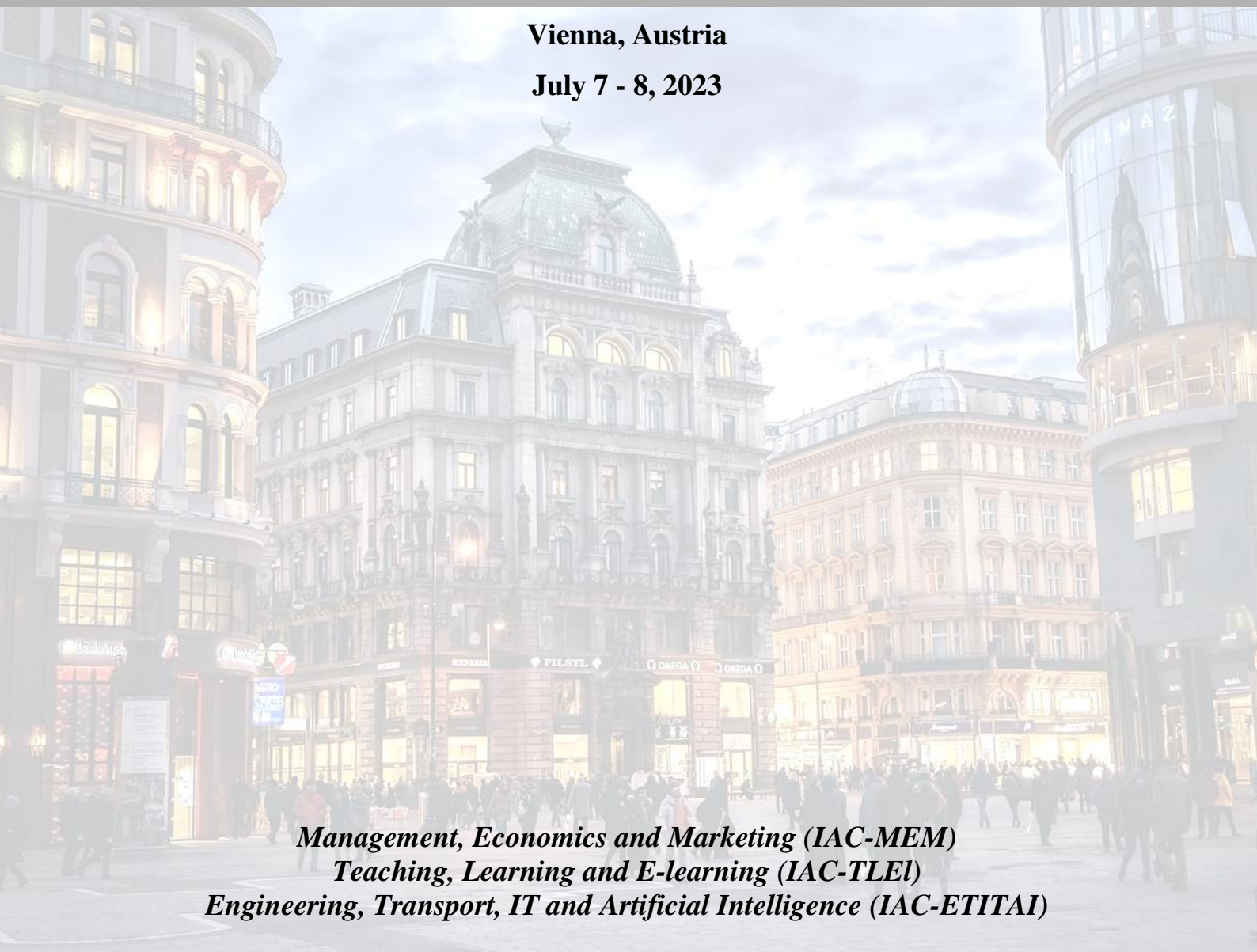




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Table of Contents

An Integrated Decision Approach for Evaluation of Education Policy in EU Countries	8 - 15
E. Ertugrul KARSAK, Ece UCAR KELES	
The Determinants of Domestic Tourism Demand for Thailand	16 - 21
Nantarat TANGVITOONTHAM, Pappusson CHAIWAT	
Health Tourism in Thailand, the Readiness after COVID-19 Pandemic	22 - 31
Phannipha ANURUKSAKORNKUL	
Risk Assessment of Rock Bolt Application in Underground Metal Mines	32
Mustafa Emre YETKİN, Muharrem Kemal ÖZFIRAT	
International Business Negotiation Strategies and Tactics of Research in International Logistics Strategic Management Decisions	33 - 39
Aleksandr POLUSIN	
B2B Brand Orientation, Customer's Dependence, and Customer–Supplier Relationship Performance	40 - 48
Tun-Chih KOU	
Tourism, Growth, Energy Consumption and Environmental Pollution: Evidence from Turkey	49 - 58
Nihat DOĞANALP	
A Novel Adaptive Model for Overall Equipment Effectiveness Prediction	59 - 77
Péter DOBRA, János JÓSVAI	
Recommendation System Algorithms for Different Sizes of Datasets	78 - 85
Meltem ARSLAN, Gülfem IŞIKLAR ALPTEKİN	

Direct and Indirect Effects of Governance Indicators on Economic Performance: MIMIC Model Estimation	86
Nilcan MERT, Rahmi YAMAK	
Using Economic Fitness and Economic Complexity Indices to Evaluate the Economic Development of BRIMC-T Countries	87
Özlem EŞTÜRK, Nilcan MERT, M. Caner TIMUR	
Police Legitimacy in Relation to Equality, Diversity and Inclusion: An Analysis of a Strategic Plan	88 - 98
James MOIR	
Capturing Innovation and Inclusive Development Performance of European Countries	99 - 110
Rashidatu BASSABI	
BIM Maturity Factors in Small and Medium-Sized Design Institutes in Sichuan Province, China	111 - 116
Feng WU, Thitinant WAREEWANCH, Thitinan CHANKOSON	
Post-Pandemic Educational Pathways: Creating the NextGreat Academic Dream for Learner Empowerment	117 - 123
Bob BARRETT	
Individual Differences in Second and Foreign Language Learning	124 - 127
Fethi KAYALAR	
The Importance of Formal and Informal Education in Growing Students' Skills	128 - 132
Ermonda FONIQI, Leonora BERISHA, Edita DEMBOGAJ	

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An Integrated Decision Approach for Evaluation of Education Policy in EU Countries

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Abstract

As the policymakers of the countries aim to propose quality and impartial education to all students and use the educational resources in a sustainable way, the educational performance assessment of countries has become a key topic. The increasing importance of the achievement of this goal promotes the application of multi-criteria decision making methods in education. This study proposes to employ the Evaluation Based on Distance from Average Solution (EDAS) method integrated with the Best-Worst method (BWM) for comparing the educational performance of member states of the European Union. The criteria used in performance evaluation are obtained from PISA (Programme for International Student Assessment) 2018 database and UNESCO Institute for Statistics database. This study not only focuses on PISA test scores for assessment but also considers other key attributes such as the teachers/students ratio, learning time of students and government expenditure as a percentage of GDP on primary education. The linear form of the BWM is employed for determining the set of criteria weights. The proposed methodology employing EDAS with BWM weights yields full ranking of the countries as well as identifies the best performing country from educational perspective.

Keywords: Educational performance of countries, multi-criteria decision making, EDAS, Best-Worst method, PISA.

1. INTRODUCTION

Governments develop education policies to support the objective of establishing more effective and equitable education systems proposed by Sustainable Development Goal 4 (SDG 4), which is set by the UNDP (United Nations Development Program) in September 2015, and aims to ensure “inclusive and equitable quality education for all” [1]. OECD (Organization for Economic Co-operation and Development) is responsible for developing data regarding the indicators that are representative for the SDG 4. In this context, the PISA (Programme for International Student Assessment) is one of the important tools that contributes to these efforts by promoting indicators, and thus, measuring the progress towards the achievement of the SDG 4. In order to measure the educational performance of countries, the PISA, which is a triennial assessment of international education systems and set in cooperation with OECD, provides valuable data about the success of 15-year-old students in PISA tests and the factors that influence the education quality of students. The PISA mainly publishes the test scores of students in reading, mathematics and science, and provides some indicators and indexes regarding the educational resources of students and their social, economic and cultural background [1].

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Some of the research works used the PISA data for performance evaluation and comparison of schools and/or countries in a multi-criteria decision making (MCDM) framework. Stamenković et al. [2] employed the ELECTRE multi-level outranking (ELECTRE MLO) approach with PISA data to evaluate secondary schools in Serbia. Aparicio et al. [3] analyzed the PISA 2012 database to compare the educational performance of 34 countries with the non-radial Data Envelopment Analysis (DEA) model. Aparicio et al. [4] compared the educational performance of Latin American countries using PISA data over the period 2006-2018. Ishizaka and Resce [5] proposed the Best-Worst PROMETHEE method to evaluate 66 countries participated in PISA survey with three indicators such as reading, mathematics and science score. Ucar and Karsak [6] employed a comparative analysis of OECD countries using common-weight DEA-based models with PISA 2018 data.

In this study, the Evaluation Based on Distance from Average Solution (EDAS) method is proposed for comparing the educational performance of member states of the European Union. The EDAS method proposed by Ghorabae et al. [7] is a multi-criteria decision making technique that evaluates the alternatives by calculating the positive distance from the average solution (PDA) and negative distance from the average solution (NDA). Unlike other methods such as TOPSIS and VIKOR, EDAS uses the distance to the average solution rather than using the distance to the ideal and anti-ideal solutions. Higher values of PDA and/or lower values of NDA represent that the alternative is better than average solution.

As the performance evaluations in EDAS are based on the weighted criteria values, the use of an appropriate weighting method is of key importance. In the literature, there are several weighting methods that can be classified into two main groups such as subjective weighting approaches and objective weighting approaches. The Analytic Hierarchy Process (AHP) [8], the Analytic Network Process (ANP) [9], the Delphi method [10], the stepwise weight assessment ratio analysis (SWARA) [11], and the factor relationship (FARE) [12] can be listed as the well-known subjective weighting methods. Although these methods aid to reflect the opinions of the experts, the consistency of the pairwise comparisons need to be justified for a robust analysis. The objective weighting methods can be listed as the entropy method [13], the LINMAP method [14], and mathematical programming-based techniques [15].

In this study, the Best-Worst method is employed for finding the criteria weights in the educational performance assessment. The Best-Worst method (BWM) proposed by Rezaei [16] is one of the recently developed weighting methods. The BWM, which is a method based on comparisons, is seen as a useful method in two ways: firstly, it requires less comparisons, and secondly, the comparisons are more consistent. In AHP, $n(n-1)/2$ pairwise comparisons are required for finding criteria weights, where n represents the number of criteria. However, in BWM, $(2n-3)$ comparisons are required as the determination of the preference of the best criterion over all other criteria and the preference of all the other criteria over the worst criterion are sufficient for finding the set of criteria weights. Rezaei [16] also justified that the BWM results in more consistent comparisons than AHP by using some numerical examples. In this study, the BWM is used to assign criteria weights for the EDAS method, which will be employed for the performance evaluation of EU countries in terms of education.

The rest of the paper is organized as follows. Section 2 delineates the basics of the EDAS method, while Section 3 presents the BWM employed in this study. In Section 4, a case study regarding the educational performance assessment of EU countries is provided. Concluding remarks are given in the last section.

