they can make.
They as well suggest them usage of online materials, books and external activities
Many teachers suggest the avoidance and not acceptance of Albanian language in the classroom.
Most of the teachers suggest the usage of group or peer work for extra practice of the language because when learners work in groups, they tend to exchange the language even outside the classroom context. Furthermore, learners of this age tend to be competitive. Being a part of a group will make them more eager to outstand.

**5. RESULTS AND RECOMMENDATION**

*5.1Results*

Regarding the first research question Albanian language affects the way learners think in English. In certain instances, it is a factor of negative transferences because learners think in Albanian and use the same sentence structure and word order, but this leads to literal translation, which is not adjustable and lacks coherence. As well false friends seem to be a worrying element of the language even though the majority of the participants were familiar with the concept but still learners tend to use words based on the similarity in sound or form in both context interchangeably. This creates misunderstandings and wrong usages of English language. Furthermore, over usage of Albanian language can make learners depended on it decreasing the chances of second language fluency and development.

Albanian learners use the first language whenever they have difficulties with the second language. Their source language during the lesson is Albanian language and all the instruction, questions and discussions are conducted in Albanian. They as well use the language to communicate with each other external to the lesson. They use the language especially during grammatical discussion to compare between the languages as a way of understanding the target language better. Learners prefer direct translation in the parts they have difficulties and not explanation in the target language. They consider this necessary for their second language development.

Teachers support the usage of the first language in the classroom in some instances, but they point to the increase of the awareness of the learners toward the peculiar characteristic of each language, which are not interchangeable and can cause misuse of the languages.

The first language is used as a facilitator of the second language. Learners prefer to use it to put forward their thoughts in English. It is used when they work in groups or individually in the preparation of the tasks, they are assigned. This method creates learners that are more independent because they work on their own slowly and then

produce a final product in the target language. False friends create confusion for learners so the usage of the first language directly clears these confusions and provides learners with the right version and meaning of the words.

Low level learners find it difficult to communicate only in English. Being part of an environment where English is the only source of communication, they will not profit anything from the lesson. Using the first language will increase learner participation and will create a more natural setting of learning. Learners of different levels feel more confident and less confused in these types of settings. Teachers claim that it is necessary to use the first language because we provide learners a known medium so that they can work easier with the new language. The first language usage instead of long definitions and explanations is a time saver for them.

Lastly, the first language serves as an indicator of the gaps learners have because whenever they lack knowledge, they tend to use it or its' characteristic patterns. Teachers can use it as a measurement to help learners remove mistaken structures, fill their gaps and help them develop a better understanding of the second language. First language should be a scaffolder of new information and learners must be trained to use it appropriately when necessary.

*5.2 Recommendations*

1) Moderate usage of first language in the classroom.
It is very important for learners to use their mother tongue in the classroom. Learners need to be aware of both languages and use them parallel to facilitate each other.
2) Language comparison
Focusing on similarities and degrees of exchange between the languages will portray internal characteristics between them, which will predicate a more accurate usage of the languages.
The first language should be a part of the medium but not the only source of solving problems and difficulties because learners must be encouraged to explore the second language.
3) Activities teachers can use in the classroom according to Bell foundation (2019) which focus on the usage of the first language as a facilitator:
A) Bilingual and multilingual glossaries
Learners can build their own glossaries through translation of words, which can help them remember the words easily.
B) Note taking
Note taking in both languages is seen as a brain training activity because learners take the input in the second language and they transfer it into their mother tongues. It also serves as a time saver.
C) Online research
This practice would not be adjustable for Albanian learners because the amount of the information in this language is low. This is suggested to be the first step of a research, but teachers need to be attentive because this level of autonomy may cause dependence on the first language and produce literal translation, which is irrelevant because English and Albanian language have different structures. This practice is effective especially when learners work together because they solve the problems of the language.
D) Written drafts in the first language
Learners are suggested to make outlines or frames of works in their own language because this will help them:
-Think faster in the second language
-Provide a broad variety of ideas and options
-Become involved with the topic of discussion
-Low level learners will find a place to express themselves, which will lead to a higher level of participation in the lesson
-Using the first language can serve as a warmup activity for learners to make them more interested in the work. Scholars agree and support the usage of the first language in the second language classes, but they strongly emphasise the tendency of learners to use it all the time and in the majority of contexts. Keeping both languages active in the class but with a balance of usage and especially a focus in English is perceived to be the solution to mistaken usages of the second language.

*Research limitations*

The scale of generalizability of the research is somehow low, this coming from the fact that the sample for this research was collected only from schools of Durrës and Tirana districts. A sample spread in more districts might yield different results. Another limitation of the study is related to the fact that in Albania there are not many studies related to this specific area. The data given is, even though, suggestive of several improvements for the education system in Albanian schools.

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# Comparison of E-commerce Business Models in Terms of Customer Satisfaction

Batuhan Buğra TEKIN[a], Mehtap DURSUN[b], Nazli GOKER[c*]

[a] *Galatasaray University, Industrial Engineering Department, Decision Analysisi Application and Research Center, Ortakoy, Istanbul, Turkey*

[b] *Galatasaray University, Industrial Engineering Department, Decision Analysisi Application and Research Center, Ortakoy, Istanbul, Turkey, mdursun@gsu.edu.tr*

[c] *Galatasaray University, Industrial Engineering Department, Ortakoy, Istanbul, Turkey, nagoker@gsu.edu.tr*

**Abstract**

This study examines current e-commerce business models and customer satisfaction research. The factors that affect the success and efficiency of e-commerce business model are evaluated, and e-commerce business model are evaluated employing Analytic Network Process.

**Keywords:** Analytic Network Process, customer satisfaction, e-commerce business model

## 1. INTRODUCTION

Internet has touched every field. It also affected the field of trade and brought great innovations. In the periods when internet infrastructures started to be used, companies used the system only to promote services and products for advertising purposes. With the solution of systemic security problems and the development of easy-to-use interfaces, companies started to create e-commerce sites where they could sell their products. In 2000, many companies in Western Europe and America offered their products and services online for customer service. For businesses, the internet is no longer just a tool used for advertising and marketing. After this point, the meaning of the term e-commerce has changed. The term e-commerce began to be defined as the process of purchasing over the Internet using secure online payment services. Later, companies started to trade online by establishing online supply chain networks. Finally, many different types of e-commerce market models have been created in online commerce.

The main reason for the increase in the use of e-commerce can be exemplified by the Internet, but it cannot be said that e-commerce is so popular only because of the increase in the Internet. Being in the e-commerce system has many advantages for businesses. It is a system that can provide 24/7 service as it is not based on human power. In this way, companies can always serve their customers. Since there is no need to operate a real store during online sales, businesses have the flexibility to sell without having to pay fees such as office space fees and staff costs. With the development of the e-commerce system, businesses are not limited to their local regions and have the opportunity to address the global market. Moreover, thanks to the online trading system, inventory tracking has become easier and more traceable supply chain networks have been formed.

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\* Corresponding author.

Many companies are involved in this advantageous e-commerce system. Thousands of companies have recently been and continue to be involved in this beneficial ecosystem. This has led to an increasingly competitive environment in online commerce. With the competitive environment, many e-commerce models have been formed to improve the system. These models differ by product variety, opportunity structure, price structure, or operational structure. Businesses should enter the e-commerce market with good market research for their products and the most appropriate e-commerce business model for their product or service.

In this study, the evaluation of e-commerce business models in terms of customer satisfaction is discussed. In this way, companies or new entrepreneurs are expected to support the choice of business model in e-commerce. This study examines current e-commerce business models and customer satisfaction research. In the next steps, surveys is applied to both users and decision makers and data is obtained. Analytic network process (ANP) is applied to the data obtained and a theoretical evaluation of e-commerce business models in terms of customer satisfaction is obtained.

## 2. ANALYTIC NETWORK PROCESS

The Analytic Network Process (ANP) is "a multi measurement theory used to take relative priority of the balance of absolute numbers of individual judgments that also belong to the fundamental scale of absolute numbers" [1]. Steps of ANP are as follows [2]:

Step 1: Describe the control hierarchies in detail including their criteria for comparing the components of the system and their subcriteria for comparing the elements of the system.

Step 2: Determine the hierarchy or network of clusters (or components) and their elements

Step 3: For each control criterion or subcriterion, determine the clusters of the general feedback system with their elements and connect them according to their outer and inner dependence influences.

Step 4: Determine the approach you want to follow in the analysis of each cluster or element, influencing the preferred approach other clusters and elements with respect to a criterion, or being influenced by other clusters and elements.

Step 5: For each control criterion, construct the supermatrix by laying out the clusters in the order they are numbered and all the elements in each cluster both vertically on the left and horizontally at the top.

Step 6: Perform paired comparisons on the elements within the clusters themselves according to their influence on each element in another cluster they are connected to (outer dependence) or on elements in their own cluster (inner dependence).

Step 7: Perform paired comparisons on the clusters as they influence each cluster to which they are connected with respect to the given control criterion.

Step 8: Compute the limiting priorities of the stochastic supermatrix according to whether it is irreducible (primitive or imprimitive [cyclic]) or it is reducible with one being a simple or a multiple root and whether the system is cyclic or not.

Step 9: Synthesize the limiting priorities by weighting each idealized limit vector by the weight of its control criterion

## 3. CASE STUDY

The "ANP" method was applied to assess the effects of all criteria and endpoints determined in the study on each other. Choosing among the options in practice, 8 main criteria and 17 sub-criteria, given in Table 1, are taken into account. At the end of the application, the most effective in terms of customer satisfaction among 5 options is selected. The surveys were conducted only with decision makers knowledgeable in the field of e-commerce. The survey was conducted during the "Zoom" meeting and lasted 40 minutes.

Table 1. Criteria and sub-criteria

| Criteria | Sub-criteria |
|---|---|
| Reliability | Accuracy of product information<br>Payment security<br>Confidentiality of customer information |
| Accessibility | Diversity of communication channels<br>Response speed of communication channels |

| Performance | Site infrastructure speed |
| | Technical competence of the site |
| Design | Site image and graphic design |
| | Ease of use |
| Diversity | Diversity of payment methods |
| | Multiple language options |
| Product | Low price |
| | Product performance |
| Delivery | On time and quick delivery of the product |
| | Complete and error-free delivery of the product |
| After-sale service | Performance of warranty services |
| | Ease of return and cancellation |

A meeting was held with 5 decision makers to determine the importance of the criteria. The process of determining criteria and alternatives was shared with decision makers. Decision makers performed pairwise comparisons for each criterion. The importance levels of the criteria were determined by the decision makers and matched comparison matrices were created.

After transferring the data to the "Super Decision 3.2.0.0" program, an unweighted super matrix, a weighted super matrix and a limit matrix were obtained, respectively. The priority values of the criteria were obtained using the comparison data as in Table 2.

Table 2. Importance of sub-criteria

| Sub-criteria | Importance degree |
| --- | --- |
| Accuracy of product information | 0.036 |
| Payment security | 0.075 |
| Confidentiality of customer information | 0.070 |
| Diversity of communication channels | 0.011 |
| Response speed of communication channels | 0.022 |
| Site infrastructure speed | 0.026 |
| Technical competence of the site | 0.026 |
| Site image and graphic design | 0.040 |
| Ease of use | 0.040 |
| Diversity of payment methods | 0.008 |
| Multiple language options | 0.004 |
| Low price | 0.092 |
| Product performance | 0.031 |
| On time and quick delivery of the product | 0.025 |
| Complete and error-free delivery of the product | 0.008 |
| Performance of warranty services | 0.008 |
| Ease of return and cancellation | 0.008 |

When the priority values of the sub-criteria are examined in the table, it can be seen that the most important factor positively affecting customer satisfaction is low price followed by are payment security and customer information privacy. It has been determined that the factor with the least impact on customer satisfaction is multiple language options.

The program created an order of priority among the options, shown in Table 3, by determining the best alternative based on the weightings of the criteria.

Table 3. Ranking of alternatives

| Alternatives | Rank |
| --- | --- |
| Horizontal business model | 2 |
| Marketing model | 3 |

| | |
|---|---|
| Private shopping | 4 |
| Group purchase site | 5 |
| Vertical business model | 1 |

## 4. CONCLUSIONS

To rank the e-commerce business model, evaluation criteria that influence success are determined through expert opinions and then ANP is employed. Importance weights of concepts are assigned by applying IFCM methodology, time scheduling and self-motivation is the most important factors however construction of a working area and getting dressed as in the office are the least important criteria. Future research will focus on proposing group decision making approaches for determining the most appropriate e-commerce business model.

**Acknowledgements**

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# The Meaning of Life in Students - Comparative Pilot Study

## Ľudmila MAJERNÍKOVÁ[a*]

*ᵃ University of Prešov in Prešov, Faculty of Healthcare, Department of Nursing, Prešov,*
*ludmila.majernikova@unipo.sk*

**Abstract**

The question of the meaning of life and death is a question that has been present in human life since time immemorial. We can say that these questions arise from the very nature of our being, from our nature. According to Viktor Frankl, the questions that concern the meaning of our life, whether they are explicitly asked or only vaguely suspected, are specifically human questions [1]. The meaningfulness of everything, not just the meaning of life and death, is a human question. By man is a being who possesses reason and is aware of its greatness, it is worthy to say that it is only he who seeks and finds the meaning of everything that touches humanity. This theme has not escaped scientific scrutiny. Even today, this issue seems to be very topical and urgent. Today there are many people who intensely experience a feeling of inner emptiness, incompleteness, general dissatisfaction and, conversely, there is also an increasing number of people who are seeking inner fulfilment and searching for the true meaning of their lives. We were also interested in whether the level of life meaningfulness is higher in secondary school students or university students.

**Keywords:** *quality of life, meaning life, student.*

## 1. INTRODUCTION

The meaning of life has a hierarchical composition arranged in a complex system in which the parts are interconnected and related to each other. It can be stated that the sources of the meaning of life are certain components of this system, its basic building blocks. In conjunction with this, attempts have been made to delineate specific characteristics that would help to describe the nature of the system of meaning in a particular individual. Reker named these properties the dimensions of meaning in life and proposed to distinguish four properties: structural components, the content of the experience of meaning (i.e., the sources of meaning), the breadth of meaning (the distinctiveness of meaning), and the depth of meaning (the quality of meaning in life). Sources of meaning in life refer to two dimensions namely: breadth of meaning in life and depth of meaning in life [2]. Breadth of meaning in life refers to an individual's tendency to experience meaning in life based on engagement in multiple values. It is about having one's meaning built on one strong value or on several not necessarily identical values that allow an individual to derive his or her meaning in life in different situations and based on different experiences [2, 3]. Thus, the breadth of meaning can be characterized as a measure of the variety of resources that fulfill the needs of meaning. Theoretical reflections on this dimension of meaning in life have raised several question marks, whether one has one main source of meaning or more. Research in this domain has demonstrated a tendency for most people to have multiple values [4]. According to Reker [2], depth of meaning in life refers to the quality of the experience of meaning. Two approaches to defining this dimension are included in the literature. Ebersole understands the depth of meaning in life as the intensity and complexity of the experience of meaning in life. He developed a qualitative method with criteria for assessing depth

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* Corresponding author.

of meaning with five classes of depth: deep, above average, average, below average, and shallow. Reker and Wong conceptualize depth of meaning in life as the level of self-transcendence that an individual realizes. They distinguish four degrees of depth: a. Self-preoccupation - the prevalence of the search for gratification and comfort, b. individualism - the predominance of the realization of personal potential, c. collectivism - the predominance of service to others and participation in public social and political affairs, d. Self-transcendence - the prevalence of values transcending the individual towards a sense of the whole world and ultimate [5]. In analyzing this categorization, Van Ranst and Marcoen found the identity of the 3rd and 4th degree factor, so they narrowed the categorization to three degrees, calling the third-degree self-transcendence. Halama, also taking inspiration from the work of Reker and Wong, elaborated on a four-stage classification of this dimension, but which was divergent, reflecting the specific statements made by the respondents in the Meaning of Life Profile questionnaire. They consisted of the following scales:

A. self-satisfaction - a value representing a direction towards one's own utility, interpreting the effort to fulfill one's basic needs.
B. striving for social support - a value oriented towards social relationships (family, friends, partner) and the support one receives from them,
Self-actualisation - a value that refers to the pursuit of self-improvement and fulfilment of one's potential,
C. self-transcendence - a value by which a person transcends himself by orienting himself towards other people (e.g., helping), towards the well-being of the whole, or towards the fulfillment of religious or philosophical ideals [6].

Also, in connection with the depth of meaning in life, questions have been generated about its relation to the degree of life meaningfulness, or to optimal functioning. In Reker research found that individuals who pursued meaning at levels 3 and 4 of his categorizations had more fulfilled lives than those who pursued it at levels 1 and 2. In Halama research also addressed differences between groups defined by the depth of realized meaning in the level of experienced meaningfulness. While the results for high school students were not very satisfactory, for college students the lowest score on the PIL questionnaire was for the self-focused group, the slightly higher scores were for the group focused on seeking social support and on self-realization, and the highest score was for the group focused on self-transcendence. This finding highlights the importance of self-transcendence as part of the meaning of life system [2].