2. EVALUATION BASED ON DISTANCE FROM AVERAGE SOLUTION (EDAS) METHOD

Evaluation Based on Distance from Average Solution (EDAS) method proposed by Ghorabae et al. [7] is a multi-criteria decision making technique that evaluates the alternatives by calculating the positive and negative distances from the average solution. EDAS is seen as a useful method when the decision-maker deals with conflicting criteria [7]. In VIKOR and TOPSIS, which are MCDM techniques proposing compromise solutions, the best alternative is identified by calculating the distance of the alternatives from the ideal and anti-ideal solutions [7]. In these methods, the best alternative is considered to be close to the ideal solution and far from the anti-ideal solution, whereas in EDAS, the alternatives are evaluated using the positive distance from average (PDA), and the negative distance from average (NDA) measures. Higher values of PDA and/or lower values of NDA represent that the alternative is better than average solution. Assuming m alternatives are evaluated with respect to n criteria, the eight steps of the method are summarized as follows:

Step 1: Select the set of criteria that are suitable for evaluating alternatives.

Step 2: Construct the decision matrix \mathbf{X} given below, with m alternatives and n criteria.

$$\mathbf{X} = \begin{bmatrix} x_{11} & \cdots & x_{1j} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{i1} & \cdots & x_{ij} & \cdots & x_{in} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mj} & \cdots & x_{mn} \end{bmatrix}, i = 1, \dots, m; j = 1 \dots n. \quad (1)$$

Here, x_{ij} is the performance value of alternative i as regards criterion j .

Step 3: Calculate the average solution for each criterion as shown below.

$$AV = [AV_j]_{1 \times n}, \quad j = 1, \dots, n, \quad (2)$$

where

$$AV_j = \frac{\sum_{i=1}^m x_{ij}}{m}, \quad j = 1, \dots, n. \quad (3)$$

Step 4: Determine the positive distance from average (PDA) and the negative distance from average (NDA) matrices considering the type of criteria (i.e., benefit or cost) as

$$PDA = [PDA_{ij}]_{m \times n}, \quad i = 1, \dots, m; j = 1, \dots, n, \quad (4)$$

$$NDA = [NDA_{ij}]_{m \times n}, \quad i = 1, \dots, m; j = 1, \dots, n, \quad (5)$$

If criterion j is a benefit criterion, then

$$PDA_{ij} = \frac{\max(0, (x_{ij} - AV_j))}{AV_j}, \quad i = 1, \dots, m; j = 1, \dots, n, \quad (6)$$

$$NDA_{ij} = \frac{\max(0, (AV_j - x_{ij}))}{AV_j}, \quad i = 1, \dots, m; j = 1, \dots, n, \quad (7)$$

If criterion j is a cost criterion, then

$$PDA_{ij} = \frac{\max(0, (AV_j - x_{ij}))}{AV_j}, \quad i = 1, \dots, m; j = 1, \dots, n, \quad (8)$$

$$NDA_{ij} = \frac{\max(0, (x_{ij} - AV_j))}{AV_j}, \quad i = 1, \dots, m; j = 1, \dots, n, \quad (9)$$

where PDA_{ij} and NDA_{ij} represent positive and negative distance of the i th alternative from the average solution according to the j th criterion, respectively.

Step 5: Calculate the weighted sum of PDA and NDA for all alternatives as follows:

$$SP_i = \sum_{j=1}^n w_j PDA_{ij}, \quad i = 1, \dots, m, \quad (10)$$

$$SN_i = \sum_{j=1}^n w_j NDA_{ij}, \quad i = 1, \dots, m, \quad (11)$$

where w_j denotes the weight associated to criterion j .

Step 6: Determine the normalized values of SP_i and SN_i for all alternatives as given below.

$$NSP_i = \frac{SP_i}{\max_i(SP_i)}, \quad i = 1, \dots, m, \quad (12)$$

$$NSN_i = 1 - \frac{SN_i}{\max_i(SN_i)}, \quad i = 1, \dots, m. \quad (13)$$

Step 7: Calculate the appraisal score (AS) for all alternatives as

$$AS_i = \frac{1}{2}(NSP_i + NSN_i), \quad i = 1, \dots, m, \quad (14)$$

where $0 \leq AS_i \leq 1$.

Step 8: Rank the alternatives according to the appraisal scores (AS) in decreasing order. The alternative with the highest AS is identified as the best performing alternative among the others.

3. BEST-WORST METHOD

In MCDM problems, the weighting of the criteria is of vital importance in terms of proper consideration of the criteria in the evaluation process of the alternatives. The Best-Worst method (BWM) proposed by Rezaei [16] is one of the recently developed weighting methods. The BWM, which is a comparison-based method, is seen as an effective approach requiring less comparisons while yielding higher consistency in comparisons [16]. In AHP, $n(n-1)/2$ pairwise comparisons are performed for finding criteria weights, where n represents the number of criteria. However, in BWM, $(2n-3)$ comparisons are required as the determination of the preference of the best criterion over all other criteria and the preference of all the criteria over the worst criterion are sufficient for finding the set of criteria weights. Rezaei [16] also justified that BWM results in more consistent comparisons than AHP via several numerical examples. The main steps of BWM are explained as follows:

Step 1: Determine n criteria for evaluating alternatives.

Step 2: Identify the best (e.g., most desirable, most important) and the worst (e.g., least desirable, least important) criteria.

Step 3: Determine the preference of the best criterion over all other criteria, using a 1 to 9 scale. The resulting best-to-others (BO) vector is

$$A_B = [a_{B1}, a_{B2}, \dots, a_{Bn}] \quad (15)$$

where a_{Bj} represents the preference of the best criterion (B) over criterion j .

Step 4: Determine the preference of all the criteria over the worst criterion, using a 1 to 9 scale. The resulting others-to-worst (OW) vector is

$$A_W = [a_{1W}, a_{2W}, \dots, a_{nW}]^T \quad (16)$$

where a_{jW} represents the preference of criterion j over the worst criterion (W).

Step 5: Find the optimal weights for n criteria ($w_1^*, w_2^*, \dots, w_n^*$).

$$\min \max_j \left\{ \left| \frac{w_B}{w_j} - a_{Bj} \right|, \left| \frac{w_j}{w_W} - a_{jW} \right| \right\} \quad (17)$$

s.t.

$$\sum_j w_j = 1$$

$$w_j \geq 0, \quad \text{for } j = 1, 2, \dots, n.$$

Formulation (17) is equivalent to the following model.

$$\begin{aligned}
 & \min \xi & (18) \\
 \text{s.t.} & \\
 & \left| \frac{w_B}{w_j} - a_{Bj} \right| \leq \xi, \quad \text{for } j = 1, 2, \dots, n, \\
 & \left| \frac{w_j}{w_W} - a_{jW} \right| \leq \xi, \quad \text{for } j = 1, 2, \dots, n. \\
 & \sum_j w_j = 1 \\
 & w_j \geq 0, \quad \text{for } j = 1, 2, \dots, n,
 \end{aligned}$$

where the optimal weights of the criteria are determined by minimizing the maximum of the absolute differences $\left| \frac{w_B}{w_j} - a_{Bj} \right|, \left| \frac{w_j}{w_W} - a_{jW} \right|$ for all j . As Rezaei [17] showed that formulation (18) can result in multiple optimal solutions, the following model of BWM is proposed.

$$\begin{aligned}
 & \min \max_j \{ |w_B - a_{Bj}w_j|, |w_j - a_{jW}w_W| \} & (19) \\
 \text{s.t.} & \\
 & \sum_j w_j = 1 \\
 & w_j \geq 0, \quad \text{for } j = 1, 2, \dots, n.
 \end{aligned}$$

Then, formulation (19) is transformed to the following linear model:

$$\begin{aligned}
 & \min \xi^L & (20) \\
 \text{s.t.} & \\
 & |w_B - a_{Bj}w_j| \leq \xi^L, \quad \text{for } j = 1, 2, \dots, n, \\
 & |w_j - a_{jW}w_W| \leq \xi^L, \quad \text{for } j = 1, 2, \dots, n, \\
 & \sum_j w_j = 1 \\
 & w_j \geq 0, \quad \text{for } j = 1, 2, \dots, n.
 \end{aligned}$$

For the linear model of BWM, ξ^L is considered as an indicator of consistency of the comparisons. Therefore, a value of ξ^L close to zero is preferable.

4. CASE STUDY

In this section, the EDAS method is employed to evaluate educational performance of 20 EU countries. The PISA 2018 database and UNESCO Statistics Institute database are used for identifying the performance values of countries for selected criteria. The teachers/students ratio, the learning time of students (in minutes per week), the government expenditure on primary education as a percentage of GDP as well as the reading, mathematics and science test scores of PISA are considered as the criteria throughout the performance analysis. The government expenditure on primary education as a percentage of GDP in 2018 is extracted from UNESCO Institute for Statistics database [18] and other

indicators are used from the PISA 2018 database [19]. The data related to decision problem including 20 countries and 6 criteria is presented in Table 1.

The criteria weights required in EDAS are determined with the linear form of the BWM, i.e., formulation (20). The best-to- others (BO) vector and other-to-worst (OW) vector of BWM indicating the preference of the best criterion over all criteria and the preference of all criteria over the worst criterion, respectively, are given in Table 2. All the criteria are considered as benefit type. Due to expert judgements, the math score is considered as the best (e.g., most important) while the learning time is considered as the worst (e.g., least important) criterion throughout the analysis. The consistency indicator of the linear form of the BWM, ξ^L , is equal to 0.071, which is an acceptable value. The set of criteria weights obtained with the linear form of the BWM is presented in Table 3.

Table 1. Data related to the educational assessment of countries

EU countries	teachers/students ratio	learning time	government expenditure (%)	reading score	math score	science score
Austria	0.092	1730	0.893	484.393	498.942	489.780
Belgium	0.108	1669	1.524	492.864	508.070	498.773
Czech Republic	0.077	1536	0.845	490.219	499.468	496.791
Denmark	0.074	1655	1.632	501.130	509.398	492.637
Estonia	0.081	1563	1.470	523.017	523.415	530.108
Finland	0.092	1479	1.349	520.079	507.301	521.885
France	0.086	1646	1.160	492.606	495.408	492.977
Greece	0.105	1662	1.253	457.414	451.370	451.633
Hungary	0.094	1586	0.640	475.987	481.083	480.912
Ireland	0.078	1730	1.159	518.078	499.633	496.114
Italy	0.107	1742	0.957	476.285	486.590	468.012
Latvia	0.091	1556	1.281	478.699	496.126	487.251
Lithuania	0.095	1510	0.718	475.873	481.191	482.067
Luxembourg	0.107	1646	1.083	469.985	483.421	476.769
Netherlands	0.057	1632	1.156	484.784	519.231	503.384
Poland	0.124	1697	1.455	511.856	515.648	511.036
Portugal	0.096	1759	1.399	491.801	492.487	491.677
Slovak Republic	0.078	1517	0.907	457.984	486.165	464.048
Slovenia	0.113	1686	1.428	495.346	508.898	507.007
Sweden	0.084	1631	1.925	505.785	502.388	499.445

Table 2. Best-to-Others (BO) and Others-to-Worst (OW) pairwise comparison vectors

Criteria	Best-to-Others (BO)	Others-to-Worst (OW)
teachers/students ratio	5	3
learning time (in minutes per week)	7	1
government expenditure on primary education as a percentage of GDP	3	5
reading score	2	6
math score	1	7
science score	4	4

Table 3. Criteria weights obtained from BWM

Criteria	Weights
teachers/students ratio	0.089907
learning time (in minutes per week)	0.044072
government expenditure on primary education as a percentage of GDP	0.149846
reading score	0.224769
math score	0.379022
science score	0.112384

The EDAS method is employed with the set of criteria weights obtained from the BWM. Finally, the ranking of the countries in terms of educational performance is obtained. The normalized weighted sum of positive distance from average solution (NSP_i), the normalized weighted sum of negative distance from average solution (NSN_i), the appraisal score (AS_i), and the rank of each country are presented in Table 4.