## 1.1 Aim and methods

The empirical part of our work was carried out in the form of a survey. In the survey of our work the following problem was addressed: What is the level of meaningfulness of life among students at the secondary school and university?
Subsequently, we set the main goal of the work. The main objective of our survey was to find out, analyse and evaluate the level of meaningfulness of life among the students at the secondary school and college. In the context of the main objective, we formulated partial objectives:
Partial Aim 1: To find out the overall level of meaning in life among students at the secondary school and university.
Partial Aim No. 2: To compare the level of meaning in life of students at the secondary school and university on each dimension.
The study population represented 92 respondents - 81 women and 25 men. The questionnaires were collected from two locations (Košice and Prešov). The results were collected in November-December 2021. We purposively sampled high school and university students.
The Life Meaningfulness Scale [7], based on the three-component model of the meaning of life, was used to ascertain the level of life meaningfulness. The scale has three dimensions (cognitive, motivational, and affective), each of which contains 6 items. The cognitive dimension is understood as the overall direction in life, life mission or understanding of life (example item Have I succeeded in finding a certain mission or task in my life?) The motivational dimension refers to goals, plans and the level of commitment to them (Do I have goals in life that I would like to fulfill?) and the affective dimension represents life satisfaction, fulfillment, optimism coming from experiencing the meaning of life (Am I satisfied with my life even though it is sometimes difficult?). Respondents answer the items on a Likert scale ranging from 'do not agree at all' to 'agree completely'. Based on the responses, it is possible to calculate an overall life meaningfulness score, but also a raw score from each dimension. The total scale score takes values from 18 to 90. To ascertain the internal consistency of the scale, Halama used Cronbach's alpha coefficient, which was 0.87 (or 0.78 for the cognitive, 0.76 for the motivational, and 0.78 for the affective dimensions). Using correlations with several other scales (PIL, Noodynamics Test, PMI - Meaning in Life Index), the author verified the validity of

the scale, and the resulting correlation coefficients ranged from 0.48 to 0.80 for the dimensions of the scale and from 0.68 to 0.81 for the total score, indicating sufficient validity of the scale [7].

The results of the survey were processed using statistical methods of descriptive statistics - calculating frequency (n) and percentages (%), calculating mean (M), standard deviation (SD), maximum and minimum values (max - min). Using t-test (Student's distribution), we compared statistically significant differences between two matched sets of respondents.

*1.2  Results*

A total of 92 respondents participated in our survey (via an online questionnaire), of which 35 respondents (12 males, 23 females) were secondary school students and 47 students (30 females and 17 males) were undergraduate students.

The total score of the Life Meaningfulness Scale for the respondents was 68.63, with the highest possible score on that measurement tool being 90. Across the domains, respondents scored highest in the Affective Dimension D3 (27.08 ± 2.98), lower in the Cognitive Dimension D1 (24.02 ± 2.99), and lowest in the Motivational Dimension (17.53 ± 2.95). The highest possible score in each dimension has a value of 30 (Figure 1).
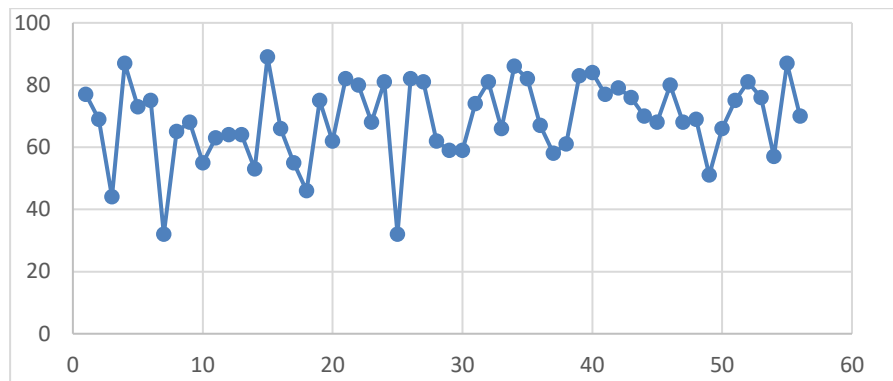


*Figure 1 Graphical representation of the total score of the Life Meaningfulness Scale*

In our work, we compared two groups of students - undergraduate and high school students - using the Life Meaning Questionnaire. On the basis of the analysis of the obtained data according to the methodology compiled by the author of the questionnaire Halama (2002), we found that there were no significant differences between the groups of respondents we studied. High school students scored lower overall (68.36 ± 9.87) than college students (68.9 ± 9.77). High school students scored lower on each dimension. In the Cognitive dimension, the mean scores were 24.02 for high school students and 24.62 for college students; in the Motivational dimension, high school respondents scored a mean of 17.53 and college respondents scored a mean of 18.36. The Affective dimension was also evaluated based on the analysis of our questionnaires in favor of high school students, where they achieved a mean score of 25.92.

Tab. 1 Results of the Life Meaning Scale Comparison

| Dimensions | Students at secondary school SS (n 35) | | |
|---|---|---|---|
| | M | SD | Min-max |
| **D1** Cognitive dimension | 24.02 | 2.99 | 22- 30 |
| **D2** Motivational dimension | 17.26 | 2.95 | 23 - 30 |
| **D3** Affective dimension | 27.08 | 2.98 | 20 - 29 |
| **LMS global score** | 68.36 | 9.87 | 37 - 85 |
| **Dimensions** | University students US (n 47) | | |
| | M | SD | Min-max |
| **D1** Cognitive dimension | 24.62 | 2.82 | 22- 30 |
| **D2** Motivational dimension | 18.36 | 2.55 | 23 - 30 |
| **D3** Affective dimension | 25.92 | 2.68 | 20 - 29 |
| **LMS global score** | 68.9 | 9.77 | 32 - 98 |

N - number, M - average,
SD - standard deviation,
Min - max - minimum and maximum values

Using a t-test, we found statistically significant differences in the responses between the compared groups of students, with the cognitive dimension, motivational dimension, and total LMS questionnaire scores analyzed in favor of the undergraduate students. Only in the affective domain did the university students achieve statistically significant responses.

Tab. 2 Statistical evaluation of the Life Meaning Scale comparison

| Dimensions | respondents (N =92) | | |
|---|---|---|---|
| | | | **p** |
| **D1** Cognitive dimension | **US (47)** | **SS (35)** | 0,004 |
| **D2** Motivational dimension | **US (47)** | **SS (35)** | 0,000 |
| **D3** Affective dimension | **US (47)** | **SS (35)** | 0,000 |
| **LMS global score** | **US (47)** | **SS (35)** | 0,008 |

p - the level of statistical significance

*1.3 Discussion*

In our work, we hypothesized that there is a statistically significant difference in the level of life meaningfulness between high school students and college students. Our survey was conducted in the cities of Košice and Prešov, addressing students using the standardized online questionnaire Life Meaningfulness by Halama.

The results showed that students achieved an overall Life Meaningfulness Scale score of 68.63, with the highest possible score on the measurement tool being 90. In each domain, respondents scored highest in the Affective dimension (27.08 ± 2.98), lower in the Cognitive dimension (24.02 ± 2.99), and lowest in the Motivational dimension (17.53 ± 2.95). The highest possible score in each dimension has a value of 30.

The aim of the Tomšík research [8] was to verify the differences in the level of life meaningfulness with respect to age, gender, and place of residence while attending school. The author hypothesized that there is a statistically significant difference in the level of life meaningfulness between high school students and university students, a difference in the level of life meaningfulness in terms of age and place of residence during study (dormitory, home environment). Through the research the author confirmed that there are no gender differences and differences between Czech and Slovak university students in the expression of life meaningfulness but there are significant differences in terms of age and home environment.

Fabián [9] in another research investigated the influence of spirituality on the perception of meaningfulness in adolescents. The results of the research indicate a significant relationship between the active practice of faith and the perception of meaningfulness in this age group.

In the research conducted by Tomsik [8], 249 college and high school students participated in the research. The study used measurement tool by Halama as we also used it in our survey. The mean score of the surveyed respondents was lower (66.12) than in our survey. The original Slovak questionnaire Profile of Sources of Meaning, or the Sources of Meaning Questionnaire [7] allows to find out the specific values that provide a given person with the experience of the meaning of life, the subjective significance of the given values, and on the basis of a qualitative analysis, the degree of transcendence of each value.

Cognitive component - refers to the cognitive framework that contains beliefs, values, and assumptions about oneself, the world, and one's life. "An indicator of a developed cognitive component of meaning in life is a high degree of purpose in life, an awareness of coherence and order in life, and an awareness of one's ultimate purpose and mission in life" [2]. Conversely, experiences of chaos and purposelessness of one's life are manifestations of an unsatisfied need for meaningfulness in life and existential emptiness. In our research, college students scored statistically higher on the cognitive dimension (M 24.62) than high school students (M 24.02) at the p=0.004 level of significance.

Motivational component of meaning in life - includes goals, values and activities that an individual finds valuable and important and also investing energy and time in pursuing them. "A well-developed motivational component is characterized by the presence of various values and goals, a high degree of commitment and effort to fulfill them, and also the ability to strive for goals despite obstacles and setbacks" [2]. An underdeveloped motivational component results in a lack of life goals, activities, experiencing boredom, apathy, and hopelessness regarding possible goal attainment. Also in this area, as it can be seen from the results of our analysis, the better scores were achieved by university students (M18.36) compared to high school students (M17.26), with the level of statistical significance reaching p=0.000.

The affective component of the meaning of life - the realization of the goal is associated with positive experiencing and, on the contrary, obstacles that make it impossible to continue on the path to the goal are associated with negative experiencing. A strongly developed affective component can be identified through various positive emotions and

feelings related to life such as happiness, optimism, satisfaction. On the other hand, a weakly developed affective component is manifested by experiencing dissatisfaction, unhappiness, depression, sadness as well as anxiety and pessimism [7]. Only in this domain we observed better scores in high school students (M27.08) compared to college students (M25.92), and the level of statistical significance was high at the level of p=0.000.

*1.4 Conclusion*

It is very important to be aware of how the lack of meaningfulness in life affects the psychological state of a young person, what the warning signs are and how we should act in each situation. This is an issue that has been very topical in recent years, but one that few people have addressed in practice. Therefore, we think that it is necessary to be informed about this topic. Lack of life meaningfulness has a great impact on the formation of personality, feelings, and future life of adolescents.

The aim of our work was to find out the level of life meaningfulness of students studying in high school and college and to evaluate each area of life meaningfulness according to a standardized questionnaire and compare their differences. We found differences in the approach to the meaning of life in the overall perception of meaningfulness as well as the perception of its dimensions according to the cognitive, affective, and motivational dimensions in favor of college students compared to high school students, except for the affective aspect of the perception of lived life meaning.

In the process of forming the meaning of life, the formation of a relationship with values is a particularly important issue. Values are determining for a person, and he approaches them by setting certain goals or living a life that meets the quality of the chosen value. A child has different values, a young person has different values, an adult has different values. The family in which an individual grows up, the environment, meeting certain people, experiences, experiences, life situations, but also the search for an answer to the question of the meaningfulness of one's life, have a significant influence on the individual's value ranking.

**Acknowledgements**

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# Preparing Students in the Helping Professions and Burnout Syndrome

## Ľudmila MAJERNÍKOVÁ[a*]

*[a] University of Prešov in Prešov, Faculty of Healthcare, Department of Nursing, Prešov,*
*ludmila.majernikova@unipo.sk*

**Abstract**

Personality characteristic might be important factors influencing the individual abilities to cope with the burnout syndrome. Aim of the study was to examine the relationship between personality factors such as self-evaluation and sense of coherence and burnout syndrome among students of nursing. Together 130 university students of nursing, (average age $20.85\pm2.94$; 97% females). Scale Burnout Inventory (SBI) in the school was use for assessing the burnout levels. Sense of Coherence Questionnaire (SOC) and Rosenberger's Self Esteem Scale (SES) were use as well. Significant negative relationship was found between burnout syndrome and self-esteem ($p \le 0.01$), as well as sense of coherence ($p \le 0.01$); it means that higher levels of self-esteem and sense of coherence was associated with lower burnout syndrome levels among students. Conclusion: Personality factors are strongly link to burnout among students. It is important therefore to follow and guide the predisposition suitably used in the management of entitlements study, as they tend to persist after a period of professional practice. It is therefore considered that improving the skills of coping with stress among students is beneficial in preventing subsequent occurrence of burnout in the profession of nurse.

**Keywords:** nursing, burnout, self-esteem, a sense of coherence.

## 1. INTRODUCTION

The concept of burnout was introduced in 1975 by the psychoanalyst, Herbert Freundenberg. He defines it as a final stage, in which people are emotionally dried out; lose their original enthusiasm and motivation [1]. The key factors of burnout are feeling exhausted and worn out, overall fatigue. The clinical picture of burnout is reminiscent of depression; it is the opposite of positive symptoms such as joy, contentment, and serenity. It is associated with negative emotions such as fear, anxiety, and anger. Most often it occurs in people in permanent social contact, people in isolation or performing monotonous work [2]. Burnout initially operates subtly. A common trigger is a change to one's job (especially promotion) or a new job. According to Bartová [3] the most vulnerable groups are doctors, nurses, psychologists and psychiatrists, social workers, teachers at all types of schools, staff in correctional facilities for juveniles and adults, police officers, managers and businesspeople. Maslach and Leiter [4] in their study highlighted the importance of personality and socio-demographic predictors such as age and level of education, which are important predictors for the development of burnout syndrome. Working conditions are also identified as significant factors affecting burnout. Everyone has a different degree of adaptability to stress factors operating on them. Burnout is a threat to people who have the following personality traits listed in Table 1.

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* Corresponding author.

Tab. 1 Predetermining personality characteristics [1, 5]

| According to Zacharová | According to Kebza, Šolcová |
|---|---|
| Enthusiasm for the thing in question | High level of empathy |
| Dedication to the given thing is meaning of life for them (workaholism) | Self-sacrifice, high level of sensitivity |
| Increasing the demands on oneself | High focus on others, |
| Experiencing failure as a personal obstacle | Idealism |
| Taking on an excessive amount of work | Anxiety |
| Inability to delegate responsibility to others (desire to have everything under control) | Pedantry |
| Inability to relax and rest | Enthusiasm |
| Low self-confidence | Tendency to identify with others |
| Experiencing shock from reality (for the reason of high ideals) | Inability to ask others for help |
| Permanently experienced pressure from several sides (work, family) | |

Several studies indicate a /to/ significant influence of personality predictors for the development of burnout. Among the most important predictors belong the ability to cope with stressful situations, disposition of coping strategies [6, 7, 8], disposition of selected individual personality characteristics from view of personality equipment /which is associated with resistance to burnout, higher degree of self-esteem and internal locus of control [9], the ability to resist the most adverse life circumstances and sense for the integrity, characterized by a tendency to see the world as consistent, relatively predictable, comprehensible [10]. The issue of burnout has proved to be relevant in students of healthcare disciplines (non-medical). The research focus is mainly on students in the health and helping professions, for which is observed a risk to burnout, lower quality of life, and increased risk of depression, experiencing negative emotions [11, 12]. For this reason, we focused attention on nursing students, future nurses during their in pre-gradual study - bachelor's degree.

## 1.1 Research methodology

Research was conducted to determine the existence of relationships between personality factors of self-esteem, a sense of coherence and the prevalence of burnout among students in the first level of university education in the field of nursing in the 2nd to 3rd year in terms of age, type of previously completed high school education, years of study in the field.

In the study we obtained the necessary data using three standardized questionnaires. To measure the level of burnout the School Burnout Inventory (SBI) scale was used. This tool is specifically designed for the purpose of determining the level of burnout in the school environment; its advantage is therefore its targeted nature and timeliness for the selected sample group of the study. The questionnaire consists of nine items scored using a Likert scale (from 1 ─ fully agree, up to 6 ─ strongly disagree). The maximum score on the questionnaire is 54, with higher scores indicating higher levels of burnout [13]. To detect levels of self-esteem the Rosenberg self-esteem scale (RSS) was used with a maximum score of 30 points. A higher score means a higher level of self-esteem [14]. In the study, we used the standardized questionnaire and Sense of Coherence Inventory (SOC) - Antonovsky scale, which consists of thirteen items [15]. The questionnaire uses a 7-point Likert scale for scoring responses. The maximum score is 91 on the scale; a higher score obtained on the questionnaire would imply an increased sense of coherence.

For processing the results of the research, we used statistical methods of descriptive statistics – calculation of frequency (n) and percentage values (%), calculation of the average scale values (M), standard deviation (SD). For statistical processing of our data, we used SPSS 15.0 software. For statistical comparison of observed groups, we used the t-test (Student's t-distribution). This statistical methodology enabled us to identify statistically significant differences between groups for the monitored parameters. Correlation analysis (Pearson correlation coefficients calculation) was used to detect interactions between variables. All tests were performed at the significance level $\alpha = 0,05 = 5\%$ .

Sample group: a total of 130-day bachelor's students in the field of nursing in the second and third years at the Faculty of Healthcare at the University of Prešov in Prešov. The response rate was 86.6%; data collection took place in February 2016. Most students (97%) were women; the mean age was 20.85 ± 2.94. More than half of respondents had completed high school education with healthcare specialization. The sample consisted of 50% of students in the second year and 50% in the third year of study. More information on the respondents is presented in Table 2.

Tab. 2 Demographic characteristics of respondents

| Gender | n | % |
|---|---|---|
| **Female** | 127 | 97 |
| **Male** | 3 | 3 |
| **Age** | **n** | **%** |
| **20 – 21 years** | 81 | 62 |
| **22 – 25 years** | 47 | 36 |
| **26 and more years** | 2 | 2 |
| **Completed high school education** | **n** | **%** |
| **Healthcare high school** | 68 | 52 |
| **Other** | 62 | 48 |
| **Year of study** | **n** | **%** |
| **Second** | 65 | 50 |
| **Third** | 65 | 50 |

*1.2 Results*

The average value of each of the variables studied by us is presented in Table 3. The average burnout score using SBI in the whole sample was $24.92 \pm 7.63$, the level of self-esteem $18.7 \pm 4.62$ and a sense of coherence was $59.61 \pm 11.64$.

Tab. 3 Average values of monitored variables in the whole sample

| Variable | | Respondents | |
|---|---|---|---|
| | | **M** | **SD** |
| **O1.** | Burnout syndrome | 24.92 | 7.63 |
| **O2.** | Self esteem | 18.07 | 4.62 |
| **O3.** | Sense of coherence | 59.61 | 11.64 |

Tab. 4 Comparison of variables based on type of completed high school education

| Variable | | Non-healthcare | | Healthcare | | p |
|---|---|---|---|---|---|---|
| | | **M** | **SD** | **M** | **SD** | |
| **O1.** | Burnout syndrome | 24.89 | 7.58 | 24.95 | 7.75 | 0.567 |
| **O2.** | Self esteem | 18.13 | 4.57 | 18.02 | 4.68 | 0.461 |
| **O3.** | Sense of coherence | 59.65 | 11.68 | 59.54 | 11.75 | 0.523 |

Key to the significance of the statistical results * $p < .05$; ** $p < .01$; *** $p < .001$

In terms of comparing groups of students with completed healthcare high school education (52%) and non-healthcare education (48%) we found at the level of average value of individual factors, a higher burnout score was among the healthcare-educated group. The level of self-esteem and sense of coherence was judged more highly among the non-healthcare educated group. The significance of the difference was analysed using the Student's t-test, but in our sample of respondents, correlation between prior healthcare education and likelihood of experience with this problem was not confirmed by a statistically significant difference (Tab. 4).

Tab. 5 Comparison of variables in terms of age

| Variable | | 21 years and under | | 22 years and over | | p |
|---|---|---|---|---|---|---|
| | | **M** | **SD** | **M** | **SD** | |
| **O1.** | Burnout syndrome | 24.04 | 7.62 | 25.8 | 7.95 | 0.042* |
| **O2.** | Self esteem | 18.33 | 4.44 | 18.00 | 4.72 | 0.461 |
| **O3.** | Sense of coherence | 60.75 | 11.42 | 59.04 | 11.55 | 0.501 |

Key to the significance of the statistical results * $p < .05$; ** $p < .01$; *** $p < .001$

In terms of age, significant differences were found in for the group of students in the age category under 21 years in the overall mean score for SBI on the level of * $p < .05$. The lower value for burnout syndrome was reported by respondents in a lower age category. In other areas of measurement, based on second-degree analysis we did not find significant differences in the observed groups. (tab. 5).

Tab. 6 Comparison of variables in terms of year of study

| Variable | | 2<sup>nd</sup> year | | 3<sup>rd</sup> year | | p |
|---|---|---|---|---|---|---|
| | | M | SD | M | SD | |
| O1. | Burnout syndrome | 23.91 | 7.51 | 25.92 | 7.98 | 0.039* |
| O2. | Self esteem | 19.23 | 4.51 | 17.55 | 4.62 | 0.046* |
| O3. | Sense of coherence | 61.55 | 11.55 | 58.03 | 11.35 | 0.033* |

Key to the significance of the statistical results * p < .05; ** p < .01; *** p < .001

We also compared the group of respondents in terms of year of study at the Faculty of Healthcare at Prešov University. Students from the lower year had a lower level of burnout (at p <.05) and a higher level of personality characteristics of self-esteem (at significance level of p <.05) and sense of coherence (at a significance level of p <.05).

Tab. 7 Correlation relationship of monitored variables

| | Length of study | Type of high school | Burnout syndrome | Self esteem | Sense of coherence |
|---|---|---|---|---|---|
| **Length of study** | 1 | 0.05 | **0.41*** | **-0.34**** | **-0.44*** |
| **Type of high school** | 0.05 | 1 | -0.11 | 0.13 | 0.14 |
| **Burnout syndrome** | **0.41*** | -0.11 | 1 | -0.31** | **-0.39**** |
| **Self-esteem** | **-0.34**** | 0.13 | **-0.31**** | 1 | **0.52*** |
| **Sense of coherence** | **-0.44*** | 0.14 | **-0.39**** | **0.52*** | 1 |

Key to the significance of the statistical results * p < .05; ** p < .01; *** p < .001

Based on the results of correlation analysis, we found a statistically significant mutual relationship between the monitored variables. A negative correlation was shown between burnout and self-esteem (r = -0.31, p <.01) and a sense of coherence (r = -0.39, p <.01). This relationship shows that factors such as high levels of self-esteem and sense of coherence were associated with lower levels of burnout in our sample group of students. A positive correlation was observed in relation to the length study for burnout (r = 0.41, p <.05) level of self-esteem (r = -0.34, p <.01) and sense of coherence (r = -0.44, p <.01).

*1.3 Discussion*

Several studies have recently focused attention on the prevalence of burnout among students, especially in fields with a higher risk of burnout (the helping professions). During studies there are already training programmes aimed at developing communication skills and improve coping strategies which are generally considered to be effective tools to prevent burnout syndrome, even though there are relatively few studies focusing on research to confirm this relationship. A positive effect of social and psychological interventions was recorded for individual components of burnout among health professionals on psychiatric wards. In Slovakia, the issue was addressed in their study by Škodová and Paceková [12]. A total of 75 university students participated in their research: 48 psychology students (mean age 21.1 ± 3.3; 29% men) and 27 students of nursing, and public health (19.8 ± 1.7; all women). To measure the level of burnout the school burnout indicator (SBI) was used; they also used the Antonovsky SOC scale for sense of coherence and the Rosenberg self-esteem scale (RSS). For statistical data processing linear regression was used. Using linear regression variables were analyzed based on age and gender as possible independent variables, the level of self-esteem (RSS) and sense of coherence as possible predictors, and the level of burnout (SBI) as the dependent variable. Burnout was significantly predicted only by the level of sense of the coherence, but not by self-esteem.

Škodová and Paceková [16] in another study focused on students from the helping professions and investigated the effect of socio-psychological training on the level of burnout and personality predictors (self-esteem, a sense of coherence). The study used a quasi-experimental pre-test and post-test. The participants were 111 university students of psychology and nursing divided into experimental and control groups. The experimental group participated in social-psychological training for a period of six months. The measuring instruments were used were standardized SBI questionnaires, SOC questionnaires and the Rosenberg self-esteem scale. The results showed that socio-psychological training had a positive impact on both the level of burnout, as well as the level of personality predictors of burnout. After completing training, the level of burnout in the experimental group significantly decreased, while the control group was not altered. On the contrary, the sense of coherence in the sample group had increased. In the case of self-esteem, the level was not altered either in sample or in the control group. The socio-psychological training in this study proved an effective support method for positively affecting burnout among students. This suggests that strategies to tackle workload will be related to the strategies of coping with stress of work, and that activities to develop stress management abilities will also be useful in preventing later development of burnout already during the performance

of their profession. Personal characteristics such as self-esteem and "sense of coherence" can be an important factor influencing the individual's capability to handle burnout.

Abroad, routine part of the evaluation of individual personality features before accepting a student in an educational institution, especially in healthcare disciplines. The applicant for study is usually in Western countries decided at a younger or middle adulthood for the job (at adolescence in our country), the benefit at acceptance plays an applicant's personal experience as a healthcare professional for lower-level positions /posts in healthcare facilities providing nursing care. In this way, such a person has a clear idea / vision of the work will be carried out before being admitted to the study. In view of the prevention and the development of burnout in the period of preparing nursing students for the job, we recommend increasing individual skills necessary for coping with stress, in both the theoretical and practical level, as well as to prepare for future health professionals to the possible workload, contact with suffering, pain, intense emotion, and continued achievement of patient needs. In view of the prevention and the development of burnout in the period of preparing nursing students for the job, we recommend increasing individual skills necessary for coping with stress, in both the theoretical and practical level, as well as to prepare for future health professionals to the possible workload, contact with suffering, pain, intensive emotions and continuous satisfying the needs of patients.

*1.4 Conclusion*

Our research results point to the fact that burnout significantly relates to low levels of self-esteem and sense of coherence and vice versa. They also confirm mutual correlation with the length of the study. Relationships between burnout and personality characteristics are therefore complex, but in the future, it will be appropriate to undertake a study to confirm the results in a larger and more consistent group of participants, since some results may have been influenced by the methodological limitations (size and composition of the sample group).

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# Socio-Psychological Impact Factors on Augmented Decision Making

## Norbert NINDL[a*]

*[a] University of Latvia, norbert.nindl@nindl.co*

**Abstract**

Fast changing business environment confronts business leaders to find new ways to organize their businesses and processes. One possible way forward is offered by the rapidly developing technology of intelligent computing. The development of basic technologies, such as cloud computing, database technologies and the use of mobile devices, which is now indispensable, provide the basis for establishing intelligent computing in business processes. The associated apparent advantages of an increase in the efficiency of decision-making processes are under the influence of socio-psychological factors, which arise from a shift in personal responsibility between humans and machines. The following paper analyses socio-psychological impact factors on augmented decision-making. Augmented by the meaning of supported decision-making by artificial intelligence (AI). Therefore, the paper is divided into two main parts. In the first part, a synopsis of the theoretical foundation of the decision-making process and artificial intelligence is created. In the second part, the theoretical research is processed. The research focuses on deriving a categorisation framework of AI applications to support decision-making to link socio-psychological input factors to certain categories in a further step. Based on the results a preliminary conceptual framework for future work on the impact of augmented decision-making acceptance and augmented decision-making efficiency is proposed.

**Keywords:** decision-making, decision-making process, socio-psychological impact factors, artificial intelligence.

## 1. INTRODUCTION

Companies and managers today face the challenge of adapting their business to the rapidly changing economic environment. Environmental influences such as changing technologies, globalisation, changing competitive situations or currently pandemics can put corporate structures, production processes, the labour market and thus the available workforce to an existential test in a very short time. Managers are confronted with having to adapt their corporate structures in order to be able to react quickly to the demands of customers and the market. One approach to this is the adaptation of new technologies to increase efficiency in decision-making processes. New technologies, in particular the use of artificial intelligence for decision-making, are not entirely new. The scientific foundation for this was laid at Dartmouth in 1956 (Russell and Norvig, 2010, p. 10). Since then, the basic technologies that form the basis for intelligent algorithms and decision-making processes have changed and developed significantly. As a result, companies are faced with the additional challenge of implementing intelligent applications in their business processes to subsequently realise competitive advantages. In the first part, this paper deals with the theoretical consideration of the topics of "artificial intelligence", decision-making and decision-making processes, as well as the influence of artificial intelligence on the decision-making process. In the second part, a classification framework of AI applications in business decision-making processes is developed by deriving from current literature. This classification framework is used to discuss the associated socio-psychological influencing factors. A conceptual framework for further future research is subsequently presented.

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\* Corresponding author.

## 2. THEORETICAL FOUNDATION

*2.1. Artificial Intelligence*

Artificial Intelligence (AI) is a collective term for computer systems that can sense their environment, think, learn and take action in response to what they are sensing. Stuard Russell a computer scientist from Stanford University and Peter Norvig Director of Research at Google structured the definitions of AI in four categories:

- (1) thinking like humans,

- (2) acting like humans,

- (3) thinking rationally and

- (4) acting rationally.

Famous definitions of these categories are cited by (Russell and Norvig, 2010, p. 2):

- "The automation of activities that we associate with human thinking, activities such as decision-making, problem-solving, learning, ..." (Bellman 1978),

- "The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991),

- "The study of the computations that make it possible to perceive, reason and act." (Winston, 1992),

- "Computational Intelligence is the study of the design of intelligent agents." (Poole et al., 1998).

Forms of AI in use today include digital assistants, chatbots and machine learning amongst others. Automated intelligence: Automation of manual/cognitive and routine/non-routine tasks. Assisted intelligence: Helping people to perform tasks faster and better. Augmented intelligence: Helping people to make better decisions. Autonomous intelligence: Automating decision-making processes without human intervention (Russell and Norvig, 2010, p. 6).

From a historical perspective term, artificial intelligence was coined in 1956 with the Dartmouth workshop invented by McCarthy(Russell and Norvig, 2010, p. 23)

One of the participants was Herbert Simon. Herbert Simon made overlapping substantive contributions to the fields of economics, psychology, cognitive science, artificial intelligence, decision theory, and organization theory. Simon's work was motivated by the belief that neither the human mind, human thinking and decision-making, nor human creativity needs to be mysterious. It was after he helped create "thinking" machines that Simon came to understand human intuition as subconscious pattern recognition. In doing he showed that intuition need not be associated with magic and mysticism and that it is complementary with analytical thinking" (Frantz, 2003, p.265).

The foundations of AI from an economic view are Herbert Simon's administrative behaviour theory, the utility theory first formalized by Léon Walras (1834-1910) and improved by Frank Ramsey (1931) and later in the book "The Theory of Games and Economic Behavior" by John von Neumann and Oskar Morgenstern (1944). Another fundamental part is the decision theory, which provides a formal and complete framework for decisions made under uncertainty. Based on the decision theory the game theory with a certain focus on "small" economies was invented by John von Neumann and Oskar Morgenstern (Russell and Norvig, 2010, p. 10).

*2.2. Decision Making Process*

The decision-making process described by Simon is generally accepted by researchers who develop decision-supported systems (DSS) as consisting of four phases: intelligence, design, choice and implementation. During the intelligence phase, the decision-maker gathers information and develops an understanding of the problem. He/she identifies criteria, develops the model, and investigates alternatives during the design phase. A selection or decision is made during the choice phase, and the decision maker acts on the decision and learns during the implementation phase. The process proceeds in a generally sequential manner with feedback loops between phases (Simon, H.A., 1987).

Decisions are referred to as structured, unstructured, or semi-structured depending on the degree of certainty of the problem representation and solution. A structured decision is deterministic with a known solution, while an unstructured decision depends on the particular decision maker and has little or no agreement on the solution. While structured decisions required no judgment on the part of the decision maker, unstructured decisions are highly dependent on the preferences or experiences of the decision maker. In between these two extremes are a broad range of problems called semi-structured decisions. Semi-structured decisions can be represented with analytical models or based on data, and, as a result, these receive the most attention from technology aiding. Technology can assist human judgment by, for example, locating and selecting relevant input, selecting appropriate data, solving a decision model under a set of conditions, presenting results to the decision maker, or helping the decision maker interpret outcomes from the decision model. Although DSS generally consist of input, processing, and output to mirror the decision-making process, the decision-maker is viewed as a crucial part of the overall system (Simon, H.A., 1987).

*2.3. AI for decision making*

Using AI for decision-making has been one of the most important applications in AI history. The roles of AI have been classified in various ways, summarised it can be defined as either supporting, assisting the human decision makers or automatizing the decision-making processes (Edwards et al., 2000). In 1988 Bader identified the roles for knowledge-based systems: Assistant, critic, second opinion, expert consultant, tutor and automaton (Bader et al., 1988).

Edwards et al., conducted an analysis of expert systems for business decision-making at different levels and in different roles based on experiments carried out two decades ago. The roles of AI (e.g. expert systems) are examined using the three organisational decision-making levels, i.e. strategic, tactical and operational decisions. Their findings show that (Edwards et al., 2000):

- Expert systems in a replacement role are effective at the operational and tactical decision levels but have limitations.

- Expert systems in a support role can help users make better decisions at all three decision-making levels, but their effectiveness can only be fulfilled through their users.

- An expert system acting in a support role does not necessarily save a user's time, but an expert system in a replacement role does improve the efficiency of decision-making.

- The users of expert systems in a support role did not believe that they had learned from using the system.

Based on the structure of decisions (structured, semi-structured and unstructured decisions) by the findings by Edwards et al. (2000) suggest that AI (e.g. expert systems) can be used to replace human decision makers for structured or semi-structured decisions, but it would be better to be used as a decision support tool for dealing with unstructured decisions at the strategic level in organisations.

In a relevant assessment on the potential use of AI in organisations in 1985 Lee, commented "Because mechanical inference relies on a stable, fixed semantics, the utility of an idealized, fully integrated, knowledge-based inference system will be limited to organizations in completely stable environments." and "integrated information systems will only be of use for those aspects of the organization's activities where semantic stability can be maintained. This conclusion corresponds to the empirical observations made by Gorry and Scott-Morton (Anthony Gorry and Scott-Morton, 1971)." This indicates that despite the limitations of early AI technologies in dealing with dynamic environments, AI for organisational decision-making was more effective in working in stable and familiar conditions.

In recent joint research with Deloitte, Davenport and Ronanki examined 152 AI deployment projects that are making use of AI-based systems across a wide range of business functions and processes (Davenport and Ronanki, 2018, p. 109).

Based on the survey results, Davenport categorises AI system applications into three categories:

- Cognitive Process Automation: Automation of back office administrative and financial activities using 'Robotic Process Automation.

- Cognitive Insights: Detecting patterns in data and interpreting their meaning using statistically-based machine learning algorithms.

- Cognitive Engagement: Engaging employees and/or customers using natural language processing chatbots, intelligent agents and machine learning.

As the progress of AI technology enables researchers to create advanced machines, it is possible for AI to undertake more complex tasks that require cognitive capabilities such as making tacit judgements, sensing emotion, and driving processes which previously seemed impossible (Mahroof, 2019). As a result, an increasing number of jobs are autonomously performed by AI systems without human control and supervision (Złotowski, Yogeeswaran, & Bartneck, 2017). There are many reports on the benefits of AI for decision-making because AI is believed to be able to help organisational employees to reach better decisions, boost our analytic and decision-making abilities and heighten creativity (Wilson & Daugherty, 2018). However, "with the resurgence of AI, a new human-machine symbiosis is on the horizon and a question remains: How can humans and new artificial intelligence be complementary in organizational decision-making?" (Jarrahi, 2018, p. 579).

## 3. RESEARCH AND DISCUSSION

### 3.1. categorization framework

A preliminary categorization framework is set up to analyse potential social psychological impact factors affecting the artificial intelligence-supported decision process.   Based on identified challenges and proposed research agendas in the recent scientific literature initial categories of the research framework are defined.

Yanqing Duan, John S. Edwards, Yogesh K Dwivedi proposed a research paper with twelve propositions for artificial intelligence in decision-making (Duan et al., 2019, p. 64).