Table 4. Results obtained from the proposed approach

	NSP_i	NSN_i	AS_i	ranking
Austria	0.038674	0.541853	0.290264	15
Belgium	0.652338	1	0.826169	3
Czech Republic	0.026922	0.325712	0.176317	17
Denmark	0.663988	0.807466	0.735727	6
Estonia	0.748533	0.864843	0.806688	5
Finland	0.448235	0.955839	0.702037	7
France	0.016706	0.856482	0.436594	11
Greece	0.185217	0.364732	0.274974	16
Hungary	0.020053	0	0.010026	20
Ireland	0.179638	0.785775	0.482706	10
Italy	0.178218	0.447999	0.313108	14
Latvia	0.084986	0.892262	0.488624	9
Lithuania	0.032159	0.084428	0.058293	18
Luxembourg	0.146486	0.578550	0.362518	13
Netherlands	0.191250	0.538460	0.364855	12
Poland	0.904338	1	0.952169	2
Portugal	0.312764	0.959537	0.636151	8
Slovak Republic	0	0.095293	0.047646	19
Slovenia	0.632778	1	0.816389	4
Sweden	1	0.916603	0.958301	1

As depicted in Table 4, the best performing country in terms of educational performance is identified as Sweden, followed by Poland, Belgium, Slovenia and Estonia. Moreover, one shall note that the proposed approach yields the complete ranking of the countries.

5. CONCLUDING REMARKS

In this study, the EDAS method is employed for the educational performance evaluation of EU countries. Considering the advantages of BWM such as requiring less pairwise comparisons and resulting in more consistent comparisons, the criteria weights are calculated with the linear form of the BWM and these criteria weights are integrated in EDAS.

EDAS method is based on the idea of calculating positive and negative distances from the average solution. Higher values of positive distance from average solution and/or lower values of negative distance from average solution represent that the alternative is better than the average solution. The BWM is a minmax mathematical programming model that identifies the best criterion and the worst criterion, and then determines the preference of the best criterion over all other criteria and the preference of all the criteria over the worst criterion.

A case study that focuses on the educational performance assessment of countries is conducted through considering 20 EU countries and six attributes including teachers/students ratio, the learning time of students (in minutes per week), the government expenditure on primary education as a percentage of GDP as well as the reading, mathematics and science test scores of PISA. According to expert judgements, the mathematics score is considered as the best criterion while the learning time is regarded as the worst criterion. The weight of mathematics score is calculated as 0.3790 while the weight of learning time is 0.0441. Finally, Sweden is identified as the best performing country using EDAS method with BWM weights, while the full ranking of the countries is also obtained with the proposed approach.

As a future research direction, the proposed weighting scheme can be combined with other MCDM methods or EDAS can be combined with other weighting methods. Moreover, the proposed integrated approach can be applied to other real-world MCDM problems.

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The Determinants of Domestic Tourism Demand for Thailand

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Abstract

The objective of this study is to analyze factors influencing domestic tourism demand in Thailand. The study estimated the model by using econometric approach. The panel data of visitors domestically travelling in to 77 provinces in Thailand from year 2015 – 2020 were provided by Tourism Authority of Thailand. The results reveal that most of the variables in the model are statistically significant. The incomes from accommodation and food service activities, national holidays, promotion campaigns of TAT through television, and the number of visitors who domestically traveled to other provinces during the same period last quarter and last year significantly influence on domestic tourism demand. The factors which statistically affect the demand are CPI of Thailand, gasohol prices, average temperature of destination provinces, and PM2.5 level in the destination provinces. Additionally, the examination of factors influencing the regional travel routes reveals that beaches are imperative resources for promoting the coastal tourism route in western and Andaman coast in southern region while recreation activities can stimulate number of visitors for coastal tourism route in eastern part. Moreover, the cultural attractions can be promoted along with the Andaman coastal route. Cultural attractions and heritage sites are important resources for historical and cultural route in central part of Thailand. However, the attractions are not statistically significant for northeastern and Gulf of Thailand travel routes.

Keywords: Thailand domestic tourism, domestic tourist demand, domestic tourism,

1. INTRODUCTION

Tourism industry is an important sector for creating economic growth in Thailand. Additionally, domestic and international tourism revenues in the first half of 2019 contribute 17% of GDP. According to the report of the Ministry of Tourism and Sports, it was found that the amount of money circulating in the economy caused by domestic tourism is approximately 8.69 hundred billion baht in 2016. [1]

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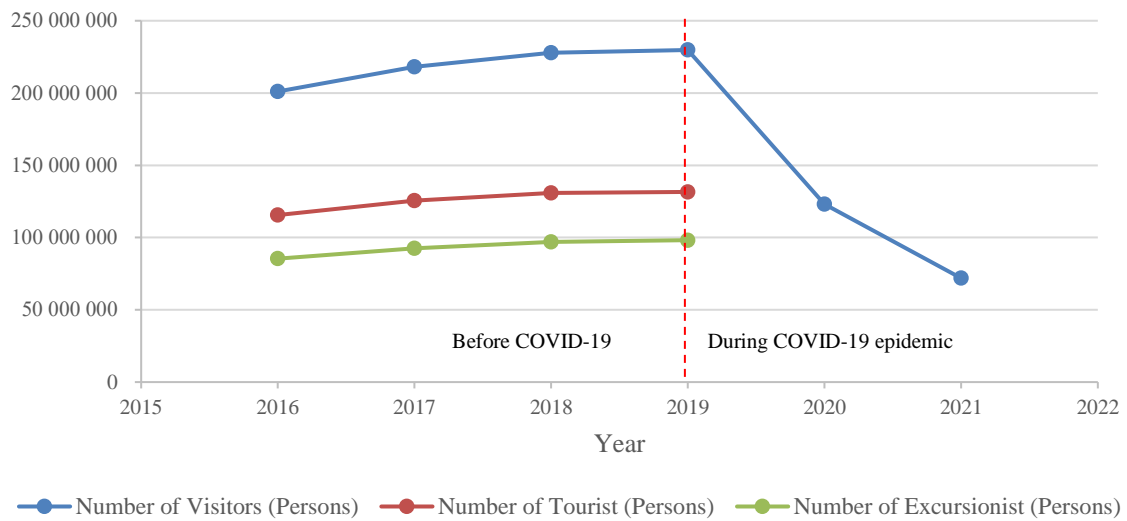


Fig. 1: Domestic Tourism in Thailand

From figure 1, Thai visitors, tourists and excursionists in domestic tourism from 2016 to 2019 increased dramatically and there was still a good trend. Before COVID epidemic, the main driving force noticeably comes from the intense marketing of entrepreneurs in the tourism business directly and publicizing tourist attractions through online social networking channels. These influence the behavior and planning decisions of tourists. The development of tourism products, creating new routing and new activities with more specific penetration to be consistent with the lifestyle can also influence the tourism growth.

However, the tourism industry was impacted from COVID epidemic not only international tourism but also domestic tourism. Although number of domestic visitors rapidly dropped after 2019, domestic tourism plays an important role to help distribute income into the local economy since the international tourism was interrupted during COVID epidemic. The domestic tourism becomes more significant and convert to be a crucial tool to stimulate local economy after COVID epidemic. Thai government tries to promote the travel routes in all regions. Then the examination of factors inducing domestic tourism demand is required to launch the appropriated policies in order to recover the domestic tourism industry.

2. OBJECTIVE

The purposes of this research are to define factors influencing the domestic tourism in Thailand as well as the factors affecting the regional travel routes and products.

3. METHODOLOGY

3.1 Data

This research had a complete quarterly domestic travel data during 2015-2020 from 77 provinces in Thailand. The panel data of number of visitors are provided by Tourism Authority of Thailand (TAT). Other dependent variables were from Bank of Thailand, Thai Meteorological Department, Tourism Authority of Thailand (TAT), Airports of Thailand, Office of the Prime Minister, Pollution Control Department and Transport Co., Ltd.

3.2 Model

The study uses econometric tools to estimate the potential factors affecting domestic tourist demand. From the literature reviews, they can be categorized into 5 factors which are economic factors, social factors, environmental factors, technological factors and institutional factors. The framework is presented as follows:

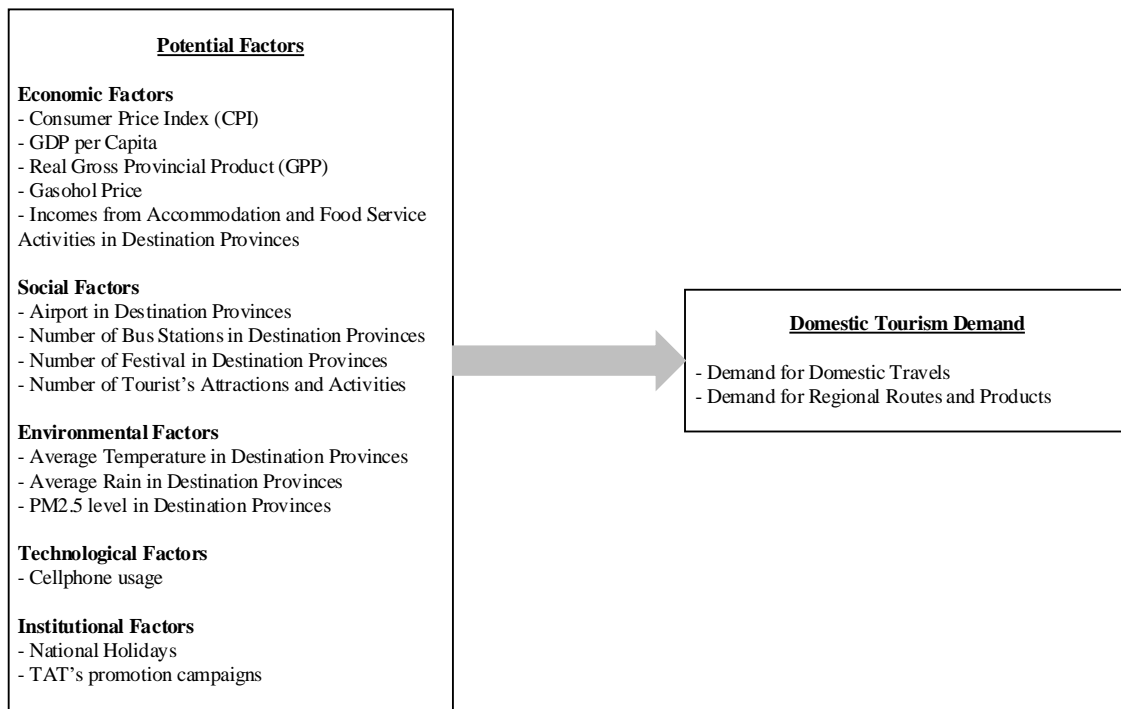


Fig. 2: Conceptual Framework

The previous researches revealed that economic factors significantly impact the tourism demand [2] [3] [4] [5]. Hence, the consumer price index (CPI) and domestic gasohol prices, GDP per capita are applied to reflect the travelling costs and incomes of the visitors. The real gross provincial products (GPP) and incomes from accommodation and food service activities present urbanization of the destination provinces in this study. Additionally, social factors are presented by number of festivals [6], attractions, and activities [7] [8] [9], and the convenience of transportation which are an airport and number of bus stations in the destination provinces. Furthermore, destinations' climates and PM2.5 levels are involved for representing environmental factors. The cellphone usage rate mirrors the technology accessibility of tourists [6]. Lastly, national holidays and Tourism Authority of Thailand's promotion campaigns launching through television and online platforms denotes the government policies which are institutional factors [10].