Table 1. Summary of research propositions on artificial intelligence in decision-making.

| Theoretical development | Technology-human interaction | AI implementation |
|---|---|---|
| 1 Proposition 1 – Defining AI can be difficult, so it is necessary and beneficial to re-define the concept of AI and related terms to reflect the changing nature of AI development and applications in the era of Big Data. | 4 Proposition 4 – AI can play multiple roles in decision making, but AI will be mostly accepted by human decision makers as a decision support/augmentation tool rather than as the automation of decision making to replace them. | 8 Proposition 8 – There are a set of critical factors that will significantly affect AI's success for decision making. |
| 2 Proposition 2 – Measuring the benefit of AI and its impact is very difficult, but possible. Therefore, there is a need to develop and test theoretically sound and practically feasible AI impact indicators to measure its benefits. | 5 Proposition 5 – The ergonomic design of AI systems is important for their success, but the ergonomic issues are different between supporting, augmenting, replacing, or automating systems. | 9 Proposition 9 –There is a necessity to fully understand the synergy of AI and Big Data and its implications for AI research and practice. |
| 3 Proposition 3 – It is necessary to theorise the use of AI and its impact on decision making, therefore an integrated conceptual framework is needed to provide a systematic understanding of AI for decision making. | 6 Proposition 6 – AI systems performance for decision making can be refined and improved by deep learning while the systems are in use by decision makers. | 10 Proposition 10 – The acceptance of AI for decision making can be affected by different cultures and personal values. |
|  | 7 Proposition 7 –AI users' personal traits and knowledge and understanding of AI will significantly affect the use and success of AI. | 11 Proposition 11 – The acceptance and successful application of AI for decision making may result in a change of culture in organisations and in individual behaviour. |
|  |  | 12 Proposition 12 – Government plays a critical role in safeguarding the impact of AI on society. |

*Source: (Duan et al., 2019, p. 69).*

- These propositions have been analysed by the author in their meaning and interpreted to define the classification subjects to create the research framework. The following classes were derived:

- Data source

- Representation

- Role

- Effect

- Acceptance

**Data source.** Proposition 1 addresses the changing nature of the data and data sources in the era of "Big Data". The main characteristics of "Big Data" are widely distributed data and extremely large datasets (Phillips-Wren, 2012,

p. 21). To classify this circumstance, the framework subject data source is defined. It addresses the distribution of the data and the origin.

**Representation**. Propositions 2 and 3 address the deep understanding of the AI methods and models in use. In 1995 Herbert Simon postulated the future of artificial intelligence. The task for research is to identify aspects of intelligence that still have not yet succeeded in handling, and attack each in turn as soon as any ideas have been found about how to proceed. It must consist, as in the past, of building systems that actually perform the tasks and produce the phenomena associated with them. The following research needs to evaluate the programs for their efficiency, and for scope and scalability. On Simon's priority list have been three candidates. These three candidates are machine learning, robotics and representation (including change of representation) (Simon, 1995, p. 95).

It is still typically the case that before a computer can exhibit intelligence in handling any task it must be provided with a representation of the task domain: a problem space that specifies the kinds of objects and phenomena in the problem states, and the kinds of operators that are available for changing one problem state into another.

In the category representation, the research framework focuses on the domain, model, and AI method.

**Role.** Proposition 4 addresses the different roles of AI in decision-making processes. Edwards et al. summarised the role of AI in decision-making either to support and assist human decision-makers or to automatize the decision-making processes, where the special interest focuses on augmentation (Edwards et al., 2000). Recent publications argue that AI should be used to augment human judgment rather than automation. One representative is Jarrahi. In 2018 Jarrahi described the complementarity of humans and AI in decision-making situations, typically characterized by uncertainty, complexity and equivocality. The benefits of AI and humans in certain situations can be summarized as follows (Jarrahi, 2018).

*The uncertainty* is characterized as a lack of information about all alternatives or their consequences, which makes interpreting a situation and making a decision more difficult (Choo, 1991). Jarrahi mentioned the main benefits of AI to assist humans are generating fresh ideas through probability and data-driven statistical inference approaches and identifying relationships among many factors, which enables human decision-makers to collect and act upon new sets of information. The advantage of the human is to act intuitive in such uncertain situations.

*Complex situations* are characterized by an abundance of elements or variables. The demand of processing a mass of information from different sources at a speed beyond the cognitive capabilities of a human decision-maker is an absolute advantage of AI.

*Equivocality* refers to the presence of several simultaneous but divergent interpretations of a decision domain (e.g. conflict of interests). In such situations, AI can furnish some utilities that enable decision-makers to overcome equivocal situations and address relevant conflict needs. Nevertheless, equivocally situations are predominantly the responsibility of the human actors.

**Effect**. Propositions 6 and 7 are addressing the effect of the decision-making process. With the classification "effect" the effect of the decision on an individual or organizational goal should be identified. The effect is the base for an efficient evaluation of the scope, time and affords reached. The results are the input to build a cybernetic system to improve the model of the representation and increase the performance in further decision situations. The ability to learn from the results and adapt to new environments and challenges is a unique strength of human intelligence. The research framework collects in the category of the effect of the realized change on an individual or an organization.

**Acceptance**. Propositions 7, 8, and 9 address the acceptance of AI support to the level of knowledge and understanding of AI models, the symbioses of AI and Big Data and the understanding of technology. Propositions 10,11 and 12 address the acceptance from a cultural and organizational perspective. For the research framework, the category acceptance summarizes the behaviour of the acceptance of an individual or an organization to a certain AI-supported decision process.

Figure 1. Research framework to analyse AI-supported decision-making processes.

| DM situations | complex situations | | uncertain situations | | equivocal situations |
|---|---|---|---|---|---|
| | Impact Categories on AI Supported Decision-Making Proceses | | | | |
| AI-application categorisation by | Data Source | Representation | Role | Effect | Acceptance |
| AI-application categorisation examples | - local<br>- company specific<br>- cloud-based | - business domain<br>- purpose<br>- phenomena -model | - level of augmentation<br>- automatisation<br>- supporting<br>- autonomous | - individual<br>- organisational | - individual<br>- organisational |

*Source: author*

### 3.2. Discussion on Socio-psychological impact factors

In the following part, the assignment of social psychological impact factors to the classification of the research framework is discussed.

In literature, **the acceptance of technology** by users or organizations is a research field followed by several scholars (Gursoy et al., 2019), (Adnan et al., 2018), (Kanoh, 2017). One famous representing use case is the research field on the acceptance of autonomous vehicles (Adnan et al., 2018).

Gursoy describes in a literature review the determination of factors influencing the customer willingness to adopt new technology, such as perceived usefulness and ease-to-use (Davis et al., 1989; Hsiao & Yang, 2011; Ozturk, Bilgihan, Nusair, & Okumus, 2016; Wang, Wang, & Lin, 2018), social influence and cognitive process (Venkatesh & Davis, 2000a; Venkatesh & Davis, 2000b), previous experiences (Morgan-Thomas & Veloutsou, 2013), and hedonic motivations (Venkatesh et al., 2012). However, those technology acceptance models have mainly focused on adoption of functional technologies, technology-enabled services and self-service technologies (Lu et al., 2019; Mortenson & Vidgen, 2016) such as mobile check-in, self-service kiosks, or Apple Pay.

While many of the factors that are included in the technology acceptance models can also explain customers' intention to use AI devices, Lu et al. argue that some of the core constructs of technology acceptance models such as perceived usefulness and ease of use may not apply to the AI device use intention context because such factors focus on customer learning of new technologies (Lu et al., 2019). In the context of AI device use, consumers are likely to focus on whether an AI device can deliver the same level of or better service as human employees are likely to deliver. Thus, Lu et al. developed a scale to measure customers' willingness to use AI service robots after conducting a comprehensive review that covered technology acceptance theories, related literature, and some focus groups. Through several qualitative and quantitative studies, Lu et al. identified six major predictors of consumers' willingness to integrate AI service robots into service delivery: performance efficacy, hedonic motivation, anthropomorphism, social influence, facilitating condition, and emotion.

N. Adnan et al. emphasised in their research the two direct factors "facilitating condition" and "behavioural intentions" to use intelligent driving assistant systems. For behavioural intention, the determinants are performance expectancy, effort expectancy and social influence. The previous examples are analysing the acceptance from a

"customer" specific view. The research of this paper focuses on using AI for decision-making in an organizational context, especially in human resource management.

In an organizational context, the use of AI in decision-making processes can be in direct competition with individual employees, teams, or entire sub-organizations.

The subject **role** addresses the direct impact of this competition with the level of augmentation, which can span the spectrum from an assisting part to a full replacement by an autonomous decision-making process.

One of the central fears is the risk to be replaced by technology. The impact on the employment rate is a major topic in prior research in the field of human resource management. To illustrate this concern, using the Gaussian process classifier, Frey and Osborne (Frey and Osborne, 2017, pp. 254–280) estimated that nearly half of all U.S. jobs are likely to be automated in the coming decades. In an attempt to transfer Frey and Osborne's study approach from the US to Europe, Bowles (2014) predicted that 54\% of European occupations could be computerized by rapid automation (Frey and Osborne, 2017). Lee (2017) applied the Frey-Osborne estimates to Asian countries and found that about one-quarter of Singaporean employment is at high risk of computerization. Another study, involving 1900 experts regarding the possible influence of machines with AI, stated that by 2025, a significant number of both blue and white-collar employees will be at risk of displacement by automated and networked AI applications (Smith & Anderson, 2014). Research conducted by Chui, Manyika, and Miremadi (2015), found that as the world becomes more technology-driven, AI and robotics could directly displace 45% of work activities previously performed by U.S. employees. Finally, research conducted by Acemoglu and Restrepo (2017) documented that an extra industrial robot per 1000 U.S. workers could reduce the employment-to-population ratio by 0.18–0.34 percentage points.

Michael Chui et al.'s research shows the impact of the hourly wage rate on the ability to automate of the position (Chui et al., n.d.). The findings are the correlation between wages and automatability in the US economy is significant (p-value < 0.01), but with a high degree of variability ($r^2 = 0.19$).

From a psychological perspective, it is recommended to go into detail to analyse the type of power related to the acceptance (e.g., experts in higher positions. The research of Goh et al. in 2016 shows strong resistance against decision supporting system in dental clinics by the dentists (Goh et al., 2016)).

The **level of augmentation** also moderates the effort expectancy as the impact on the acceptance, which even is moderated by the individual type of social power. (e.g. experts in higher positions. The research of Goh et al. shows strong resistance to decision-supporting systems in dental clinics by dentists. They even can easier handle support systems, which more acting as assistants than replace decision tasks of the expert) (Goh et al., 2016).

The subject **representation** addresses the model, the domain and the AI method. In the AI context representation is directly linked to Knowledge Representation. Knowledge Representation in AI describes the representation of knowledge. It is a study of how the beliefs, intentions, and judgments of an intelligent agent can be expressed suitably for automated reasoning. One of the primary purposes of Knowledge Representation includes modelling intelligent behaviour for an agent.

Knowledge Representation and Reasoning (KR, KRR) represent information from the real world for a computer to understand and then utilize this knowledge to solve complex real-life problems like communicating with human beings in natural language. Knowledge representation in AI is not just about storing data in a database, it allows a machine to learn from that knowledge and behave intelligently like a human being ("What is Knowledge Representation in AI?", 2019).

From a social psychological perspective, the representation is knowledge about the implementation of intelligence in the AI application. For example, how deep learning implementation is trained on which knowledge domains they are specialized in, is it a forward-oriented decision algorithm or there are any recurrent learning strategies implemented?

The knowledge about the internal structure and design hence transparency and trust.

The impact of transparency to decision making acceptance is described as not strong enough to change the emotion of the decision's target audience to the opposite. Gregory A. Porumbescu and Stephan Grimmelikhuijsen show in their study that transparency can stifle the voice for fair decision-making procedures but does not stimulate the voice when decision-making procedures are unfair (Porumbescu and Grimmelikhuijsen, 2018). Also, Monika Bauhr and Marcia Grimes described similar phenomena in their empirical study where they confirm that an increase in transparency in highly corrupt countries tends to breed resignation rather than indignation (Bauhr and Grimes, 2014).

Trust in the reliability of the application of AI in the decision-making process could have a significant impact. The significance of trust as the impact on the UTAUT model is shown by Esteva, Eduardo and Rubio-Sanchez, A. (Nemati, 2014, pp. 162–186) in 2013 to Voice over IP adoption in the US market. Similar results on the impact of trust on the UTAUT model were described by Lee, Ji-hwan and Song, Chi-Hoon in 2013 (Lee and Song, 2013).

The subject **data source**. The data source in AI applications is the base for making any decisions, interpretations or forming any intelligent behaviour. The data source is the base to make decisions with a trained behaviour (in machine learning implementation), which is even trained based on a huge amount of data. To link possible social-psychological impact factors the author refers to the bounded rationality theory of Herbert Simon (Simon, 1982) which is described as the core assumption of the "natural assessments" view of heuristics and dual-system models of thinking (Gilovich et al., 2002), and it is one of the psychological foundations of behavioural economics. Compared to the bounded rationality theory the data source limited information as a base to train AI algorithms or being the base for decisions. A negative example in the era of digital assists was Microsoft's chatbot "TAY" in 2016. It morphed within hours from a fun-loving bot to a racist and sexist (Metz, n.d.). This happens by the interpretation of the data source grounded on the conversion with different users. The training and interpretation of data in the AI need to take into account the impact of ethnicity, morality, values and culture.

*3.3. Conceptual framework*

Figure 1. Conceptual framework – socio psychological impact factors on AI-supported decision-making processes.
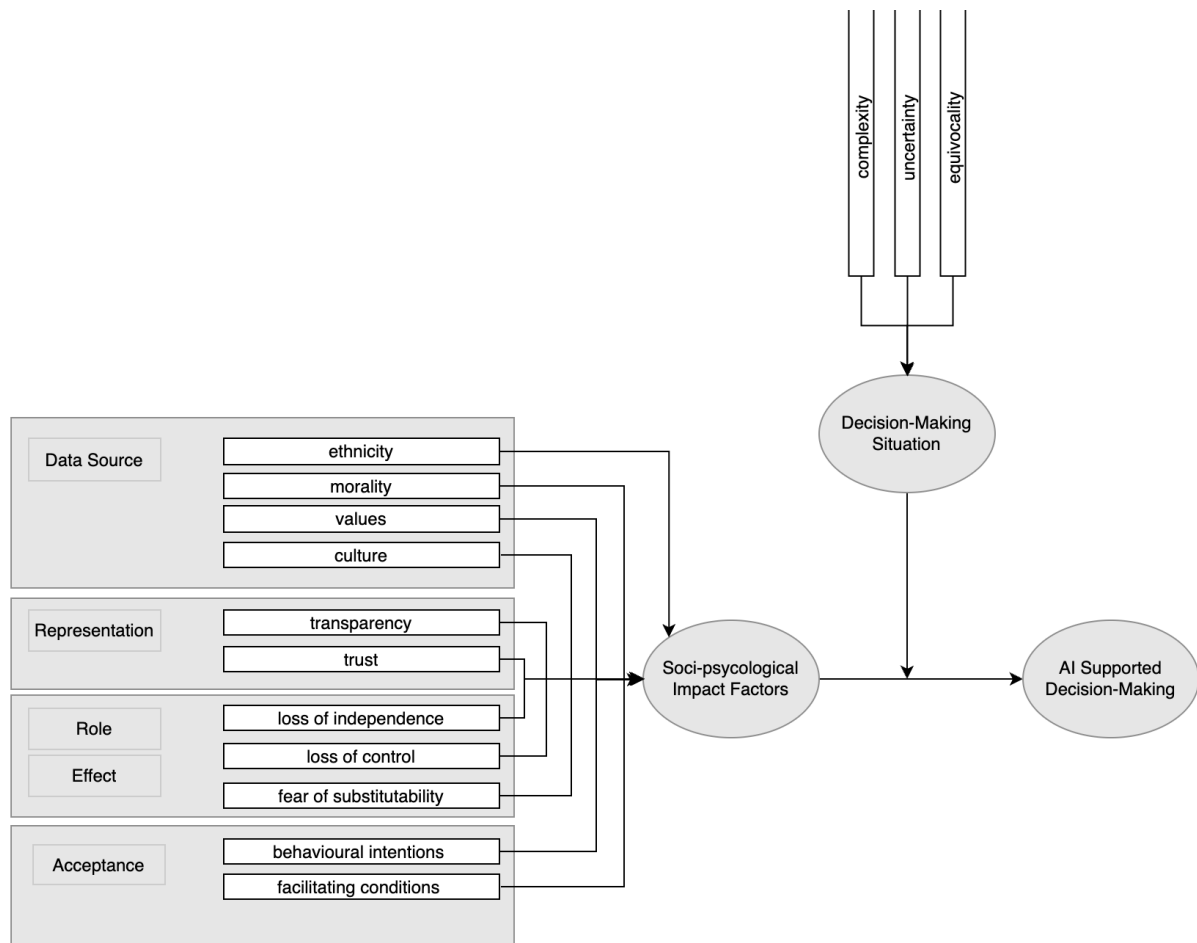


*Source: author.*

The results from the derivation of the socio-psychological influencing factors on AI-assisted decision-making are synthesised in a conceptual framework (see Figure 2). The derived socio-psychological influencing factors are grouped according to the categories of the Categorisation Framework for the analysis of AI applications supporting decision-making processes shown in Figure 1.

The category
- "Data Source" is assigned the influencing factors: a) ethnicity, b) morality, c) values and d) culture,

- "Representation" is assigned the influencing factors: a) transparency, b) trust,

- "Role" and "Effect" will be the influencing factors: a) loss of independence, b) loss of control c) fear of substitutability,

- "Acceptance" is assigned the influencing factors: a) behavioural intentions, b) facilitating conditions.

The Decision-making situation was derived as a moderating influence. This is described via the influencing factors a) complexity, b) uncertainty, and c) equivocality.

## 4. CONCLUSIONS, RECOMMENDATIONS

This paper conducts a deduction of socio-psychological impact factors on an AI-supported decision-making process within a business.
- The paper includes a synopsis of the theoretical foundation of artificial intelligence, decision-making processes and AI for decision-making.

- For the interpretation of socio-psychological impact factors, a categorisation framework for AI applications was deducted from the current literature.

- The categorisation framework synthesises five categories of AI applications, which are a) the data source, b) the role of the application within the decision-making process, c) the representation by the AI model, d) the target effect and e) the acceptance of AI applications in use. Additionally, the decision-making situation was divided into three categories a) complex, b) uncertain and c) equivocal.

- Based on the categorisation framework eleven socio-psychological impact factors were interpreted: a) ethnicity, b) morality, c) values and d) culture, e) transparency, f) trust, g) loss of independence, h) loss of control i) fear of substitutability, j) behavioural intentions and k) facilitating conditions.