4. ESTIMATION RESULTS

As present above, the domestic tourism demand depends on 5 factors which the estimation results of the coefficients are shown in Table 1. This study applied OLS estimation with regional fixed effect in order to eliminate the vulnerability among regions. The research offers 3 different models which are controlled model, autoregressive distributed lag (ADL) model and Full model. The controlled model includes only the basic control variables though ADL model include both control variables and the variables which represent the time series factors; the number of visitors who travelled to the route during the same period last quarter and last year. Finally, the full model contains control and time series variables as well as variables which reflect TAT's travel promotion policies. Also, the PM2.5 level in the destination provinces is added to the full model to examine the visitors' responsiveness toward environmental problems.

Table 1. The results of overall Thailand domestic tourism demand estimation

	Controlled Model		ADL Model		Full Model	
CPI	-0.005		-0.007	***	-0.012	***
ln GDP per capita	0.480		-0.285	***	-0.183	
ln Real GPP	0.309	***	0.003		-0.004	
ln Gasohol price	-0.176		0.009		-0.583	***
ln Accommodation and food services	0.189	***	0.007	***	0.020	**
ln Average temperature	-0.992	***	-0.120	***	-1.034	***
ln Average rain	-0.004		-0.004	*	-0.006	
National holidays	0.002		0.003	**	0.009	**
Airport	-0.027		-0.006		-0.040	***
ln No. bus stations	0.141	***	-0.004		-0.004	
No. festival	0.054	***	-0.002	*	0.000	
ln Cellphone usage	0.002		0.010	**	0.016	
ln Visitors L1 (ADL)			0.028	***	0.034	*
ln Visitors L4 (ADL)			0.961	***	0.921	***
PM2.5 level					-0.001	**
TAT's TV campaign					0.048	***
TAT's online campaign					0.007	
Cons_	8.707	**	3.599		8.603	
R-square	0.706		0.996		0.998	
Adj R-square	0.700		0.996		0.998	

Source: Estimated by author

From table 1, R-squares of controlled model, ADL model, and full model are 0.706, 0.996, and 0.998, respectively. The results show that all models perform satisfactorily. The variables that significantly influence in all models are accommodation and food service activities and average temperature at the destination provinces. Accommodation and food service activities positively affect the demand. As a result, visitors prefer travelling to the high developed provinces. Average temperature at the destination provinces is negative for all models. This means visitors desire to travel at the end of the year when the temperature is low.

Moreover, time series variables; the number of visitors who travelled to the route during the same period last quarter and last year, positively simulate the demand. The visitors favor the same destination, so they always travel to the same province as last quarter and last year. If government announces to have more national holidays, the policy increases domestic tourism demand. In addition, the TAT's promotion campaigns on TV channels still have statistically impact rising of number of visitors compared to online platform. Moreover, the result reveals Thai visitors concern on environmental issues. PM2.5 levels at the destination provinces influence their decision making. The higher PM2.5 levels are, the less visitors visit the destinations.

In conclusion, the results reveal that most of the variables in the model are statistically significant and consistent with the demand theory. The incomes from accommodation and food service activities, national holidays, promotion campaigns of TAT on television, and the number of visitors who domestically traveled to other provinces during the same period last quarter and last year significantly influence on domestic tourism demand. The factors which statistically affect the demand are CPI of Thailand, gasohol prices, average temperature of destination provinces, and PM2.5 level in the destination provinces.

Table 2. The results of Thailand domestic tourism demand estimation categorized by regional routes

	Central Historical and Cultural Route	Western Coastal Route	Eastern Coastal Route	Northeastern Sport and Cultural Route	Southern Andaman Coastal Route	Southern Gulf of Thailand Coastal Route
CPI	-0.001	-0.013	-0.021 *	-0.009	-0.008 **	-0.009 **
ln GDP per capita	-1.630 *	0.048	10.045 ***	-0.298	-0.640 **	-0.442
ln Real GPP	-0.175	5.502 ***	-1.531 *	-0.310	-0.012	-0.144
ln Accommodation and food services	1.295 *	-4.442 ***	-6.154 ***	0.251	0.445 **	0.246
ln Average temperature	0.201	-0.143	0.362 **	0.051	0.036	0.397 **
ln Average rain	-0.002	0.002	-0.018 *	-0.033 **	-0.020 ***	-0.003
National Holidays	-0.002	0.005	0.002	0.007	0.007 **	-0.002
No. festivals	-0.001	0.000	0.001	0.013	0.000	-0.001
ln Cellphone usage	0.958	6.234 ***	-9.123	0.020	0.092	0.035
ln Visitors L1 (ADL)	0.013	0.004	-0.238 ***	-0.024	-0.020	-0.003
ln Visitors L4 (ADL)	0.999 ***	0.891 ***	0.770 ***	0.876 ***	0.949 ***	0.974 ***
Natural attraction				-0.114	-0.101 **	0.003
Beaches		0.073 **			0.297 **	-0.022
Cultural attraction	0.707 *			0.099	0.328 **	
Heritage Sites	16.833 *					
Museums	-6.357 *					
Recreational attraction			0.656 ***	0.299	-0.219 **	
Sport				0.033		
_cons	-40.414 *	-106.839 ***	86.915	2.269	0.954	3.620 ***
R-square	0.999	0.998	0.996	0.964	0.999	1.000
Adj R-square	0.999	0.996	0.992	0.952	0.998	0.999

Source: Estimated by author

This section estimates the coefficients of tourism routes and products in each region. There are 6 routes for all regions. First, the historical and cultural tourism in the central region involves Phra Nakhon Si Ayutthaya, Sing Buri, Ang Thong and Lop Buri provinces. The factors positively influencing the number of visitors are the number of Thai visitors who traveled to this route during the same period last year, number of cultural attractions and the number of heritage sites. However, the GDP per capita of Thailand and the number of museums are the variables that have negative impacts.

The second route is the western coastal route. The provinces which included in this route are Phetchaburi and Prachuap Khiri Khan. The variables that have a significantly positive influence on the demand of this route is the real GPP of the destination province, the number of Thai visitors who traveled to this route during the same period last year, the cellphone usage in destination provinces and number of beaches. The variable that has a negative influence on this route is incomes from accommodation and food service activities.

The third route is eastern coastal route. The provinces that comprise in the coastal route in the eastern region are Chonburi and Rayong. The variables that have a positive influence on this province are GDP per capita, the average temperature of the destination provinces, the number of Thai visitors who traveled to this route during the same period last year and the number of recreation attractions and special interests. Thailand's CPI, real GPP of the destination provinces, accommodation and food service activities, average rainfall in the destination provinces and the number of Thai visitors who traveled to these provinces in the last quarter are the factors that have negative influences on the number of visitors to this route.

The demand for sports and cultural route in the northeastern region, including Buriram, Surin, Sisaket and Ubon Ratchathani provinces, was positively affected by the number of Thai visitors who traveled to this route during the same period last year. The variable that has a negative influence is the average rain in the destination provinces.

Next, the provinces that promote tourism along the Andaman coast in the southern region are Phuket, Phang Nga, Krabi, Trang and Satun. National holidays, the number of Thai visitors who traveled to this route during the

same period last year, the number of cultural attractions and number of beaches significantly influences the demand of the route in positive direction. The negative factors are CPI, GDP per capita, rainfall in the destination provinces, number of attractions for recreation attractions and special interests and the number of natural attractions.

Finally, Surat Thani, Ranong, and Chumphon are representing coastal tourism route in the Gulf of Thailand in the southern region. The average temperature of the destination provinces and the number of Thai visitors who traveled to this route during the same period last year positively impact the demand. However, CPI has a negative influence on this route.

Indeed, attractions and tourism resources can stimulate domestic tourism demand. Noticeably, the number of Thai visitors who traveled to this route during the same period last year positively impacts for all routes. This means the visitors normally prefer to repeat the same route every year. Beaches are imperative resources for promoting the coastal tourism route in western and Andaman coast in southern region while recreation activities can stimulate number of visitors for coastal tourism route in eastern part. Moreover, the cultural attractions can be promoted along with the Andaman coastal route. Cultural attractions and heritage sites are important resources for historical and cultural route in central part of Thailand. However, the attractions are not statistically significant for northeastern and Gulf of Thailand travel routes. Travel routes in central part and Andaman coast are inferior good whereas the coastal route in eastern region is normal goods in the domestic tourists' perspectives. CPI reflects the cost of travelling; therefore, when CPI increases, there are less visitors travel to eastern and southern regions.

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Health Tourism in Thailand, the Readiness after COVID-19 Pandemic

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Abstract

Thailand is a famous Health Tourism destination in the world. At the end of 2019, there was the COVID-19 Pandemic. Thailand is preparing to become a Health Tourism destination and able to maintain the existing tourist and attract new tourists. Therefore, it is necessary to plan for the development of Health Tourism. This research uses secondary data to study the elements of Health Tourism destination development in Thailand and the government policies to support and revive Health Tourism after the COVID-19 Pandemic. The study found that the key elements of Health Tourism destinations include supporting wellbeing resources and factors, core wellbeing resources and attractions, wellbeing destination policy and planning, wellbeing destination development, and management. The main resource in Thailand can create diversity and differentiation from other countries, such as geography, culture, history, a combination of activities, entertainment, amenities, and tourism services. The government policy to support Health Tourism after COVID-19 Pandemic includes 1) Increasing competitiveness in health service provision 2) developing medical services, health promotion services, Thai traditional and alternative medicine services, academic services and research, medicines, and health products, and 3) marketing promotion and advertising. The strategy of the Tourism Recovery of Thailand call 5R includes Reboot, Rebuild, Rebrand, Rebound, and Rebalance.

Keywords: Health Tourism, Readiness, Thailand, COVID-19 pandemic

1. INTRODUCTION

Health Tourism can be divided into 2 types: Medical Tourism, Thailand is ranked as the 18th destination in the world. Wellness Tourism, Thailand is ranked as the 13th destination in the world (Global Wellness Institute, 2018). In global tourism, Health Tourism is valued at approximately 1,604 billion baht, Thailand has a market share of approximately 285 billion baht for approximately 15.6% of the total tourism revenue and a high growth rate of about 7.5% per year. The Health Tourism market during 2015 - 2020 is growing steadily up to 14% per year (Ministry of Tourism and Sports, 2019).

The Health Tourism market is a group of high-quality tourists and a niche market with high spending potential and different travel behaviors. Thailand's Health Tourism market is characterized by natural resources, multiculturalism, and medical personnel, the hospital is certified by JCI (Joint Commission International) for quality of service and facilities. (Ministry of Tourism and Sports, 2020) Therefore, foreign tourists decide to choose Thailand as a destination for Health Tourism.

At the end of 2019, there was the COVID-19 Pandemic. As a result, Thailand's tourism industry is the most affected in the world about 22% of the country's GDP (World Travel and Tourism Council, 2020). Entrepreneurs are affected because of the measure of lockdown and social distancing. The tourism sector adapts and prepares for the New Normal of tourism under safety

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standards. The Tourism Authority of Thailand has prepared a plan to revive tourism with a strategy 5R (Reboot, Rebuild, Rebrand, Rebound, Rebalance) with both domestic and foreign tourists with high spending potential. Especially Medical Tourism and Wellness Tourism to generate income and drive sustainable tourism. During 2020, there were only 6.7 million foreign tourists traveling to Thailand, generating tourism income of 330 billion baht, with both numbers and revenues decreasing by 83%. The contraction was affected by the COVID-19 Pandemic. Thailand has implemented measures to prohibit flights from entering the country since April 2020, as a result, there were no foreign tourists entering Thailand during that period.

The COVID-19 Pandemic affects the Health Tourism market. Thailand is preparing to become a Health Tourism destination, able to maintain the existing tourists and attract new tourists. The strength and uniqueness of the Health Tourism market are important in determining the positioning of local main resources, the way of life, and culture that can link with Health Tourism. Including supporting factors such as technology, system, safety standards infrastructure, personnel, etc., to be able to respond to health tourists. Therefore, it is necessary to plan for the development of Health Tourism.

Therefore, this research aims to study the elements of Health Tourism destination development and the government policies to support and revive Health Tourism in Thailand after the COVID-19 Pandemic. It is information in response to health tourists and ensuring the safety of supporting health services, leading to repeat tourism and it can generate income for Thailand sustainably.

2. RESEARCH OBJECTIVES

- 2.1 Study the elements of Health Tourism destination development in Thailand.
- 2.2 Study the government policy to support and revive Health Tourism in Thailand after COVID-19 Pandemic.

3. CONCEPTUAL FRAMEWORK

The purpose of this research is to study the elements of Health Tourism destination development in Thailand linking the key local resources, the way of life, and culture and study the government policies to support and revive Health Tourism after COVID-19 Pandemic to provide information to prepare for supporting Health Tourism in Thailand after COVID-19 Pandemic. Using Secondary Data from research, articles, documents, related journals as well as Internet resources related to the elements of Health Tourism and the government policies to support and revive Health Tourism in Thailand.

4. THEORY, LITERATURE REVIEW AND HEALTH TOURISM SITUATION

4.1 Health Tourism

4.1.1 The definition of Health Tourism

The World Health Organization (WHO) defines health as a state of physical, mental and social well-being, not merely the absence of disease or infirmity (World Health Organization, 1948). Tourism refers to social, cultural, and economic phenomena leading to the movement of people to countries or places outside their normal environment for personal or commercial purposes (United Nations World Tourism Organization, 2011).

Researchers and agencies have defined the meaning of Health Tourism as follows.

- The Global Wellness Institute (2020) defines Health Tourism as natural and cultural tourism to learn how to live and relax. It is tourism promotes physical and mental health which can be divided into 2 types which are Medical tourism and Wellness tourism.

- The Tourism Authority of Thailand (2008) defines Health Tourism as a trip to visit beautiful attractions in natural and cultural attractions as well as learn how to live and relax by dividing part of the time from traveling for Wellness Tourism activities and health rehabilitation activities.

- The World Tourism Organization and European Travel Commission (2018) defined Health Tourism as covering the main types of tourism incentives, physical health support mentally or spiritually through medical and wellness activities that enhance a person's ability to meet their own wants and better function. Health Tourism is a broad term for Wellness Tourism and medical tourism.

4.1.2 Types of Health Tourism

Health Tourism can be divided into 2 types, Medical Tourism and Wellness Tourism (Global Wellness Institute, 2020) as shown in Table 1.

Table 1 Definition of Medical Tourism and Wellness Tourism.

Medical tourism	Wellness tourism	References
Traveling to another location to receive medical treatment is mainly such as surgery, dentistry, cosmetic surgery. There is an incentive cost of treatment is cheaper than other country, excellent service and the reputation of the destination.	Tourism trips that involve seeking maintenance activities restoration or promotion of good health such as spa, massage, trekking, etc. Activities that promote overall health related dimensions as follows: <ul style="list-style-type: none"> - Physical aspects such as fitness, food, health, spa and beauty. - Mental aspects such as yoga. - Spiritual aspects such as meditation therapy. - Emotional aspects such as seclusion. - Environmental and adventure activities such as cycling, climbing, visiting nature. 	Global Wellness Institute (2015)
Tourism activities that involve traveling outside the normal circumstances of domestic or international travel to use medical resources and services which may include diagnosis, treatment prevention and rehabilitation.	Tourism activities that aim to improve and balance all of life. It consists of body, mind, emotions, career, intellect and spirit. The main incentive for wellness tourists is engaging in proactive and lifestyle-enhancing activities such as healthy eating, rest, relaxation and healing.	World Tourism Organization and European Travel Commission (2018)

Medical Tourism and Wellness Tourism have different meanings. Including activities, products, and facilities that meet the wants of healthy tourists (Smith and Puczko, 2009). Overlapping health activities between Medical Tourism and Wellness Tourism. The resulting of continuation of that activity can both promote good health and maintain health as shown in Figure 2.1 (Global Spa Summit, 2011).

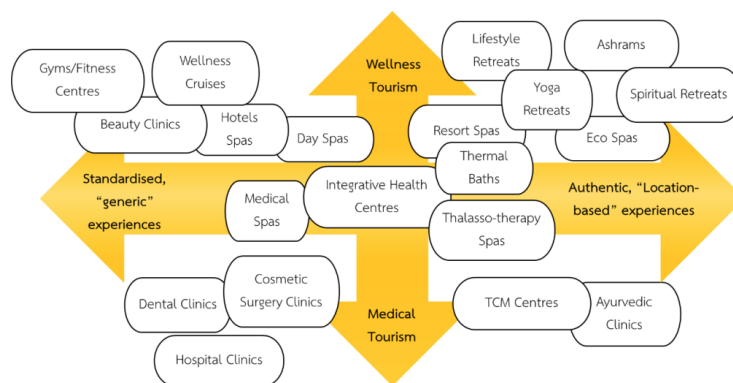


Fig. 1 Relationship of activities in Medical Tourism and Wellness Tourism.
Source: Global Spa Summit. (2011)

From Fig. 1 health activities are divided into 4 parts: Wellness Tourism, Medical Tourism Standardized, “generic” experiences, and Authentic, “location-based” experiences such as integrative health centers and thalassotherapy. This is an activity that can be used for both Medical Tourism and Wellness Tourism. It depends on consumers and the activities of service providers. Staying healthy and wellness is a top priority and intertwined with creating a successful Medical Tourism market because in addition to being a Medical Tourism market that meets the wants of healthy tourists with facilities abundance of nature including wellness and treatment services but it also helps the local to have a career and earn income from these tourists as well. Therefore, Medical Tourism can apply activities together to promote good health and maintain health together as an incentive for consumers to choose a destination based on their own preferences. In addition, tourists are regarded as a niche segment, which is a customer market segment that offers high returns to operators.

4.2 Situation of Health Tourism in Thailand before the COVID-19 Pandemic

The Global Health Tourism market is growing in both Wellness Tourism and Medical tourism. Thailand's main income is derived from tourism accounting for 18% of the Gross National Product in 2018. The tourism sector employs 4.4 million people, accounting for 12% of total employment, income from foreign tourists, and about 25.35% of export revenue in 2019 and in 2019, there were almost 39.8 million foreign tourists traveling in Thailand, generating income from foreign markets of 1.93 trillion baht. Tourism in Thailand generates revenue of 1.08 trillion baht. (Ministry of Tourism and Sports, 2020)

Division of The Ministry of Public Health reported that in 2018, there were 610,851 foreign tourists who used medical services in Thailand with medical service expenses of about 112,331.25 million baht, and in 2019, there were 632,000 foreign tourists with expenses of about 121,917.81 million baht, an increase of approximately 8.53% from 2018 (Ministry of Public Health, 2019). In addition, Thailand has the highest number of health facilities that have been accredited with international standards (Joint Commission International Accreditation: JCI) in ASEAN, reaching 64 locations covering many provinces such as Bangkok, Phuket, Chonburi, Khon Kaen, Chiang Mai, and the fourth highest in the world. In addition, Thailand's private hospitals are ranked among the top 10 world-class hospitals for Medical Tourism making medical tourists more confident in the reputation and quality of Thai health services. (WordPress, 2019).

4.3 Situation of Health Tourism in Thailand after the COVID-19 Pandemic

The COVID-19 Pandemic has resulted in the number of foreign tourists arriving in Thailand in the first quarter of 2020 decreasing from the same period in 2019 by 38.01%. Implement international travel restrictions to prevent the spread of the COVID-19 Pandemic. The tourism industry and tourism-related businesses such as hotels and aviation have been severely affected. Although the current situation is improving in other countries there is also a serious outbreak of infection causing the tourism recovery to take a long time. The United Nations World Tourism Organization forecasts that domestic tourism demand will recover faster than international tourism will recover within the third quarter of 2020 or the last quarter of 2020. While international tourism will be able to recover in the last quarter of 2020 or 2021 (Office of the Permanent Secretary for Tourism and Sports, 2020). The COVID-19 Pandemic has caused tourists to change their New normal, including paying more attention to their own health because tourists who are healthy when infected with the COVID-19 Pandemic will have mild symptoms and can be cured more easily than those who are physically weak and have chronic diseases. As a result, tourists are beginning to seek alternative activities and lifestyles that lead to physical and mental health (Global Wellness Institute, 2020). Therefore, Health Tourism is one of the options that tourists are interested because tourists was able to travel to beautiful natural places but still have good health an additional factor in tourism as a new way of life that will attract healthy tourists is the introduction of technology to play a role in tourism to create safety and credibility for tourists such as Digital platform, Big data.

5. RESULT AND DISCUSSION

5.1 The elements of Health Tourism destination development in Thailand.

The key elements of Crouch and Ritchie's competitiveness as a tourism destination can be described as follows:

(1) Core resources and attractors are things that attract tourists to choose as a destination, such as geography, culture, interesting history, a mix of activities and tourism facilities and services, etc.

(2) Supporting factors and resources are facilities and convenience that support destination tourist attractions to increase competitiveness, such as infrastructure facilities, and the political commitment of destination governments that are ready to support and provide convenient and smooth tourism services.

(3) Destination management is to make the destination efficient travel and able to provide a good travel experience for tourists and build confidence in the quality of service for tourists, including coordinating with related businesses and activities to make tourists want to use the service repeatedly.

(4) Destination policy, planning, and development. Tourism policy is an important aspect of being a tourism destination, system development or planning operation philosophy, vision, branding, cooperation monitoring, and evaluation operation.

(5) Qualifying and amplifying determinants or situational conditioners to maintain competitiveness, such as setting conditions in tourist attractions, safety, and operating costs, the value of business receives increases by providing services, interdependence awareness, and image building in service tourism capacity to make travel destinations desirable.

(6) Comparative advantages occur when tourists have to decide between destinations by comparing resource endowments, the destination must create a comparative microenvironment. Imported resources include human resources, physical, knowledge, funding, and tourism infrastructure such as shipping routes or wharves, etc., that can create differentiation and competitive advantages for each travel destination, etc.

Dwyer et al. developed a new concept based on a combination of the concept of creating a competitive tourism destination that aims to be sustainable and business competition aiming for business prosperity. The model developed by Dwyer et al. is a model of competitive building elements that aim to create economic and social prosperity for the destination, divided into 4 parts: Primary elements, Second core elements, Situation conditions and Demand including elements according to Crouch and Ritchie's concept

were analyzed in each part of the elements. As a result, the concept of Dwyer et al. is another popular reference concept. In analyzing the elements of building competitiveness for a destination shown in Table 2.