- The findings were summarised in a conceptual framework, to conduct fruitful input for future research.

  Recommendations for further research.

The conceptual framework provides the framework for further in-depth research. Recommendations for future research are:

- empirical evidence on the significance of the individual influencing factors,

- empirical dependence of the individual influencing factors on each other and presentation of possible multi-coliniarities,

- empirical evidence of the moderating effect of the decision-making situation.

- The proven socio-psychological influencing factors can be the basis for research into the challenges of managers in decision-making processes involving intelligent algorithms as well as humans.

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# University Student´S Procedures Applied when Learning from Study Resources

## Michaela MILEROVÁ[a]*, Zuzana SIKOROVÁ[b], Tereza VAŠUTOVÁ[c]

*[a] University of Ostrava, Faculty of Education - Department of Education and Adult Education, Fráni Šrámka 3, Ostrava – Czech Republic, michaela.milerova@osu.cz*

*[b] University of Ostrava, Faculty of Education - Department of Education and Adult Education, Fráni Šrámka 3, Ostrava – Czech Republic, zuzana.sikorova@osu.cz*

*[c] University of Ostrava, Faculty of Education - Department of Education and Adult Education, Fráni Šrámka 3, Ostrava – Czech Republic, tereza.vasutova@osu.cz*

**Abstract**

The research study focuses on the issue of procedures of university students in preparation for schooling. The aim of the work is to map what procedures university students use in preparation for schooling in an effort to clarify aspects, to influence the overall attitude. One of the main parts of the work is the theoretical basis, which clarifies the main determinants and other issues of research studies. The research survey is mediated through qualitative research with elements of quantitative design. The methodological research became an analysis of interviews from 13 students across tertiary education. Based on this survey, the results are interpreted, which are then categorized into four groups. The single strategy provides sources of information, requires related procedures in preparation for schooling. The analysis of the survey showed a whole series of represented procedures, which do not have an identical dependence on the studied field. Students from fields more focused on the theoretical level according to research using a combination of procedures. In this context, the use of procedures in preparation for schooling has a significant degree of motivation and other aspects affect psychic attributes.

**Keywords:** Learning habits, procedures, digital resources, printed resources, learning.

## 1. INTRODUCTION

The main impetus for the choice of the topic concerning the procedure of university students in preparation for teaching was the fact that, at present, the state of the research field does not correspond to the demands placed on it. A substantial body of research on similar topics is usually oriented away from the main object of investigation of the study habits in question, and it is often the case that study habits are investigated as mere "supplementary information."

Teaching preparation procedures are quite a hot topic among students. With regard to pedagogical knowledge, learning practices represent certain strategies that can help to make information meaningful and then practical. In this context, research on students' study habits in preparation for teaching is more typical for foreign countries.

The research study highlights not only the nature of the pedagogical aspect, but also the nature of the psychological aspects that are related to the actual procedures of university students in preparation for teaching. The use of these procedures may therefore depend on the motivation, attitude and personality characteristics of the individual. Both extrinsic and intrinsic determinants have an impact on the formation of procedures, which are conditioned by various

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\* Corresponding author.

influences. A typical example is the student's beliefs about his or her beliefs and strength of the motivation. There are a number of approaches to preparing for teaching and it depends only on the attitude and creativity of the student. An essential element is the individual's belief in the goal itself, which becomes the driving force that influences the procedures of preparing students for teaching. The learning process, which involves the learning resource itself, its subsequent initial familiarisation and manipulation, also has an impact on the formation of practices. Related to the topic of the research study is the use of different learning strategies and approaches to learning, which are closely related to students' attitudes towards learning.

Study habits are also a central theme, where learning resources and their forms are mainly represented. Currently, there is no clear definition of the use and implications of digital resources in education and whether they provide sufficient support for students compared to print resources.

The goal of this study is to map the practices of university students in their preparation for teaching and the contexts associated with the use of learning resources. Another goal is to find out what specific procedures students use and what kinds of resources they prefer when preparing for class. Students' attitudes to learning and motivation to learn are examined in relation to their preparation practices.

The research investigation was conducted using mixed methods research. Data were collected using semi-structured, in-depth interviews and the ASSIST 2020 questionnaire. This empirically-oriented research focuses on students in tertiary education in an attempt to capture a holistic picture with the most accurate conclusions. Thirteen undergraduate students from different disciplines participated in the research: law, health, management, arts and construction.

There are a number of alternative approaches to preparing for teaching, which, according to the participants, depend on the preferences, motivation and personality of the student. The research shows that students' procedures in preparing for classes are closely related not only to the individual's motivation to learn itself, but also to the approach they take to learning. The individual findings are interpreted and specifically categorised in the last chapter of this research study.

*1.1. Theoretical basis*

The procedures of university students for learning are a key aspect that, together with motivation and other phenomena, indicate the success of university studies, which are based on the very approaches to learning. The term approach to learning includes the method of obtaining resources, the time point of view or the way, procedures of working with resources. The terminology of the concept of ways of using study resources is not yet settled. Some authors lean towards methods of use (Sikorová, 2019), while others use the term study habits (Berry et al, 2011). Berry et al (2011) attempted to explain the terminology. While ways of using resources include the time aspect of working with resources, ways of obtaining or ways of working with resources. The concept of study habits includes the way students behave when using study resources.

## 2. RESEARCH METHODOLOGY AND RESULTS

The present text is a study based on semi-structured, in-depth interviews supplemented by the ASSIST 2020 questionnaire. Using the ASISST questionnaire, we gain a more comprehensive view of the issue.

The aim of the research method was to obtain a description of the peculiarities of the cases and to develop theories about student phenomena in the pedagogical world. In our study, the students' procedures in working with the text became a constructed concept to which we investigated through analysis, a holistic picture of the issue. The relationship between qualitative and quantitative research according to Hendl (2005) is not adversarial, but the results obtained by both strategies complement the research. The qualitative method in our research provides a description of structural conditions, deviations, processes and norms, while the quantitative element in the form of the ASSIST 2020 questionnaire enriches the research with a systematic specification of specific qualitative findings using a questionnaire survey.

This questionnaire was included in the research because the procedures of university students interact with several other factors: motivation, study habits or approaches to learning. The ASSIST 2020 questionnaire helped us to capture more closely the participants' attitudes to learning and thus helped us to build a comprehensive picture of the reality we were investigating.

The main objective of the research was to clarify how university students behave in certain situations. How they understand what is going on in the situation. For what reason they act in a given way and what circumstances influence

their decisions. Miovský (2006) considers the use of qualitative research appropriate in the above case. The qualitative research helped us to create a holistic picture of the issue under study by communicating with individual participants and seeking understanding between the phenomena.

The use of both types of methods not only helps to capture key facts as accurately as possible, but also supports more precise methodological procedures in the analysis and subsequent interpretation of the data obtained.

The goal of this study was to find out what are the study habits of students in relation to the use and preference of learning resources. To map the practices of undergraduate students in preparing for classes and whether these practices differ from the field of study, how effective the procedures used are in interpretation, and what forms of resources students prefer.

The research problem is constructed on the basis of theoretical knowledge that is relevant to the issue under study and is a key aspect of this topic. The research problem consists of one main research question*: „What practices do university students use when learning from study resources in preparation for an exam/test?"* And four specific research questions. *1. What does a student's exam preparation look like and what resources are used to prepare?", 2. „What practices do university students use when learning from learning resources?", 3. „Do learning practices differ between print and digital resources?", 4. „ Are resource-based learning procedures related to student motivation to learn?"*

The research sample consisted of 13 students from different universities in the Czech Republic and from different disciplines. The sample of participants consisted of individuals with predetermined criteria.

The first essential criterion was the level of education, full-time university graduates. The selected participants were then divided into five groups of 2-3 members according to the category in order to facilitate data coding.

The first group consists of participants from the field of dentistry, the second group is represented by participants from the field of general nursing and the subsequent groups are completed by students from law, art and, last but not least, students from technical and economic fields.

The sample of participants was selected by purposive sampling with maximum variability due to the representation of students with different disciplinary backgrounds (Hendl, 2005).

The collected research data was, with the help of open coding, sequentially divided according to similarities, into units of sequences, sentences and words, as also reported by Gulová & Šíp (2013). Subsequently, codes were assigned to these characteristics, which revealed not only the categories themselves, but also their properties and dimensions.

The process of giving these codes became a process of highlighting and writing notes in the transcribed interviews. This analysis yielded the main categories, which were then subjected to typological analysis for the precise organization of the data, according to which the data were merged into further groups and sub-categories. According to the qualitative organization, the identified data were subsequently presented according to Šeďová & Švaříček (2013), according to the similarity of the problem or theme under study.

Learning as a meaningful activity that procedures effective results

According to Čap and Mareš (2010), the essence of meaningful learning lies primarily in the activity, which is influenced by the degree of motivation of the individual to learn. During meaningful learning, higher cognitive operations take place than during mere memorization. These higher cognitive processes not only drive the perception of new information, but also activate the understanding of its meaning. Without productive activity, meaningful learning cannot be achieved.

When acquiring new knowledge, the individual does not take in information in a ready-made form, but active processing and construction takes place, when at the same time reconstruction of the existing knowledge takes place, because it is with them that the newly acquired knowledge is connected. The implication of this theory is that the constructiveness of learning is highly individual and no two individuals will gain the same understanding of the facts they have studied while learning.

Further, the essence of meaningful learning is based on the so-called commulativity. Commulativity in learning is somewhat akin to "building." That is, knowledge or skill does not emerge all at once, but gradually. The results of learning are cumulative and the parts group together. This process could be compared to a pyramid, where the bottom parts must have a solid foundation so that "building" can continue. Thus, new learning is dependent on prior experience and knowledge, which is highly influenced by the way knowledge is acquired. These modes of practice can facilitate the whole learning process, but also complicate it considerably.

Another important aspect is the self-regulation of learning, which is the responsibility of the student himself, who has reached the ability to manage and make good decisions about the organization of the learning. Learning itself will be more successful if the individual has a general idea of the goal he wants to achieve.

The contemporary pedagogical world today is predominantly concerned with making learning effective and, above all, meaningful. This term, which in the past was associated with the American psychologist D. P. Ausubel, who pointed out that learning is not mere memorization but a much more complex process. According to many erudite specialists, meaningful learning is characterized above all by an active, constructing, cumulative approach, which is targeted as situated and individually distinct (De Corte, 1996, Shuell, Moran 1996 in Čáp, Mareš, 2001).

Learning from text is closely related to didactic communication, which is defined as a specific type of human communication. Learning from text is a process of perceiving, understanding, processing and subsequent memorization of didactic information that is communicated with the help of didactic text, the source (Čáp & Mareš, 2001, p. 475).

This communication involves the teacher and the pupil. Didactic information is the kind of information that is transformed for didactic purposes by its specific characteristics. The form of didactic information is both verbal, e.g. printed text, and non-verbal, which includes, for example, teaching images (Čáp & Mareš, 2001).

The text itself is primarily understood as a sequence of utterances through which the speaker intends to achieve a goal (Čáp & Mareš, 2001, p. 474) A text can be defined as a complex utterance that is a specified type of action.

Students usually work not only with didactically oriented texts, but also with texts that are characterized as textbooks. In recent years, texts that have the characteristics of a textbook text, but do not take the form of a traditional printed textbook, but are digitally produced, have become increasingly common.

Learning from text is subjected to a goal-directed focus of interaction between the learner and the text itself.

In research oriented towards learning from text, the focus is primarily on qualitative methods. In 1998, research was conducted by Swedish authors F. Marton and R. Saljoa, who focused on exploring the concept of learning. The focus of this work was on observation-oriented observations of a small number of pupils based on very detailed interviews with analysis of pupils' creations. The research showed that pupils usually have their own conceptions of learning. Five conceptions of learning were identified in these pupils:

(1) Learners' acquisition of increasing amounts of knowledge. (2) Orientation to rote learning. (3) Acquisition of facts, methods that the individual can recall and use when needed. (4) Discovery of abstract concepts of meaning. (5) Interpretation of what is learned so that one understands the world.

Another research study by Alexandrova and Singer (2017) involved a qualitative analysis focused on comparing learning from print and digital resources. The purpose of this study was to explore the differences that might exist in comprehension related to the use of digital and print resources. Natural literacy is changing rapidly with new technologies entering people's lives and the lives associated with the learning environment. Over the past decade, new textual forms have developed, including multimedia books and media. The presentation of said texts, can present new opportunities and new challenges for readers. Related to this aspect is the function of digital literacy, which is the ability to extract information from graphical representations of digital resources and to successfully navigate in digital space. The research was conducted regardless of the age of the participants and the school level. One of the findings is that to establish a general statement that there is a higher efficiency of learning or understanding text from print or digital format is quite non-specific. The research found that 90% of students use both digital and print resources.

Analysis of these studies suggests that there are important factors that can greatly influence outcomes. One finding is the length and type of text, where longer texts have been shown to be easier for participants to understand from a printed source. Closely related to this is the type and level of comprehension. In terms of comprehension, the research findings point to the importance of larger units, where, for example, the main ideas of the material studied are included; the differences between print and digital sources are not relevant in this case. In contrast, if the emphasis is on more detailed and more specific understanding, students perform better if they have studied from a printed source.

Strategy as a path to results

A learning strategy is primarily a sequence of activities that are hierarchically ordered to achieve a learning goal. These activities usually require forethought and planning. Through this ordering, the individual is aware of which skill to use and in what order. Learning strategies lead to effective memorization and increase motivation to achieve better results (Průcha, 2020).

According to Škoda and Doulik (2011), problem solving is always related to the individual image of the problem, which is influenced by the learning style and the planning and execution of activities aimed at solving the problem. Learning tactics can then be characterized as individual sub-steps or procedures that, when thoughtfully arranged, form an overall process or strategy Škoda and Doulík (2011, p. 60). Fundamental to finding effective learning strategies that are individually distinct is a foundation in critical thinking and self-reflection. Hoferova et al. (1998 in Mareš, 2013) present strategy practices that rely on metacognitive strategies in self-regulated learning:

Planning strategy

The planning strategy sets objectives as a way of orienting oneself to the material and generating questions after studying the material. It also includes analyzing the tasks given and identifying the parameters.

Regulatory strategy

This is a strategy based on repeatedly reading the text and looking for explanations in different sources.

Monitoring strategy

The monitoring strategy directs attention and monitors comprehension of the material through various techniques that reinforce the stimulus of the content. This strategy primarily leads to the ability to pass the test.

Learning environment strategy

Proper selection of the learning environment increases overall concentration and aids efficiency in learning. It also involves time management and seeking support from peers and others.

Furthermore, learning strategies are presented by Mares (2013) as one of the key determinants of lifelong learning effectiveness, and above all, they are a very important determinant of learning and educational outcomes. Learning strategies themselves are characterized as "...sets of practices used by learners to facilitate the acquisition, retention, re-equipment and use of information" (Mares, 2013, p. 490).

According to the study Learning Strategies in the General Education Curriculum, Vlčková (2018), direct and indirect strategies, or also general or specific strategies, are currently the most represented. These types of divisions are particularly important from the perspective of subject didactics and different disciplinary focus. Many of the strategies, especially the indirect ones, are common to multiple educational fields. In other words, different educational areas and subjects require the acquisition and use of specific strategies, specific to the area in question.

The use of strategies is influenced by a number of factors, including age, gender, reason for learning, level of awareness, demands of the learning tasks, and/or teacher expectations.

Learning strategies themselves are understood more generally as a tendency to act in a particular direction, which is related to the student's overall approach to studying and learning. These strategies further include, for example, in-depth, surface and strategic approaches (Sikora, 2019).

Horsley, Knight and Huntly (2010) specified a closer understanding of learning strategies as the ability to adapt to the available resources in order to acquire knowledge quickly and efficiently for examination with a predominance of a surface approach, hence a focus on meeting requirements rather than a deep grasp of the material. The learning strategy may also be related to the sociological issue of the lifestyle of students who very often supplement their studies with work and other extra-curricular activities. This choice of using strategies is at certain moments a no-win situation for students with this lifestyle.

Specifics of approaches to learning

The right learning approach is an important factor that influences not only the choice of the learning resource itself, but also the way in which the resource is used. According to Entwistle and Ramsden (1983), the term learning approaches is characterized by the well-known theories of deep, surface and strategic approaches.

The essential difference, between the priority-oriented in-depth and surface approaches, is the ability to reproduce the acquired information and furthermore to understand it as well. The main significance of the in-depth approach is the fact that the knowledge gained is related to previous knowledge, experience, skills and the search for i.e. patterns and connections to the findings. In contrast to routine memorization of facts and learning without thinking about its purposes or strategies, it represents a characteristic of the surface approach (Entwistle, 2009). The definition of learning approaches is based on research from successful authors Marton and Säljö Entwistle and Ramsden in the UK and Biggs in Australia. Thus, the depth and surface approaches represent the main subdivisions. In order to account for the effect of formal evaluation, the approaches were further complemented by a third major category of strategic approach. This approach is based on the fact that an individual's behaviour in relation to learning is systematically organised with effort and focus on the demands of assessment.

According to Entwistle, the learning process that is typical of the depth approach cannot be specifically described, nor can it be applied in the same form to all subjects. In attempting to best conceptualize the depth approach for students, it is necessary to specify the actual learning processes that are necessary to develop conceptual understanding for a subject area, and even a topic (Entwistle, 2009, p. 37). The depth approach style of learning is preferred by students who are motivated to achieve maximum results and see the value of applying theoretical knowledge to future applications, whether in their personal or professional lives. This theoretical foundation is something that the individual seeks not only to understand but also to comprehend. In order for there to be a deep understanding of the material, it must be embedded in the structures of an internal knowledge system, which is a very lengthy and complex process. This later utilized knowledge is permanently usable at the application level. Using the depth approach, the

text of the learning resource is viewed in a stratified way, which is a set of information among which there are certain relationships and hierarchies. In this case, the depth approach takes three other forms:

If learning is characterized by systematic progression and mastery of details at the expense of more general principles, it is called progressive learning. If the individual's attention in learning is focused on general principles and the subsequent integration of this information, cumulative learning occurs. Lastly, the concept of flexible learning is characterized by understanding general principles and learning details in order to illustrate and argue Skoda & Doulik (2011).