Table 2 Primary elements of competitiveness as a tourism destination according to the concept of Dwyer et al.

Primary elements group	Description of primary elements group	Primary elements
1. Resource	Physical tourist attraction represents the uniqueness of the destination.	1. Natural resources: mountains, lakes, plants, wildlife. 2. Heritage resource: custom, traditional, history, language. 3. The resources created: tourism infrastructure, entertainment venues, special events, special activities. 4. Support resources, infrastructure, reaching the destination.
2. Destination management	Collaborative arrangements to incentivize travel decisions of tourist with government agencies, private sectors and business sectors in administration destination management from planning in resource management as well as marketing.	1. Government: policy, planning and development. 2. Industry: destination marketing and organization management.
3. Situational conditions	The situation or environment of the business, industry, government and relevant authorities of the destination.	1. Location of destination 2. Security and safety 3. Political dimensions
4. Demand	The personal decision of the traveler is reflected in the desire to choose a destination.	1. Awareness 2. Perception 3. Likes

Sources: Neto et al. (2020)

The elements of competitiveness building for Health Tourism destinations are not different from those of building competitiveness for general tourism destinations because there is a prototype of the same concept. Health Tourism will have a description of the elements and objectives of the elements clearly stating that they are intended to attract health-conscious tourists and there are expectations of tourism for better physical and mental well-being.

Sheldon and Park have summarized the steps of business administration to create a competitive element for a Health Tourism destination. The goal is to create sustainability in Health Tourism as follows.

- Supporting well-being resources and factors are the basic elements that businesses must manage to make the destination aware of the quality and perceive the difference and prominence of the destination that has more to promote and support the destination to be more attractive than competitors such as infrastructure, hospitality, destination atmosphere, etc.

- Core well-being resources and attractions are destination resources that already exist or resources created by the destination which can create a good image for the destination such as natural, cultural, traditional, and therapeutic, well-being resources, etc.

- Wellbeing destination policy and planning are a policy to promote Health Tourism or operational strategies that affect the development and support of Health Tourism business operations.

- Wellbeing destination development and management is business management by using human resources skills.

Health Tourism creates life balance, both Medical Tourism and wellness tourism. There must be travel activities to learn ways of life and relax including activities that promote or restore health (Ramon et al., 2012).

Tuominen et al. conceptualized the composition of building competitiveness for a Health Tourism destination to create an understanding of destination development that wants to use the Health Tourism program as one of the activities of tourism, divided into 6 elements as follows:

1. Endowed resources and quality services enhancing well-being are key elements of a destination that businesses must offer to attract tourists, including cultural resources, traditions, credibility, and the reputation of the destination. These resources can create a healthy balance, for example by using culture or tradition as an element in tourist therapy.

2. Supporting tourism services are the supporting elements that businesses must provide and planning to attract tourists along with planning to manage the core elements, divided into 2 categories, (1) tangible services and (2) intangible services.

Tangible support for travel services or called concrete service, such as food and atmosphere inside the shop. Intangible tourism services are called abstract services, such as friendliness and empathy.

3. Seamless service chain for a homogenous customer experience provided by friendly, qualified staff is a key element that demonstrates that staff service is one of the reasons travelers choose a destination. Expressed through reputation, image, or service experience.

4. Essential requirements guiding destination and company-level development. Good characteristics of a destination are composed of 3 main parts: (1) Sustainable development, (2) Hospitable attitude and atmosphere in the destination, and (3) Customer orientation Sustainable development. It can be divided into three dimensions: (1) Socio-cultural, (2) Ecological, and (3) Economic.

5. The destination management and destination development process are strategic management that businesses must develop and Communicate for a Competitive Advantage. It is developed through policy and cooperation between business, government and private sectors, including destination localities participating in the development, divided into 4 parts (1) Organization for destination management and public-private network leadership (2) Understanding health and wellbeing tourism concepts and demand, (3) Operational activities, and (4) Evaluation of the level of quality and improvement. All relevant agencies jointly plan and manage 4 destinations, (1) Systematic participatory strategic destination planning (2) Brand identity development and management. (3) Destination-level planning and policy-making supporting health and well-being tourism as well as health promotion, and (4) Continuous evaluation and development of infrastructure and service offerings. Health Tourism in Thailand is linked to the key local resources, lifestyles, cultures, and other forms of tourism. The main resource in Thailand can create diversity and differentiation from other countries to attract health tourists similar to the key element of Crouch and Ritchie's competitiveness as a travel destination, such as the destination's geography, culture, and interesting history. Combination of activities, entertainment, amenities, and tourism services or attractive place, etc., divided into 3 types as follows:

- Natural resources, including plants, animals and forests, national parks/nature reserves, and physical geography.
- Cultural heritage, including customs and traditions, handicrafts, cooking, architecture, and traditional art.
- Human-made resources, including special events/activities, entertainment such as massage shopping malls, amusement parks, coffee shops, restaurants, nightlife activities, sports activities, and adventure activities.

In addition, the conceptual study of Nulty (2004) and Hussin & Kunjuraman (2014), categorized the main local resources. It is divided into 4 types as follows:

- Natural resources such as mountains, forests, waterfalls, rivers, seas, and lakes.
- Community culture such as handicrafts, festivals, traditions, local music, agriculture, and community lifestyles.
- Historical human-made attractions such as historical attractions, architecture, villages, castles, museums, and galleries, cultural centers.
- Activities such as bird watching, cycling, mountain climbing, hiking, water activities, sports activities, adventure activities, exploring the beauty of nature religious sites, cooking lessons, marine tourism, golfing, and yachting.

Therefore, the researchers summarized the main resource types of Health Tourism destinations to be used in this research into 3 categories, details as follows in Table 3.

Table 3 Main resources in Thailand.

Main Resource Type	Attractions
1. natural resources	1.1 Beach 1.2 Island 1.3 Waterfall 1.4 River 1.5 Coral 1.6 Cave
2. culture and history	2.1 Ancient sites/antiques 2.2 Temple/Church 2.3 Local market 2.4 Handicraft 2.5 Agro-tourism sites with herb gardens
3. Activities	3.1 Bird watching, adventure activities, mountain climbing, trekking, sightseeing of the beauty of nature, religious sites, cooking lessons, marine tourism, golfing, yachting. 3.2 Outdoor activities such as cycling, climbing, walking. 3.3 Water/sea activities such as diving, fishing, kayaking, playing water gear sailing yacht. 3.4 Sports activities such as golf, Thai boxing. 3.5 Shopping 3.6 Tour of various herb gardens/agricultural gardens.

Source: Survey

5.2 The government policy to support and revive Health Tourism in Thailand after COVID-19 Pandemic.

The government has the policy to develop an international health center to drive the new engine of growth and drive economic growth (S-curve) by building on existing industries with potential (First S-curve). In the tourism industry, potential income groups and Health Tourism (Affluent, Medical, and wellness tourism) and additional industries of the future (New S-curve) in the medical industry (Medical hub) to support the expansion of product groups and health service businesses with the goal of connecting trade and investment as well as advances in technology to provide health services that reduce inequality in access to health systems in accordance with the Thailand 4.0 policy that drives innovation (Value-based economy) with the 20 year national strategy on building competitiveness and the 12th National Economic and Social Development Plan on Strengthening the Economy and Sustainable Competitiveness (Health Tourism and medical services) with the strategy to develop Thailand into an international health center (2017-2026), all 7 strategies and 4 main products (Department of Health Service Support, 2017) as shown in Table 4.

Table 4 Strategies for the development of a Medical Hub

Development of a Medical Hub	Strategic	Strategies
Medical service hub	1. Increase competitiveness in health service provision.	1.1 Develop infrastructure facilities and management system to be ready to support the international health center. 1.2 Manage and drive the “Medical Hub” policy without affecting the Thai health system.
	2. Develop medical services.	2.1 Promote and develop medical services to the international level.
Wellness hub	3. Develop health promotion services.	3.1 Promote and develop the standard quality of establishments and personnel to international standards. 3.2 Develop hot spring sources to be spa towns and hot spring tourism routes in Thailand. 3.3 Develop the potential of community enterprises to support Health Tourism.
	4. Develop Thai traditional and alternative medicine services.	4.1 Promote the development of health services that provide Thai traditional medicine services and alternative medicine to the international level.
Academic hub	5. Develop academic services and research.	5.1 Increase the capacity and potential of medical institutions. 5.2 Develop potential/increase medical personnel. 5.3 Raise the level to be the center of international medical conferences.
Product hub	6. Develop medicines and health products.	6.1 Development of herbal medicines to the international level. 6.2 Development of modern medicine to the international level. 6.3 Development of medical device manufacturers industry. 6.4 Development of cosmetics manufacturers industry.
	7. Marketing promotion and advertise.	7.1 Marketing and advertise in the form of “Thailand Branding” to maintain the number one position in the world. 7.2 Marketing and advertise in the country. 7.3 Marketing and advertise abroad.

Source: Chanokporn Boontriksiri. (2017)

Measures to revive the Thai tourism industry

It consists of 5 important policies as follows:

- 1) Thailand tourism brand, push and promote to "Create a memorable Thai tourism brand" along with environmentally friendly tourism.
- 2) Smart tourism village, supports "Tourism in community and Happiness at the destination" with a modern management system.
- 3) Tourism Safety and Health standards raise safety standards and health of tourists to build confidence in traveling with the definition of "confident, traveling in Thailand with good health".
- 4) Skilling, upskilling, and Reskilling tourism workers, upgrade the skills of the tourism personnel in the whole system to become "professionals".
- 5) Tourism database development, developing the tourism database and enhancing the ability to analyze big data as well as enhancing cleanliness to develop the tourism management system to be internationally accepted.

In addition, the Ministry of Tourism and Sports has remedial measures the COVID-19 Pandemic, which are divided into 2 phases of remediation under supporting factors and assessing potential impacts under risk factors, i.e. Phase 1 measures to revive and develop tourism businesses in all affected sectors, and Phase 2 measures that expand in addition to measures in Phase 1 with more safety measures being upgraded for the health of tourists and for the sustainability of the tourism business as follows:

Phase 1 consists of 2 measures:

- Measure 1: Monetary and fiscal measures.
- Measure 2: Measures to provide remedial assistance to those affected.

Phase 2 consists of 6 measures:

- Measure 1: Measures to enhance and maintain tourism capacity.
- Measure 2: Measures to generate income for tourism establishments.
- Measure 3: Tourism personnel skill development standardization.
- Measure 4: Tourism safety and hygiene.
- Measure 5: Helping tour operators.
- Measure 6: Effective communication.

There are two main strategic objectives of the tourism recovery plan of the Tourism Authority of Thailand: Goal 1 create jobs, generate income, enhance liquidity, and encourage internal consumption through domestic travel and Goal 2 generate income from the foreign tourist base on high spending potential, create a new structural balance for sustainable tourism by the 5R strategy is used as a driving mechanism as shown in Figure 2.