Individuals who are characterized by a deep approach, finding personal meaning in learning and learning itself. Such meaning in a practical setting is very rarely found, as not every student is motivated to study according to their true personal priorities.

While the deep approach is associated with a higher level of motivation, the surface approach is linked to a lower level of motivation of interest in the subject matter, which is dependent on the orientation of personality priorities of interests. Such an individual is motivated to expend as little effort as possible towards the act of learning itself. The essence of the surface approach is not to understand the learning, but merely to memorize knowledge for the purpose of extrinsic motivation - to achieve results in the form of maximum marks, for example. This principle is characterized, as a collection of information that the individual is unable to perceive structurally, and a hierarchy of ordering of individual concepts, but the content is perceived as coherent monolithic information that is a necessity to remember. This information does not form any associative links with previously acquired information. Such superficially stored information cannot be applied later in practical conceptualization.

An important criterion for the surface approach is the amount of time it requires. The aim is to minimize this amount. Therefore, some students with this learning style do not like to learn from texts that contain extensive theoretical background, but use their own extracts, which may take the form of wordy and concise notes.

A very popular approach with students is the strategic approach. The intention of the strategic approach is to succeed in any way. The strategic approach is characteristic of students who strive for the best grades and competition with others is an important component. These students try to use artifice to get the best grades without a deeper interest in the subject matter. They approach learning according to the teacher's demands. When it comes to the liberal teacher, students usually approach the curriculum more laxly than the teacher who has higher demands. Thus, it can be deduced that learning styles are tailored according to demands and are contingent on performance.

According to many experts, learning approaches are dependent on the actual content of the curriculum. Biggs and Tang (2011) specified learning styles as a flexible adaptation to the content of the curriculum. A student may approach different tasks in different ways.

The nature of study habits in the context of learning resources

The behaviours and attitudes of students, coherently referred to as 'study habits' (Berry, Cook, Hill & Stevens, 2011; Judd & Elliot, 2017), primarily include the learning resources that students use in their studies. According to Sikorová (2019), study habits include the actual ways of obtaining these resources, which may include specific ways in the form of- borrowing, buying, downloading, sharing, but also includes the temporal aspect of resource use with the actual frequency of use.

Learning resources and the role of the textbook were explored in 2010 by Horsley and colleagues who focused on 12 different university courses and across seven Australian universities, who used classroom observation, in-depth interviews and focus groups to examine student and teacher use of learning resources. The research found that the types of resources that were requested as recommended did not vary to a great extent according to the field of study, that is, with the exception of practice-oriented areas. In this case, these were mainly textbooks, scripts or supplementary materials that contained comments from the teacher. Based on these findings, Horsley, Knight, and Huntly concluded that textbook use varied according to the degree of "source centrality." Within this conclusion, four major categories of resource centrality were subsequently identified: integrated core resource, primary resource, supplementary resource, and peripheral resource.

Considering the current situation, these findings can be considered very inspiring, as students draw on both print and digital resources in preparation for teaching, and it is not only the contribution and possibilities of each resource that can be focused on, but also the interaction between them that matters most. It is clear from the results that when students evaluated the work as a systematic activity with integrated primary sources, the work was perceived as essential to successfully completing the requirements. Slightly less weight was given by students to the core resources, which were still primarily used and formed the skeleton of the source of essential information. Sources that students evaluated as more of a "background information" were identified, as a supplementary source. Peripheral sources were considered to be very marginal information, used in the case of a more comprehensive orientation to the issue.

Research has also been conducted across different disciplines to investigate study habits in relation to the use of learning resources. Sikorová (2019) describes these individual research studies in her research synthesis. These research investigations focused on disciplines such as finance, mathematics, medicine, psychology, and other social science disciplines. Research has shown that study habits may differ precisely because of the difference in the field of study, but in conclusion, there are some contingencies that apply regardless of the field of study. These findings are characterized below.

Obligation as a motivation to study

Building on previous research studies, it is clear that some students, although they have some affection for learning resources, only use them in exam preparation, despite teachers expecting students to use them during their studies. In a study through focus groups, students were approached with the question, "Why do they not study the designated text from the learning resource, despite knowing its importance." Students' responses overwhelmingly pointed to the same judgement, namely that the main reason for not doing so was time and, not least, busyness.

It is also evident from the research that some students use learning resources in the form of textbooks when they have inconsistencies in their knowledge and do not sufficiently understand a particular topic in a lecture or in assignment problems.

Textbooks as a second choice

Juban and Lopez (2013) came up with the concept that students overwhelmingly prefer powerpoint presentations. This is due to quick accessibility and reduction of essential information. Other substantially used sources to prepare for the exam are notes and attending lectures, thus scripts and textbooks become merely an alternative source of information according to students.

The less the better or quantity does not guarantee quality

Students often find themselves overwhelmed by the number of shared and recommended learning resources and lose track of the actual requirements. Each student's main goal is to pass the exam, so the orientation is directed towards defining the specific material. It is crucial for students to know the primary source in which the essentials are contained, rather than a multiple list of "supplemental resources."

The new trend- "pass it on"

As technology grows, so do new opportunities, especially the ability to share among others. This trend is a widespread practice. Because of this opportunity, and because of the reach of these technologies, the percentage of book resources represented that students previously used as their primary source of information is declining. Sharing offers a variety of choices for instructional resources. Elaborate materials from older students, book excerpts, lecture notes, etc. often circulate among students. Recommended materials, both printed and handwritten, also become a source of sharing.

There are now a large number of teaching resources, ranging from printed resources published by qualified publishers and developed by erudite teams, to digital materials developed by teachers themselves, to electronic, digital resources freely available on the Internet.

The meaning of a printed resource is any printed or manuscript document that is graphically designed and forms a body of thought. A printed resource means a book, magazine or other specially printed document. The most popular printed resource is primarily a book, which may be a teaching text, scripts or manuals (Fiala, 2007).

The term digital resource refers primarily to a source of information that is in electronic form. Such a resource is mainly available through modern technologies. The content of such a resource is independent of the material medium. A digital resource, on the other hand, is dependent on the technical environment and on the various programs that are an essential part of making the content of the learning material accessible. Digital resources have the advantages of being both rapidly available and subject to rapid equipage. One of the most important aspects is the quality of the retrieval apparatus. The information that is part of a digital resource is very easily retrievable and updatable. The information that is part of a digital resource is flexible and thus becomes dynamic.

Digital resources have different forms and availability. Freely available resources may be subject to the risk of untrustworthiness of information, unlike licensed resources that are made available under licensing agreements that are relevant in the representation of professional expert information (Jelínková, 2009).

According to Sikorová (2019), new "genres" such as digital applications, graphic novels or various podcasts are emerging among the new resources used in teaching. The reason why such a turnaround is noted is that there is a paradigm shift in practice away from traditional teaching to a more learner-centred concept of activity, which in the very end also encourages a change in teaching materials.

In today's modern world, which brings many new opportunities, it cannot be assumed that all learning resources are conceived on the same principle or even identical. In contrast, Stein (2003) adds that from a professional

pedagogical and didactic point of view, there is an essence of instructional resources and textbooks based on basic concepts.

Research points to the fact that, despite the modern representation of digital sources, print sources are still preferred, which are evaluated as mediators of knowledge that include underlying norms and values that generate specific cases of perception.

In 2018, the study Academic reading format preferences and behaviors among university students worldwide (Mizrachi & Salaz & Kubanoglu & Boustany) was published, which was a comparative research analysis describing the inferential statistical results of a survey of academic reading format preferences and behaviors among 10,293 tertiary students worldwide. The research method was the ARFIS questionnaire, which was used to examine reading format preferences.

This instrument was piloted and refined prior to use and subsequently expanded to 16 Likert-style statements with six demographic questions and an open-ended qualitative prompt for additional comments.

Using the LimeSurvey electronic platform, students responded to eight statements regarding format preferences in general and under specific conditions. This study hypothesized that differences in socioeconomic development, culture, and other country-based factors may influence format preferences, whether print or electronic resources.

The main findings are that country of origin has almost no relationship with reading format preference, but at the very end, the results of the survey showed that overall 78.44% of the 10293 participants preferred print format for preparing for teaching. Digital format of learning resources is preferred by 10.04% of the students and the remaining 11.52% of the students do not express their preference in any way.

Attitudes towards electronic resources are less favorable than printed textbooks. According to the findings, participants believe that they concentrate better when reading print, remember the information represented,

and are even more likely to use engagement strategies in terms of text handling practices: highlighting, notes, pictures, etc.

In our daily lives, it is clear that the use of digital resources for personal purposes is highly prevalent, but in contrast, much research shows a high preference for the use of print resources in actual classroom preparation. Based on these claims, there is also research where digital resource use is over-represented.

In 2017, Singer and Alexander conducted a study to explore the role that print and digital resources play in text comprehension. The results of this study suggested that the medium plays an influential role under a particular text or according to the specific task conditions given to students. After identifying the key points that were related to the reproduction of subtopics, it emerged that students using print sources performed much better in reproducing knowledge than students who studied the details of the instructional material preferentially from a digital source.

Research points to the fact that, despite the modern representation of digital sources, print sources are still preferred, which are evaluated as mediators of knowledge that include underlying norms and values that generate specific cases of perception.

For example, research findings by Daniel & Woody (2013) adds that the use of digital resources in preparation for teaching, results in longer time spent on overall preparation than the use of printed material.

Another finding is the level of achievement, which is influenced by the form of the instructional resource. Students who use print resources achieve better results than when using digital resources. This leads to the conclusion that learning from printed material, enhances better retention of information in memory. The reason why this is the case may be because the current generation has not yet learned how to work effectively with digital resources and use this acquired knowledge effectively.

The influence of motivation on the formation of memory traces

Motivation is central to learning success because many learning problems are primarily related to motivation problems. Many experts point out that when a student is motivated and really wants to achieve something, the learning process is much easier than for an individual who approaches learning as mere memorization without a deeper interest. "The formation of a memory trace is dependent on the intensity of the learning process in terms of speed. If the subject of learning is motivated, the memory trace is formed very quickly and can occur after just one connection, especially if it is a biological or emotionally significant stimulus" (Škoda & Doulík, 2011, p. 27).

In the context of motivation on the formation of memory traces, the nature of the motivation itself is relevant. The greatest influence on the formation of memory traces is the strength of the intrinsic motivation represented, which activates the learner to learn for the sake of knowledge itself, and primarily out of self-interest. This character of motivation is closely related to the deep learning approach.

When a learner is motivated by extrinsic motivation, he or she approaches learning as a purposeful outcome,

and therefore reduces learning to the information that is required of him/her and, once the requirements are completed, this information falls into oblivion. The nature of this motivation is also specified below in the surface approach.

Finally, one more type of motivation can be specified, which is the most negative in terms of value. These are pupils for whom study is a mere necessity. In other words, the pupil learns in any way, and only to pass. A typical characteristic of such a student is a strong negative attitude towards learning, which manifests itself even in the inability to learn independently, hence the ineffective formation of memory traces depending on the motivation represented (Škoda & Doulík, 2011).

According to many authors, performance motivation is understood as the need to achieve something difficult, to overcome obstacles or to reach a high standard, in short, to "outdo oneself." The social aspect characterizes this perspective as a struggle for higher value within society. According to McClelland et al. (1953 in Vyrost, 2008), performance-oriented motivation is activated within a person, by the need to achieve a goal, which is accompanied by the anticipation of success or failure.

The achievement of this goal may be hindered by external obstacles or personality deficiencies, which may lead to negative personality states that may be an actual obstacle in the perceived attitude.

Related to this fact is performance motivation, which is related to two basic aspects: qualitative and quantitative performance, which is related to the perceived goal. Either the goal is perceived as a requirement demanding circumstances or the goal is perceived as a commitment and in the case of the latter option, the desire for self-actualization figures here (Vyrost, 2008).

J. Atkinson in Výrost (2008, p. 155) assumes that the tendency to achieve success stems from two opposing attributes:

"If performance motivation is generally oriented toward obtaining success, then the value of success is inversely proportional to the probability of success in a given activity. If, on the other hand, a person has a stronger motive to avoid failure, a different process is involved and the value of success is directly proportional to the probability of success in the activity."

## 3. CONCLUSIONS

In the context of the issue we are addressing, there are studies that seek to draw relevant conclusions from a pedagogical context that focuses on the issue of study habits. Study habits, in the narrower sense of practices, can be considered a "phenomenon" that is current not only across the Czech Republic but also in many countries around the world. Provisional research in the Czech Republic has a somewhat lower percentage of represented studies compared to the foreign one. This fact was a decisive element for the selection of the topic of this research study. Considering the fact that there is a growing interest in higher education among the Czech population, it is also very essential to expand scientific knowledge in the context of what procedures these students use to make the results of their studies as effective as possible. According to many pedagogically oriented researches, practices represent specific strategies that can have a very positive impact on the outcome of the set goal. The essence of this study is based on both the pedagogical perspective and the psychological perspective, which is very closely related to the issue under study, since it is the personal characteristics, attitudes and motivations of the individual that are very closely related to the area of learning outcomes.

A prominent representative of research on this topic in our country is Sikorová (2019), who dealt with the topic of the use of learning resources in secondary and tertiary education. One of the main objectives was to clarify the study habits of university students in relation to the use of learning resources and to verify the relationship between study habits and students' approaches to learning. The survey showed that the resources used and study approaches of students with a deep approach to learning and students with a surface approach differed significantly. This is also consistent with the results of our research, which indicated that students with a predominantly surface approach significantly used fewer learning practices.

Thus, it is clear that the role of the represented motivation played an important element in this context, which manifests itself as one of the main determinants in shaping the approach to learning and in the very choice of practices of students in preparation for learning. Awareness of the importance and nature of learning leads to more responsible practices that help shape the learning process. The practices chosen depend, also, on the form of the resource represented.

Instructional resources and the role of textbooks have been investigated by Horsley and his colleagues, who found that the use of textbooks and instructional material varies according to the degree of centrality, that is, whether the

material is regarded as a primary resource or merely supplementary. Another important element is the form of the resource represented, which greatly influences the representation and use of instructional preparation practices. Our research also reveals the fact that students prefer to use one primary source for studying and supplementary sources are mostly used for better understanding of the material and include mostly digital sources. According to the results, supplementary resources are used by students who have a predominantly in-depth approach with a higher level of motivation to achieve better learning outcomes.

Digital technologies are part of an individual's everyday life in pretty much all areas. The potential for a higher representation of digital resources in education can be seen as a transformation of educational opportunities. In my opinion, the ability to use digital resources in a way that is effective lies primarily in a sufficiently developed preference not only for the resource itself, but also the ability to solve tasks with the ability to sustain attention. Current studies so far do not sufficiently suggest that this may be the case.

It is clear that students prefer brevity, clarity and timeliness in their learning which digital resources offer this alternative as they further offer self-regulated learning. We could understand this as the use of digital technologies being conditioned by an internal self-regulation that is shaped by students' individual preferences, values and interests.

In a sense that is based on the principles of media preference and satisfaction theory, in 2008 Prázová investigated what resources students use and which resources students identify as effective.

The results showed that although digital resources are more accessible, students preferred print resources and used electronic resources only as a supplementary resource. According to students' own preferences, textbooks and scripts became the clear choice of resource they use in preparation for class. In terms of percentages, textbooks and scripts were the choice of 50% of the students mentioned, 22.6% had the preference of professional books, 10.6% had the preference of reference books and 6.9% had the preference of professional journals.

From our research, it is somewhat evident that students greatly prefer the use of printed sources, mainly because of better handling and application procedures. A somewhat interesting finding was the preference of digital source for the purpose of ecological thinking, which was mainly associated with the strong idea of environmental protection. The preference of printed resources is in relation to the ability of concentration and manipulation. In contrast, digital sources come into clear confrontation.

However, these findings do not detract from the idea that digital resources represent great potential in the future, we are just faced with the current problem of learning how to work with this alternative and use it effectively.

In the analysis of the data, it is clear that there are different perspectives on the issue of using practices in preparation for teaching. In the interviews, we encounter views that are conditioned primarily by the motivation of the individual by his or her character and the attitudes he or she takes in the context of his or her studies. With regard to the practices themselves, it is demonstrable that students mainly use leafing through the source as part of familiarisation with the source, and that practices targeted at learning from the source itself include extracts, constructing their own scripts, highlighting, note-taking, mnemonic devices, reading or reciting aloud. Participants' accounts and subsequent analysis revealed that students' practices included tracking down information on their own.

Considering the fact that the researched topic is quite topical in the pedagogical world, especially in the context of the increase in the use of modern technologies, there is still a certain absence of scientific research on this topic.

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# Analysis of the Challenges in Educational Activities far from School during the Recent Pandemic

Fethi KAYALAR [a]*

[a] *Erzincan B. Y. University), Faculty of Education,, Erzincan, TURKEY fkayalar@erzincan.edu.tr*

**Abstract**

The recent pandemic, which has taken the world by storm, has interrupted normal human activities. The governments all over the world issued a policy to run almost all activities at home, including education, in an effort to contain the spread of the Covid-19 virus. This policy turns the traditional learning application system into a network (online) so that the learning process can be carried out. Online learning is a set of teaching methods in which teaching activities are conducted separately from learning activities. As students live far from the educational institution or school environments, the separation of two activities may be in the form of physical distance. Online learning is a learning process that uses internet technology to perform various learning interactions. Online learning uses media facilities with various applications to support learning. The application of online learning brings out the various benefits and problems faced by students and teachers. The main benefit felt by the community in online learning is that it can protect children and family members and avoid exposure to the covid 19 virus. Out of this benefit, the principals, the teachers, the students and the parents in educational environments have had various difficulties in carrying out the educational activities far from schools. In this study we have tried to analyze the difficulties in this process.