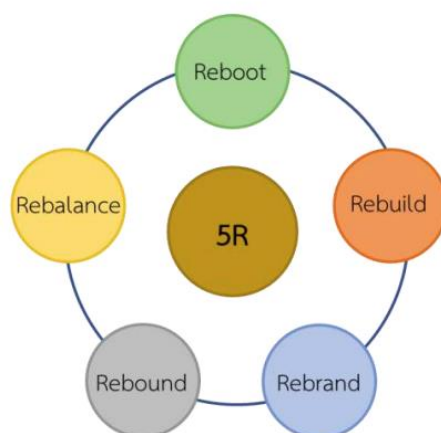


Fig 2. Strategy of the Tourism Recovery Plan.
Source: Tourism Authority of Thailand. (2020)

Figure 2 describes R1: Reboot: stimulate domestic tourism, build consumer confidence in spending on tourism, strengthen the grassroots economy using the "Go Again" approach, encourage repeated trips in the country, focus on increasing the travel frequency of the target group, promote "Thai teaw Thai", focus on specific audiences through various partnerships, "Go Local" approach to develop and promote tourism to support the local economy.

R2: Rebuild: rebuild, adjust to the New Normal, enhance long-term competitiveness, develop products and services to increase their value using the “Go New Normal” approach, fix the problem and build a sustainable foundation for the tourism industry, coordinate assistance for entrepreneurs, develop and upgrade the skills of personnel at all levels, the “Go Digital” approach develops information systems to ensure security, develop the platform as a marketing tool, create opportunities and provide modern marketing knowledge to entrepreneurs.

R3: Rebrand: communicate marketing with a new image to make Thailand a tourist destination that both Thai and foreign tourists think about and decide to choose travel in Thailand with the “Go Top” approach, impress Thailand as one of the hearts of tourists, “Go Confident” approach to build trust in Amazing Thailand brand value, safety tourists are sure to be happy when they arrive and return safely.

R4: Rebound: stimulate the foreign tourist market to recover in a short time, especially for tourists with high spending potential, maintain quality tourist bases and target groups through the “Go High” approach do a niche market, especially the Health and Wellness group, the “Go Quality” approach focuses on markets with potential for growth.

R5: Rebalance: rebalancing for sustainability through a “Go Responsible” approach, preserving nature that has recovered better from the COVID-19 period, supporting participation in promoting socially and environmentally responsible tourism, “Go Sustainability” approach reduce dependence on any one market, spatial and time travel distribution, earning income from tourism on the basis of balancing the economy, society, and environment.

6. CONCLUSION

Consumer behavior enters the digital age and more communication channels on Omni channels, including more than 10% of entrepreneurs who grew up on online platforms to sell products to customers increased due to the COVID-19 Pandemic. Tourism Authority of Thailand in collaboration with Expedia Group and Thai Hotels Association summarizes the behavioral trends of tourists in the new normal with a total of 5 factors.

1) Nothing will be the same: everything will change and cannot be reversed. Various measures to prevent the spread of the COVID-19 Pandemic and create safety for tourists such as airline health safety measures and hotel accommodations.

2) Only strong travel: travelers pay more attention to health and safety. Tourists want information on cleanliness, and basic hygiene to build confidence in traveling. In addition, various information will be shared to reduce the risk of the COVID-19 Pandemic.

3) Everything's under control: various tourism products and services will be able to continue but must be under the limitations of disease control measures and change the way of travel the movement or gathering of a group of people, etc.

4) Rise of the individual: the first group of tourists to travel is Gen Y or Millennial group, who are highly independent and passionate about new innovations. Entrepreneurs must pay attention and adjust the service method to be more in line with the behavior of this group

5) Digital future is now: technology will be used to create security and confidence in various services.

Therefore, Health Tourism in Thailand must quickly adapt to survive this crisis situation. Bring together the strengths of Wellness Tourism and applied Medical Tourism covering from entering the service in the hospital to traveling to Thailand with alternative medical activities. Wellness Tourism services such as spas and Thai massages make Thailand a comprehensive Health Tourism destination as private hospitals originally focused on the treatment of various diseases turn to develop Wellness Tourism services including beauty services to meet the growing demand. Taking advantage of the credibility of consulting doctors as well as the adaptation of the tourism business that requires the use of social networks in the business.

Destination management is to be different from other companies to attract tourists such as customers with disabilities who need special care. Renovating hotels to be quarantine facilities for those who are infected or who are being quarantined for observation or as a shelter for vulnerable groups which the family wants to stay away from infected people, such as those with cancer and in recovery elderly people with diabetes and high blood pressure, etc.

In the long term, it may change to take care of an increasing number of elderly people or hospice care that does not have communicable diseases and is a safe long-stay accommodation for foreign senior citizens (Ministry of Tourism and Sports, 2020). If Thailand can adapt quickly, the government, the private sector, and those involved in the tourism sector can work together to develop this new normal of Health Tourism effectively. It can attract more groups of tourists both in Thailand and abroad to travel. Thailand's tourism economy will be more stable.

The trend of Health Tourism in the future will be able to grow continuously to support the tourism behaviors of new groups who are more health conscious and the same group of healthy tourists who want to travel for Wellness Tourism. Thailand has managed the spread of the COVID-19 Pandemic effectively until Thailand is internationally recognized. It made many countries see the strengths of Thailand's healthcare system and medical industry. As a result, the drive to become one of the world's leading medical centers. Global Health Security Index 2019 of John Hopkins University ranks Thailand as the 6th best-prepared country in the world. Experiencing COVID-19 Pandemic reflects the readiness of Thailand's healthcare system to deal with public health emergencies such as the COVID-19 Pandemic. As Thailand's reputation for dealing with the COVID-19 pandemic presents an opportunity to promote Medical Tourism and Wellness Tourism in accordance with the National Strategic Development Plan.

Developing Thailand to become an international health hub (2017-2026) with the goal of “Thailand hub of wellness and medical services within 2017- 2026” (Department of Health Service Support Ministry of Public Health, 2016)

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Risk Assessment of Rock Bolt Application in Underground Metal Mines

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Abstract

Rock bolts are steel rods that are used to reinforce underground rock masses in mining and tunneling operations. They are installed into drilled holes in the rock, and then grouted or anchored to provide support and prevent rock movement. Rock bolts are commonly used in mines to secure the roof and walls of tunnels and to prevent rockfalls and cave-ins. They can also be used to stabilize slopes in open pit mines. There are several types of rock bolts, including fully grouted, friction, and resin-anchored bolts, each with different advantages and disadvantages. The choice of rock bolt type depends on the specific conditions and requirements of the mine. There are many dangerous situations that may occur during the use of rock bolts. A detailed risk assessment should be carried out before the process and then the process should be carried out. By carrying out a detailed risk management, it is possible to prevent the potential dangerous situations or reduce their harmful effects to the minimum. In this study, the possible dangers that may occur in underground metal mines during rock bolt applications are determined and the risk scores of these dangers are calculated, and preventive measures are listed.

Keywords: Rock bolt, metal mine, risk assessment, risk analysis.

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International Business Negotiation Strategies and Tactics of Research in International Logistics Strategic Management Decisions

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Abstract

As the world becomes more globalized and internationalized Chinese business negotiation becomes more frequent, more important especially in the field of the importance of culture in the Chinese business environment. At present business, solutions are used for the development and implementation of negotiating strategies for international business, which are not universally suitable for business development in all situations in the context of globalization, with current challenges, which are characterized by increasing risk, uncertainty, and cultural differences. The purpose of the research is to provide a theoretical model for developing and implementing international business negotiation strategies, based on bargaining power assessment, as well as to conduct an experiment and test the suitability and adaptability of the developed model in an international business negotiation situation – in case of attracting investments. Research methods – scientific literature analysis, comparative, logical analysis and synthesis, comparative and generalization methods.

Keywords: international business, guanxi, confucianism, learning, teaching, research

1. INTRODUCTION

The overall aim of the article is to capture, analyze and communicate the complex interactions between students, and teachers that occur in the classroom. The guiding principles are interrelated and interdependent. Some relate to the broad intellectual environment of the University while others describe specific components of the teaching and learning process. Together, these principles reflect the balance of evidence in the research literature on the conditions under which student learning thrives. Each principle has a direct bearing on the quality of student's intellectual development and their overall experience of university life and beyond as they embark on a process of lifelong learning, regardless of whether they come to the University as undergraduate, postgraduate coursework, or postgraduate research students. Its purpose is to introduce students, briefly, to examples of psychologies, philosophies, business guanxi, and opinions regarding the different models. With this information, a teacher can build their knowledge base for instruction, and, in turn, choose the model or combination of models that best fit his/her style of teaching and, more importantly, the style of learners he/she is teaching. One of the key issues in higher education towards the end of the 22nd century was the debate about the respective virtues and requirements of traditional academic education and no traditional education. Much of the debate took place within universities, particularly in the new context of the knowledge society. In the new spirit of openness, students became much more conscious of what was offered, what was excluded, and what their rights were. One response to these changes was to try and make transparent the relationship between university education and core or transferable skills. The most

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explicit response was the development of an ‘outcomes’ approach or a competence - based model for curriculum development in universities. Two major schools of thought have emerged which can be broadly divided into those approaches which post higher education as a public good, versus those which also emphasized the post - utility of higher education. Institutions of higher education have a key role in developing appropriate strategies and tactics. It is the responsibility of higher education institutions to prepare their students, from a lifelong learning perspective, for a productive career, and citizenship. Universities and other higher education institutions increasingly have come to realize that theirs is a moving target and that their leadership in the field of the elaboration transmission of knowledge and understanding implies a new sensitivity toward developments in society. They increasingly look to consultation with their stakeholders regularly. Education inspires progress in society, but at the same time, it must respond, with foresight, to society, preparing adequate strategies for future studies on Chinese international business mainly in negotiations and tactics. The purpose of a featured article is to explore a particular topic about cross-cultural business negotiations in China and promote the successful proceeding of business negotiation with Chinese negotiators. This article analyzes the problem from different angles Chinese business negotiation process in a global world perspective. The article intends to present different stages of Chinese business negotiation styles, approaches and processes, it will be described a phenomenological examination of negotiation strategies in international business, which play the most important factor in understanding Chinese business culture and starting negotiations in the Chinese business environment. China started its economic open-up in the 1990 year and plenty of countries started to involve in negotiating with the Chinese in international business. China joined WTO in the 2001 year and negotiation with the Chinese is becoming an increasingly important factor for international business in the global world. The process of globalization is going faster, with the rapid development of the world economy including other countries in the business negotiations. Culture is one of the most important factors which influence business negotiation in the international business arena. Cross - cultural negotiations are a field of considerable interest in this age of the global economy [10-14]. Every country has a different business negotiation style, different strategies, different cultures, different thinking modes, and different lifestyles. In a cross-cultural environment one most important factor is to understand influence of culture on negotiations and decision - making. A variety of misunderstandings in business negotiations with [4] define cross-cultural negotiation as “discussions of common and conflicting interests between persons of different cultural backgrounds who work to reach an agreement of mutual benefit”. The negotiation process is considered an interaction process of reaching agreements to provide terms and conditions for the future behavior of the parties involved [10-14]. According to Ghauri [10-14], the international business negotiation process is divided into three stages: pre-negotiation, negotiation, and post-negotiation. Consensus about negotiation in China is of two minds.

Aim of research

The aim of the study is to prove the prominent role of business negotiations strategies in logistics strategic management decisions

Purpose of research

To create scientific theory business negotiation strategies and tactics in international logistics strategic management decisions

Tasks of research

1. Scientific theoretical literature analysis
2. Scientific empirical negotiation processes analysis

Object of research

International business negotiation strategies and tactics in international logistics strategic management decisions

Basic hypothesis

International business plays a prominent role in negotiation strategies and tactics in international logistics strategic management decisions.