**Keywords:** Online Learning, Education at home, Homeschooling, Mobile Learning, Education Management

## 1. INTRODUCTION

The age we live in is called the age of information, science and technology. The developments in science in accordance with the requirements of the age have led to the emergence of different alternatives as well as traditional education methods. Distance education method is one of these alternative methods. The relationship between distance education and the technology used in education is a very strong one. Letters were first used in distance education, and then distance education began to be continued with technologies such as radio, television, computer and internet that entered our lives (Cabi & Ersoy, 2017). The distance education method, which brings together educators and students from different fields, provides benefits for the effective use of time. Distance education is spreading rapidly in the higher education level. Universities at the higher education level are educational institutions that play a major role in the development of societies. These educational institutions offer practical training on the profession, as well as professional knowledge, in order to train an expert workforce in their field. In this sense, distance education is one of the methods used to gain professional knowledge and experience to university students. In this way, the student has the opportunity to attend the course he wants, whenever and wherever he wants. However, apart from the benefits it brings, distance education also brings many problems with it. Problems increase especially in cases where the transition to distance education is fast and there is not enough information about this process.

Distance education, which has qualified applications today, started for the first time in the world with the announcement of shorthand lessons in the Boston newspaper in 1728. While teaching using communication tools such as radio, television and mail at the beginning had a one-way information transfer feature, this transfer has become a

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* Corresponding author.

two-way process with the use of the internet (Ak, Oral and Topuz, 2018; Etlioğlu and Tekin, 2020). Many benefits such as low cost, independence of time and place, equality of opportunity have been achieved with the educational materials offered in electronic environments. Distance education is widely used in the world with various methods suitable for the technological trend of the period. The tools used in distance education are changing with the development of technology. The internet is a widely used distance education tool today. Computers, phones and tablets are tools that enable internet use.

The need for lifelong learning and unprecedented technological innovations in communication has pushed distance education approaches to the forefront of educational practice (Garrison, 2000; Kataoka and Mertala, 2017; Figaredo and Álvarez, 2019). Distance education has created a favorable opportunity for students to learn at any time or anywhere. Universities that provide distance education offer this education method in order to meet the demands of those who cannot receive face-to-face education, who want to go back to school, and those who want to receive vocational and personal education at an advanced age. Other student groups who prefer distance education are students living in rural areas, children who are sick or hospitalized, gifted children, families traveling and students who have problems in regular classes. Visual, written and verbal communication needed by students and educators in different places can be provided via the internet. In this way, the student can attend the course he/she wants whenever he/she wants. This situation provides benefits in terms of effective use of time. Distance education is spreading more rapidly, especially in higher education. It can be said that while distance education provides many benefits to users, it can also cause some disadvantages. For example, a student researching in an uncontrolled virtual environment will reach some harmful and unnecessary information. This will cause both loss of time and information pollution. The lack of clear ethical rules based on computer use also leads to crimes with virtual content. (Mupinga, 2005; Günter, Güneş, and Demir, 2012; Cırık, 2016).

## 2. EDUCATION IN THE PERIOD OF PANDEMIC

Schools in 194 countries were closed throughout the country in the second half of the 2019-2020 academic year due to the COVID-19 outbreak. In Turkey, education was suspended in schools in the second week of March. Immediately after the interruption of education in schools, the continuity of learning was tried to be ensured by using distance learning tools and opportunities urgently. The infrastructure and facilities of all institutions across the country have been mobilized to prevent the epidemic, to minimize learning losses while the epidemic continues, and to ensure the continuity of learning.

It is clear that the pandemic, which is accepted as a global problem, reveals many deficiencies in the education system. It can be said that these deficiencies are factors such as access to computers, supportive environments, unbalanced distribution between resources and needs (Schleicher, 2020). According to the results of Emin and Altunel (2021) from the PISA database, a "digital distinction" has emerged between students who have and do not have digital devices and schools that have similar technological equipment and lack this equipment. Consequently, the risk of inequality of opportunity has come to the fore. Students' access to distance education differs according to factors such as the country/region of residence, family and age (García and Weiss, 2020). According to the report published by OECD, students who are supported by their parents and willing to learn are more advantageous in finding their way to alternative learning opportunities even though schools are closed. Students with disadvantaged conditions generally faced negatives in the distance education process (Schleicher, 2020). Many teachers had to meet the distance education process, which they were unfamiliar with, to understand the application and realize the demands of the digital environment, since they did not have to use it before. On the other hand, some students try to cope with problems such as their parents' ignorance about the process and lack of access to the necessary technology and internet in the distance education process (UNESCO, 2020).

## 3. DISTANCE EDUCATION DUE TO PANDEMIC

Distance education applications provide students with many advantages in terms of accessing information sources, education and evaluation methods. However, individuals may tend to exhibit unethical behaviors in distance education environments (Akbulut, Odabaşı, and Kuzu, 2008). This situation is explained by the concept of "psychological distance" in the US Department of Justice report. Accordingly, when interacting face-to-face with others, the consequences of inappropriate and unethical behaviors are faced, but since there is no face-to-face relationship in distance education, the behavior becomes less personal, thus making it easier to use information technologies in a way that harms others (Gearhart, 2001).

In distance education, teachers and students attend classes using networks of personal computers or other devices. Thus, depending on the characteristics of the tools used, the way of accessing resources also changes. At this point, it should not be forgotten that the distance education process brings with it the risks inherent in the internet (Reamer, 2013; Yılmaz & Aksoy, 2020; Koç, 2020). For example, distance education environments support undesirable discourses and multiple relationships due to the uncertainty of online sites, causing physical, cultural and linguistic boundaries to be crossed. As can be seen, not using the internet correctly in distance education is one of the important education problems.

When the literature is examined, it has been seen that various studies have been conducted on the distance education process during the pandemic period (Alan, 2021; Chahin-Dörflinger, 2020; Graumann, 2020; Jones and Sharma, 2020; Işık et al., 2021; Korkmaz and Toraman, 2020; Marek, Chew and Wu, 2021; Smiley et al., 2020). The topics covered in these studies are generally related to determining the needs of educators regarding distance education during the pandemic, and the development of distance education in schools with the evaluation of teachers and principals. In addition, the effects of the Covid 19 process, the future of online learning in the post-Covid 19 period, classroom transformations and organizational problems of the school, the experiences of teachers, students and families were evaluated in these studies. Apart from these studies, it has been observed that the difficulties and opportunities of the transition to online education have been examined through the evaluations of educators in different countries. In a study conducted by Özdoğan and Berkant (2020), various evaluations were made by taking the opinions of provincial national education directorate officials, school administrators, teachers, school psychological counselors, faculty members, students and parents in the Covid 19 pandemic. As a result of these evaluations, the problems of plagiarism were examined under the title of ethical problems, and a solution was suggested that ethical rules should be determined in order to combat these problems. A study by Köksal (2013) focused on the ethical principles that academicians should follow in distance education. Despite these studies, it has been seen that there is a need for research that comprehensively reveals the ethical problems experienced in educational institutions during the pandemic period.

## 4. THE PANDEMIC AND BLENDED LEARNING

The Pandemic crisis has brought to light the importance of the physical space provided by the school, as well as the fact that the school is not the only place where education takes place. While education systems are responding to the Pandemic crisis with distance education, in fact, seeds for the future have been planted for the recovery, flexibility and restructuring of the system. Today, it is expected that the decisions and investments made to enable and maintain the learning of students outside of school with distance education will create a normal that will blend the space and time where learning takes place, at school and outside of school. Therefore, in order to be prepared for a new crisis, countries have started to focus on blended learning models that blend face-to-face education and distance education, taking into account the flexibility of education to be everywhere at any time. In the simplest definition, blended learning, which is a combination of face-to-face learning and online learning experience, and the delivery of some of the lessons through distance learning can reduce the number of students in the school and a solution can be produced for the lack of physical capacity of the school and the classroom. The capacity problem of the schools can be solved within the framework of social distance by dividing the students into groups and by switching to a transformative model, some of which will receive distance education at school.

## 5. CONCLUSION

The negative effects of school closures on students' social and emotional development, behavior, economic future and academic success have been revealed by many studies during the COVID-19 process. It is known that these effects will be much more severe for disadvantaged students, those with learning difficulties and students whose self-learning skills are not sufficiently developed by using distance learning tools. Primary school students are among the groups that will be most affected by the closure of schools. Although distance learning contributes to the learning process, the difficulties of acquiring literacy and basic skills using distance learning tools are well known for a student who has just started primary school. However, face-to-face education will be more effective than distance learning in gaining skills at all levels and supporting the social and emotional development of students.

The limited communication and interaction of students with their peers in distance learning will also negatively affect their development. In this process, we need to approach education in a more pragmatic dimension in terms of students' development and learning, rather than approaching and criticizing education in a paradigmatic dimension. We know that distance learning can be very effective in cognitive learning, especially through live-interactive online

courses. However, when we evaluate this effectiveness together with the limitations of distance education in acquiring many professional skills, it is clear that distance learning cannot replace face-to-face education.

Each country has taken various measures within its own means to continue learning at the level of K-12, vocational and technical education and higher education. Some decisions taken in this process have made the measures more inclusive, more qualified and more applicable (TEDMEM, 2020).

For K-12:

• Identifying students with access barriers and providing the necessary technological device and internet connection
• Broadcasting on TV channels to reach more students, and delivering printed resources to students who do not even have access to TV.
• Making plans for students who need special education
• Collaborating with various institutions and evaluating existing resources by acting proactively during the creation of learning resources
• Creating distance learning plans and sharing these plans with the public.
• Defining the duties and responsibilities of students, parents and all personnel working at the school (teachers, administrators, IT personnel, nurses, etc.).
• Creating different programs for different education levels and sharing daily or weekly study schedules for students.

For Vocational and Technical Education:
• Continuation of theoretical courses through distance education
• Continuing the skills training in the workplaces as much as possible by taking the necessary precautions; postponed/compensated when it is not possible to continue
• Economic support of students within the scope of apprenticeship and internship training
For Higher Education:
• Establishment of support centers at universities, making plans, preparing and sharing instructions, both for the management of the distance education process and for the ongoing campus activities.
• Strengthening the digital infrastructure, establishing an effective communication network
• Identifying students with access barriers and providing the necessary technological device and internet connection
• Guidance to faculty members on both distance education and assessment and evaluation.
• Ensuring the continuation of laboratory, clinical study and practice training by creating appropriate conditions

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# Case Study: Electric and Hybrid Vehicle users in India

## HIMANSHU[a*]

*[a]Rajkiya Engineering College Banda, Final year student, Department of Mechanical Engineering, Banda, Uttar Pradesh, India, himanshuautogear@gmail.com*

**Abstract**

From over the past several years, almost every automobile manufacturing company has introduced at least one electric vehicle in the country. They reveal their technologies, and new vehicles at the expo, auto shows every year and try to establish trust with the customers. The response from the customers for buying non-electric cars is higher than electric cars. Electric cars have many benefits and advantages over gasoline and diesel cars. They are emission less, so they are good for the city and densely populated area to reduce air pollution, regeneration braking helps improve range while driving downhill and city traffic conditions. Electric cars are silent running and do not produce noise pollution. Also, buyers for electric cars are predominantly from metro cities as compared to smaller cities. The main reasons for poor attraction towards electric cars are range anxiety, high cost, taxes, maintenance, unavailability of proper fast-charging stations. There is a requirement of highly trained technicians for the repair and service, also the parts of the cars are very expensive for electric and hybrid vehicles. Government and officials can play a major role in promoting public transportation electrification by launching campaigns and public awareness. At present, there is a big demand for improvement towards technologies, infrastructures such as authorized and local service stations regular electricity supply and fast-charging stations in public buildings. Bus terminals, public parking spaces, and bus stops can be mandated to have charging stations. Highways with a heavy density of vehicles, battery swapping infrastructure at every 100 kilometers can be promoted.

**Keywords:** EV, HEV, IC, ICE

## 1. INTRODUCTION

The first electric cars were used about 100 years ago, until the advent of fossil fuel cars which become very popular and more affordable, due to the development of low-cost IC engine technology, ICE dominated the Market. eventually surpassing the electric car. Today with an ever-increasing interest in renewable energy and environmental protection, electric vehicles (EVs) have once again gained the interest of many manufacturers. EV'S are emission-less and can be a remarkably better option to achieve the world's future emission-less goals. Since, the past decades almost every automobile manufacturer has presented their EV concepts, prototypes, and fully electric production models in the country. The study seeks to examine the advantages and benefits of electric cars over regular internal combustible cars and analyse the sales, factors, and future scopes, development, improvement, and building of infrastructure needed to grow in the country. This study includes a review of information and a survey on the randomly chosen dealers in the country who are selling electric vehicles. The survey was done by Google Docx, an online mode to know the actual reality faced by the dealers out there in the country. The dealers belong to all the segments of electric vehicles where the prices of the cars vary.

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\* Corresponding author.

## 2. ADVANTAGES OF ELECTRIC AND HYBRID CARS OVER ICE CARS

The Indian Automobile sector is growing very rapidly. The vehicle to people ratio is high, However, the population is high, and emissions are also high. There is a huge increment of 335% of the Carbon dioxide emissions from 1990 which turned out as a third rank in global carbon dioxide emission or a total of 6.8% of the world's emission.  [1]
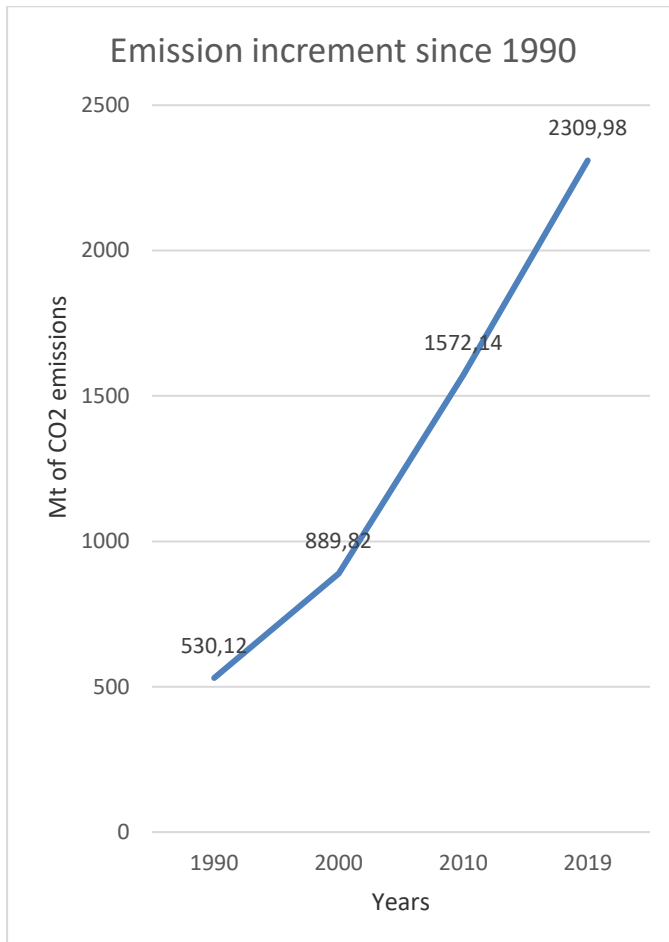


Fig 1. This chart shows the CO2 Emissions of India from 1990 to 2019 with an interval of 10 years.

Hence there is a need to investigate factors and challenges for the development of sustainable EV technology with zero emissions and clean alternatives for transportation systems. An electric car has no conventional engine and gearboxes while it has a battery, motor, reducer, onboard charger and an electric power control unit as a powertrain. A Hybrid powertrain uses a small battery along with a conventional internal combustion engine which uses power only from the battery when the drive starts from rest, it provides an additional boost of torque while driving in uphill and hard acceleration conditions. Electric and Hybrid cars both are capable to recharge the battery by regenerative braking when going downhill and braking situations.

Electric cars can be more useful considering the following reasons.

1. Electric cars can give the same amount of torque and power from the initial throttle input instead of a conventional fossil fuel engine car that needs to be in a certain rpm range to give maximum torque and power output.
2. Indian roads have low driving speeds therefore Hybrid or electric powertrains operate at much higher efficiency than an Internal Combustion Engine (ICE).

3.  A greater amount of energy per trip in the country is lost in braking while manoeuvring through heavy traffic conditions and densely populated areas, which is almost recoverable in a hybrid-electric vehicle (HEV) and EV (Regenerative braking).
4.  HEV's and EV's use main/auxiliary battery power while idling and no fuel is used during idling. This is a great benefit of electric or hybrid powertrains considering the fact that idling time in traffic is much higher in India.
5.  The average range travelled in India is much smaller, making EVs much more feasible and with fewer range problems with a single charge.
6.  Vehicle use and vehicle distance – Urban driving cycle patterns have frequent start and stop, high traffic benefits to provide high efficiency by electric vehicles.
7.  Electric cars have usually a low centre of gravity due to heavy battery packs located at the floor of the car which helps to achieve improved vehicle dynamics compared to a car equipped with diesel or gasoline engines.
8.  Electric cars run silently without any noise, vibration and harshness which improves overall driving comfort and creates a huge contribution in reducing noise pollution in urban driving conditions.

## 3. HEV AND ELECTRIC CARS IN INDIA

At present, multiple countries and global summits have taken many steps for electrification and conversion of pre-developed non-electric infrastructure into an electric one. Globally a large number of EV's are on sale. Currently in India, almost each manufacturer has introduced either a hybrid or a full electric car. The country has almost one electric car from every manufacturer. They are from different price ranges, segments and performances. A few of them from different price ranges are listed below.

Table 1. Vehicles and price list

| Vehicle | Price |
|---------|-------|
| Tata Tigor EV | INR 11.99 lakh |
| Tata Nexon EV | INR 13.99 lakh |
| MG ZS EV | INR 21.00 lakh |
| Hyundai Kona Electric | INR 23.79 lakh |
| Audi e-Tron | INR 99.99 lakh |
| Jaguar I-Pace | INR 1.05 crore |
| Mercedes Benz EQC | INR 1.06 crore |
| Audi e-Tron GT | INR 1.79 crore |
| MG Hector Hybrid | INR 15.38 lakh |
| Toyota Camry Hybrid | INR 41.20 lakh |
| Volvo XC90 Hybrid | INR 89.90 lakh |
| BMW 7 Series Hybrid | INR 1.39 crore |
| Lexus LC500 Hybrid | INR 2.09 crore |

Note: Prices are ex-showroom New Delhi base variant at the time of launch.

The Indian automobile market is sensitive towards price. The maximum number of sales is achieved by Tata Nexon. It was launched in January 2020, and it becomes the most affordable electric car with attractive features and safety.

*3.1. Sales*

The overall sales of electric and hybrid cars compared to the conventional internal combustible engine is low.

Therefore, multiple reasons are there in the EV market are responsible for it. Several factors that can play an important role are considered. These factors include the most important of all, Range Anxiety or in other words commonly known as 'mileage' in India. Other major factors such as the cost of the vehicle and charging infrastructure were also included in the survey so that a better framework of the reasons can be found and verify them.
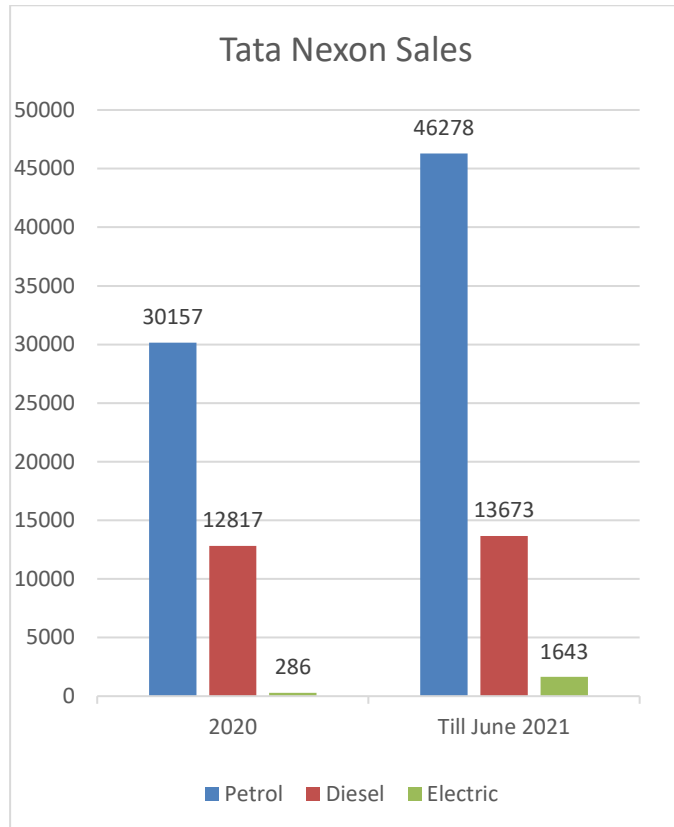


Figure 2. This is the sales statistics for two years of Tata Nexon with three powertrains. These are Petrol 1.2L, Diesel 1.5L, and Electric 30.2 kWh Li-ion Battery. [3]

*3.2. Prices and Taxes*

India EV manufacturers outsource the battery and other electrical components from China which increases the taxes on the battery and components, therefore, increases the overall prices of the car. [4]. An electric vehicle uses batteries that are made up of rare earth metals which increases the prices since the extraction of these materials involves big projects and investments.

Usually, the initial cost of hybrid cars is higher than the cars with the powertrain of gasoline only. The vehicle has combined gasoline and a parallel electric powertrain. This creates complexity in technology and engineering. The presence of electronics and electrical components requires software, semiconductor chips which are expensive than mechanical devices and take a long time to research and develop. The capital investment in the entire production is high. Thus, resulting in increases in the final price of the car. The graph is scaled for the prices of an electric and a hybrid car. Both vehicles are from totally different segments to take estimation and idea of all the vehicle segments. Tata Nexon is considered as a compact economic family crossover that comes under the price ranges of 10 to 20 lakhs INR depending upon the state, registration and transport office taxes. Tata Nexon has three powertrain options petrol, diesel and electric. Similarly, The BMW 7 series is a luxurious limousine that comes under the price range from 1.4 to 2.5 crores INR depending upon the variants and overall state, registration and transport office taxes.
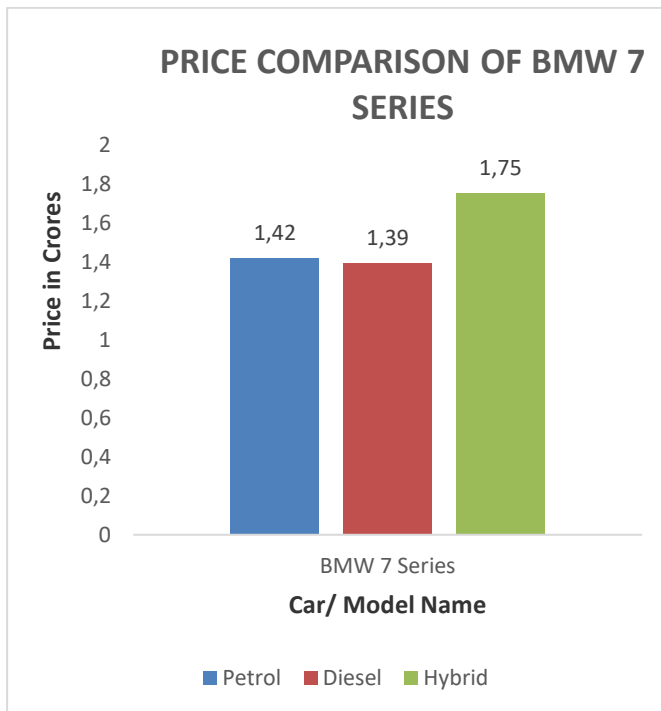
Figure 3. This is the price comparison in crores, of the BMW 7 Series with three powertrains. These are a 3.0L Petrol Engine, 3.0L Diesel Engine, Hybrid (3.0L Petrol and 11.2 kWh 355V Li-ion Battery). [5]
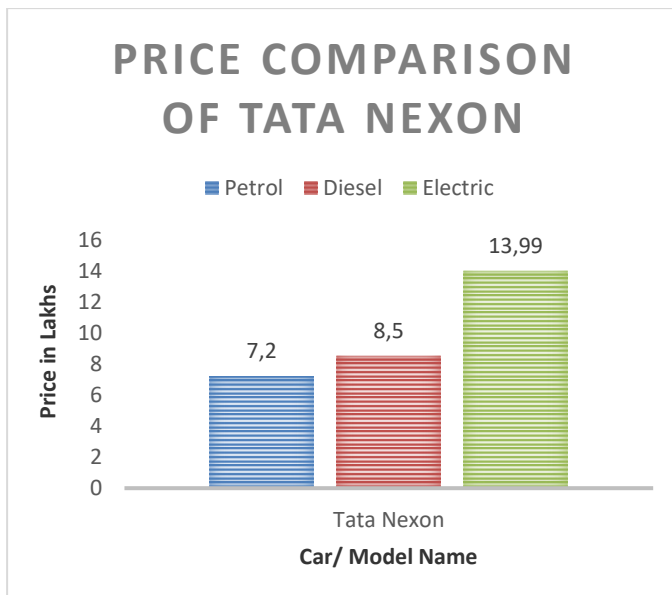


Figure 4. This is the price comparison in lakhs, of Tata Nexon with three powertrains. These are Petrol 1.2L, Diesel 1.5L, and Electric 30.2 kWh Li-ion Battery. [6]

The above figure clearly shows the differences in price for the same vehicle and different powertrains. Electric drivetrains become the costliest in comparison to conventional ICE vehicles. However, the price range between gasoline and diesel is closer. The survey results also agree with the cost factor of electric vehicles over regular IC vehicles. Also, survey results help to explore more key reasons as well.

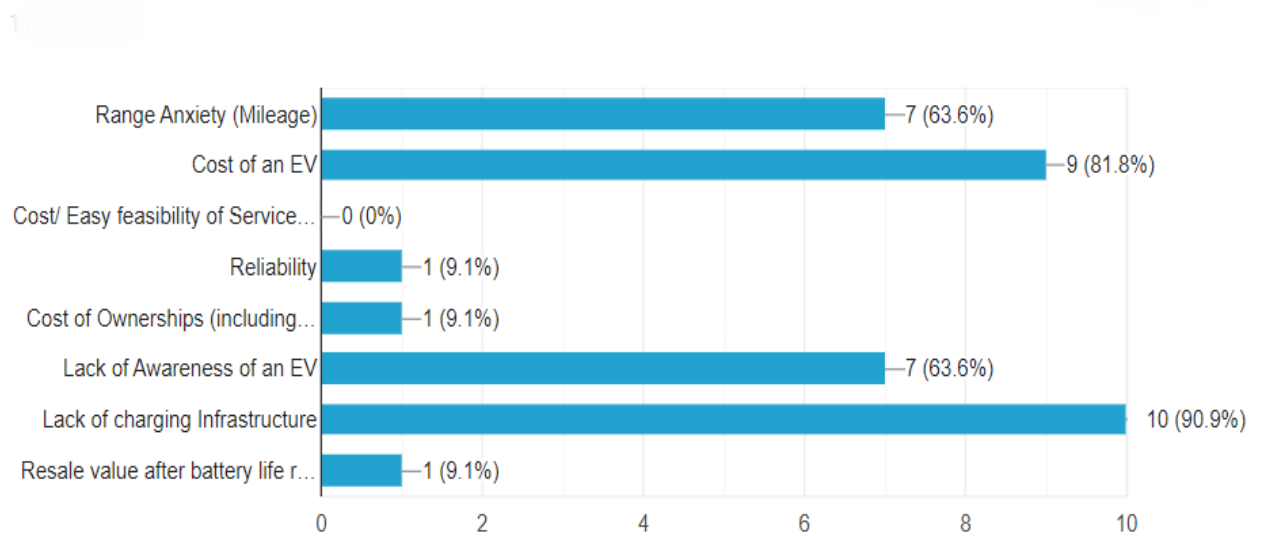## 11) Possible reasons for low sales of Electric vehicle



Figure 5. Response from the survey question asking about the low reason of EV sales according to the dealers.

### 3.3. Current Charging Infrastructure

Lack of Charging Infrastructure is a major concern for EV's. In October 2021 the total charging station in the country is 427, out of which 77 are located on the major highways and motorways. Other 350 of them are in another part of the metro politician cities. [7]. Local towns and rural areas do not have electricity available 24 hours a day. They get electricity for fixed hours at regular intervals of time. For that scenario, it would be difficult to charge the EV's at home considering the average time taken for charging by a regular AC charger is approximately 8 hours. This is the reason that a maximum number of EV buyers are predominantly from metro cities.

### 3.4. Range Anxiety

Range anxiety is a psychological barrier termed for electric car users. It creates fear and doubts in the driver's and occupant's minds about the remaining charge left in the battery to finish the trip to their destination. For the current number of charging stations, this is a common thing faced by many electric car users in India [8]

A hybrid car has the advantage of range over electric cars. The two- powertrain option in a single vehicle provides an additional alternative in a case when the battery gets fully depleted. Petrol can be used to drive the vehicle. The downhill driving conditions, regeneration braking regular.

### 3.5. Range Anxiety

Charging time depends upon various factors. Fully charging a car can take from 30 minutes to 12 hours depending on 5 main factors: battery size, battery status, weather conditions, vehicle charging rate and charger capacity, and charging rate. [9]

Size of the Battery: A battery of larger capacity and size takes a long time to recharge. Cars with long-range are usually equipped with larger capacity batteries to improve range.

Status of the Battery: A fully drained battery will take a longer time to charge than a partially charged battery.

Weather conditions: An optimum working temperature is required while charging and driving the electric car. Charging and driving electric in winter or lower temperatures would not be as efficient as compared to non-winter days. The charging time will be longer, and the range will also reduce from the average range.

Charging rate of vehicle: The Vehicle with a maximum charging rate will charge faster than the vehicle with a lower charging rate operated and plugged in on the same charger.

Charging rate of charger: The charger with a higher capacity will charge a car faster than regular chargers. These cases are applicable for both categories, electric as well as a plug-in hybrid.

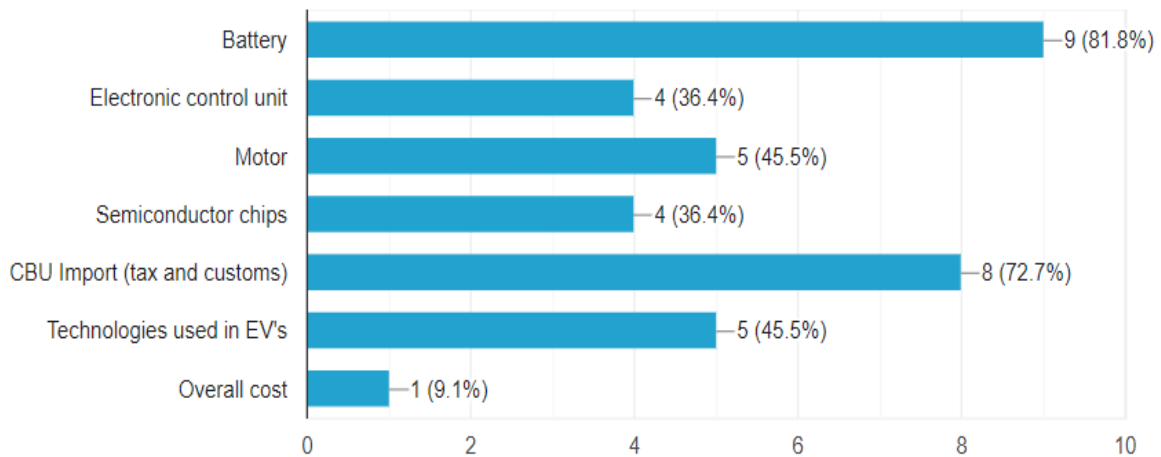What do you think, what are the factors responsible for maximizing the cost of an EV?



Figure 6. Response from the survey question asking about the reasons of high cost of the EV' according to the dealers.

## 4. MAINTENANCE

### 4.1. Electric Vehicles

Servicing and Maintenance of electric cars are a bit different from regular conventional IC cars. Electric cars have fewer mechanical parts. It has major electronics and electrical parts tuned by specified software. It requires skilled and specifically trained workers for servicing electric cars. Along with it, they require a well-insulated service area, insulated clothes and equipment to ensure proper safety majors.

Example- Let us Assume a case where a person is driving in a remote area where there is no fast-charging station and service center. If the person suddenly notices any technical faults or runs out of the battery and stops in between the midway where the nearest possible authorized service center and charging station is hundreds of kilometres away. In that scenario, the assistance and help from service stations will also be going to take a long time to navigate and arrive at that person, since that electric vehicle cannot be repaired at regular mechanic shops and garages. So, it would be a complete nightmare to find a local assistant considering the present infrastructure of service stations of EV's. The person will get stuck over there and the only help it could get is from the nearest service station. Imagine this situation in a place with improper connectivity of mobile networks and after sundown where it would be a matter of huge anxiety for that person and their family while getting stuck in an unknown remote place.

Analyzation of this situation gives the result that there is a big demand in the development of proper infrastructure in the present scenario is needed.

Improvement in infrastructure can raise the confidence to the new EV and HEV buyers and give more sophistication to the customers who have already owned them.

### 4.2. Hybrid Vehicles

Hybrid cars do have a petrol engine, so they need regular servicing, oil and parts change just like a regular gasoline engine car. Despite this hybrid cars has technologies and electronics different than the regular gasoline-powered car they need to maintain carefully. They also need service, parts change, software updates at certified and authorized service centers by skilled, professional and experienced workers only.

## 5. CONCLUSIONS

### 5.1. HEV and EV promotion in India

We are strictly required to switch towards hybrid and electric public transportation to reduce emissions and improve efficiency in energy and air quality. Government and officials can play a major role to promote public awareness through campaigns. The strict guidelines about the electrification of transportation by officials and the ministry could create a remarkable impact on society and many relative sources and departments. A report by the Society of manufacturers of electric vehicles shows that only several banks approve loans to electric car customers whereas other banks refuse them. This refusal can easily break the trust of a customer and make them doubtful about the reliability, feasibility and sources available to buy an electric car. [10]

In the capital New Delhi, the "Switch Delhi Campaign" is launched by the government in February 2021. The motive of this campaign is to give incentives and subsidies to new EV buyers, assign vendors for the installation of charging stations and give guidelines to use EV's in multiple departments and the commercial, hence taking a big initiative to promote electrification of transportation and EVs. [11]

### 5.2. Charging Infrastructure

A continuous power supply is the most important factor needed to fulfil the requirement of developing a good infrastructure for charging points and authorized service stations. Public buildings, charging and service stations. EV charging requires space to set up a unit of EVSE (Electric vehicle supply equipment) and a parking area during the charging duration. Private and semi-public spaces, like apartments, offices, buildings, schools and independent homes at accessible sites can be mandated for EV charging space. For public charging, it is required to develop a fully functional and 24x7 accessible space and be well distributed among the city or town. [12].

Bus stops, Bus Terminals can be equipped with fast chargers and should allow 24x7 access. Installation of fast charging stations and battery swapping facilities can be done on prominent motorways and highways at regular intervals of 100 kilometres can be promoted. It can give the benefit of getting a charged battery within a few minutes and allowing users to cover more distances in a single trip without worries and anxieties about the range. It will also improve the life of the battery due to similar charging conditions. The basic improvements in structure will help to get a framework with maximum accessibility and utilization of sources at minimum cost.

### 5.3. Electric vehicle transition in public and private transportation

In order to promote electrification in public transport, electric buses, electric two-wheeler taxis, three-wheeler tuk-tuks, or rickshaws can be promoted. Special utility vehicles such as school vans, ambulances and police vehicles can be promoted. These all factors will try to generate an impact on consumers' minds and the local public about the goal of electrification up to a certain level. It would emphasize them to move towards electric and hybrid cars.

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