Methods of research: comparative scientific literature, negotiations analysis

Methods and methodology

The aim of this study was to provide insight into the issue of international negotiations management in the environment in the time of global business time. At the same time, we wanted to quantify the degree of business negotiation profit of companies over time.

1.1. The empirical study methodology for the application and assessment of the model for preparing international business negotiation strategies based on bargaining power assessment

The purpose of this paper is to conduct an empirical study to analyze the preparation of international business negotiation strategies based on bargaining power assessment in a typical field of business negotiations – attracting investments. In order to apply and test the model for preparing international business negotiation strategies based on bargaining power assessment, this study is necessary, because it may show the application opportunities and test its major parameters. To test the model, the empirical study would benefit from using the methods of the game theory, because this enables to analyze of the interaction of the objects that have their objections. This is particularly important during international business negotiations, which involve interactions between people representing different cultures and thus resulting in a number of uncertainties. To develop an international business negotiation strategy based on the negotiators' bargaining power assessment, it would be beneficial to use the methods of the game theory that help to develop a model for creating a successful strategy. The game theory is defined as the entirety of methods for examining conflict situations and its purpose is to develop recommendations that enable the conflicting parties to make rational decisions. We can apply the methods of the game theory if we can predict the options of the negotiating parties by analyzing each of the options of each of the negotiating parties. Of course, in some cases of negotiations, the game theory can not always provide a full definition of the decision-making process; however, practice shows that the application of the methods of the game theory is a great tool, which helps to make reasonable and appropriate strategic solutions. In many business negotiations negotiators have to make their decisions with a several uncertainties. Of course, the purpose of bargaining power assessment is to reduce this information deficit, however it's impossible to eliminate it due to a large number of variables. Therefore, we can use various optimum strategy calculation rules.

1.2. A model for developing an international business negotiation strategy, based on bargaining power assessment

The contemporary business world has to encounter a huge variety of different cultures and their specifics, which requires adequate theoretical solutions for international business organization and management. International business development under global conditions involves conducting business negotiations participated by representatives from all kinds of different cultures. This poses additional difficulties in developing strategic solutions and ensuring their support. The complexity and systematic nature of negotiation issues determines the necessity to consider the abundance of situations, processes and the criteria for evaluating negotiation potential. Here we will employ a multi - criteria analysis by using experts. According to the results, the developed model can be used to reinforce international business negotiations and electronic business negotiations, as an independent systemic unit of the negotiation process (a measure that is autonomous or requires only partial intervention of the negotiator). The problem is that management, as well as business management theory does not provide any theoretical solutions for evaluating bargaining power during international business negotiations, especially considering the possibilities of using negotiation support technology, which is rather important for international business development. The object of this research is the support for developing international business negotiation strategies, based on bargaining power assessment. The purpose of the research is to provide a theoretical model for developing and implementing international business negotiation strategies, based on bargaining power assessment, as well as to conduct an experiment and test the suitability and adaptability of the developed model in an international business negotiation situation – in case of attracting investment. A model for developing an international business negotiation strategy, based on bargaining power assessment. In opinion, the development and implementation of negotiation strategies should be based on bargaining power assessment. However, the process of getting to know the situation may take place during the negotiation process, thus strategic tactics and actions (steps) may change on each new issue examined during the negotiations. The analysis of scientific literature [15] shows, that the application of heuristic algorithms in developing and implementing negotiation strategies in order to assess bargaining power and reflect on the process of negotiation itself, is rather promising. We will define a condition, that each negotiation issue will be examined only once, without coming back to it. The purpose of the heuristic algorithm will be to find the negotiating strategies-payoffs that bring the greatest total benefit for the negotiation process. In order to find them we will use various optimization rules proposed by various scientists. International business negotiation strategies based on bargaining power assessment the negotiation issues from the most important to the least important, in order to make sure that the further course of the negotiations will not be in vain, e.g. to avoid situations of finding out that the other side of the negotiations is unable to implement the main criterion at the end of the negotiations (e.g. no one in the negotiation team has the authority to sign an agreement or a contract), thus making the entire negotiation a waste of time and effort. The purpose of optimization is rather complicated, because the individual most beneficial payoffs of the primary negotiation issues will not necessarily make the most

beneficial aggregated payoff of all of the negotiation issues, which means that it is necessary to search for the most beneficial aggregated payoff of the entire negotiation process, i.e. to solve the issue of global optimization. Example: certain negotiations revolve around three issues and each of these issues have several alternative solutions; although the payoffs of the first two issues were not very beneficial, choosing them has led to the best payoff of the third question, which results in the most beneficial possible final payoff of the entire negotiation process.

1.3. The preparation of international business negotiation strategies based on bargaining power assessment in case of attracting investments

This study examines the preparation of international business negotiation strategies based on bargaining power assessment in case of attracting investments. This will enable to check, if the model for developing negotiation strategies and its algorithm are suitable for supporting business negotiations based on bargaining power assessment. The cases of attracting investment have been examined by the following researchers: [23, 24].

1.4. Chinese culture and Chinese business culture

Chinese culture is rooted in four major factors which have bound the Chinese together for about 5000 years [16-18]. The second factor/root is their sense of morality - writings of the great philosopher Confucius discussed above, have influenced the Chinese culture morality for over 2000 years [16-18]. [5] mentioned that Chinese cultural is consisted of cultures in different ethnic groups and regions with changes in different eras that co-exist and mutually absorb each other, different values as traditions culture, education, or negotiation styles due to their sub-cultural influences. According to [5], though both sub-cultural negotiators are from the same mother culture, but their different residence-locations lead to different values and styles of behavior, thus differences and even conflicts may still emerge when both parties use the same language. Chinese culture has been molded by three philosophical traditions – Confucianism, Taoism, and Buddhism [9]. The Chinese stratagem (*Ji*) is a strategic component in Chinese culture [6; 7;26]. A Chinese proverb “The marketplace is a battlefield” reflects a deep-seated Chinese belief that the wisdom that guides the general commander in the battlefield is the same one that applies to business [7]. Sun Tzu’s Art of War is the best introduction to strategic Chinese business thinking, or Chinese stratagems doing business globally and internationally. Culture is a key factor affecting negotiation processes and outcomes, furthermore cultural values can influence international business negotiations in significant and unexpected ways from the first to the last stage of a negotiation. Culture is the most important factor to influence business negotiation, on which depends the failure or success of business relations with foreign countries, mainly in China. Business negotiation is based on business communication and interaction, which join different cultures with different thinking modes, values, mentalities, and different internal worlds. Business communication permit encountering cross-cultural problems, and misunderstandings and solving them in different ways depending on negotiating countries’ business cultures. The word “cultural” is used in a sense of “collective programming of the mind which distinguishes the members of one category of people from another” [19-20]. Chinese businessmen have earned a reputation for many years as tough negotiators who have mastered the art of business negotiating in the global world. Cultural differences in terms of business practices, negotiation styles, and social customs were perceived as most important [25]. Cross-cultural negotiation as “discussions of common and conflicting interests between persons of different cultural backgrounds who work to reach an agreement of mutual benefit”. Cross-cultural negotiation is more difficult than mono-cultural negotiation because of differences of language and culture. These interpersonal relationships are characterized by the following important concepts: *Guanxi* - A network of personal relationships that forms the basis of mutual interactions [9]. *Guanxi* is characterized by the notion of “reciprocal obligations” and is prominent in Chinese business processes; necessary in order to get things done and having access to resources (2; Woo & Prud’homme, 1999). Principal Chinese values are harmony, hierarchy development of moral potential and kinship are based on Confucian thoughts which influence business negotiations with Chinese negotiators in the global world. Within the business context, “*Guanxi*” can be classified as one important intangible barrier in doing business in China, [3] consider it so important, that it can be compared to a “second currency” which permeates the economic sphere and constitutes a “key and ‘secret’ to corporate success in China”. These interpersonal relationships are characterized by the following important concepts: *Guanxi* - A network of personal relationships that forms the basis of mutual interactions [9]. Confucianism encourages respect for hierarchy and status. Cross cultural negotiations are a field of considerable interest in this age of the global economy [10-14]. Culture is a key factor affecting negotiation processes and outcomes, furthermore cultural values can influence international business negotiations in significant and unexpected ways from the first to the last stage of a negotiation [21]. Negotiators in international negotiations, by definition, have different national cultural backgrounds. The word

“cultural” is used in a sense of “collective programming of the mind which distinguishes the members of one category of people from another” [19-20]. Cross cultural negotiations are a field of considerable interest in this age of the global economy [10].

1.5. Chinese business Pre-negotiation process

At the heart of Chinese business negotiations, one of the most important things is to provide a good strategy and final goal, to create an operational scheme based on architectural planned stages until the negotiations will be completed. The business plan for international negotiations must be fully prepared and thought out before starting business negotiations in the host country, also a plan must reflect all the objectives, aspirations, and possible business inconveniences. Business negotiations may include: the conditions influencing the successful business decisions, taking into account the precautions in contestations during business negotiations, also one of the most important factors, there is vigilance and flexibility for reaching an agreement in the final stage. Business negotiating position is based on the following aspects: providing a chance to win, expected losses, and expected change in the situation after negotiations depending on the progress of the business negotiations. Consider potential issues before negotiations interest in the position and propositions that influence the next step in business negotiations and decision-making. Predict in advance the business negotiations and possible alternatives, and a few unpleasant situations that already occur in the course of negotiations. In the pre-negotiation process it is necessary to take into account the following statements: The risk of misunderstanding needs to be proven by the problem. Arguments and evidence are prepared in advance, addressing the thorny issues arising out of both sides of the misunderstanding. Anticipating an expert or some experts who could negotiate in right direction, the two sides would be satisfied. Preview problems and tactical bargaining way that reflects the progress of negotiations ambition. It is important to promote business between the negotiators between the confidence-feeling because it is a matter of both sides to a unified goal. Exemplary business negotiators based on the right tactics can create an atmosphere of trust. By default, a constructive strategy and tactics can be used for achieving the ultimate objective. It is important to get acquainted enterprise culture in which it will conduct business negotiations, and which represents organizational habits, values, traditions, and norms, these mentioned factors influence the business negotiation process and take the final decision to start international business negotiations.

1.6. Chinese business face-to-face Negotiation process

At the beginning of the business negotiations, it is important to make contacts on specific topics, creating a working environment in the management of the business negotiator’s behavior. Business negotiations it is important to split into several steps from the most important to less important, the sequence order of needs is a very important negotiating step influencing the final decision in business negotiation on the suggested theme. Negotiations must be based on the language of facts and arguments, and their benefits to existing business partners' needs, interests, and positions for satisfaction. It is important to remember, that business negotiations are not always smooth, though well in advance be prepared for them. Negotiators must be prepared in advance for objections, manipulations, and attacks, which are raised during business negotiating in misunderstanding and tension rising. The most common reasons for emerging issues in business negotiations: negotiator age and sex differences, negotiator internal and external cultural flaws, disregard for the norms of business ethics, personal negotiator characteristics, differences (political, ideological, religious), the other person different mindset, a hasty presentation of information, incomplete information talker, concentration lack of desire to dominate, sophisticated and convoluted thoughts, guiding negotiations between the main idea and secondary idea.

1.7. Chinese business Post-negotiation process

Going to the end of business negotiations it is needed to take the following actions: to provide constructive suggestions for further long-term cooperation and common starting a business, to analyze the position after business negotiation and weigh up the advantages and the disadvantages, evaluate the possible outcomes and suggest new problems discussion guidelines, adoption of the best possible solution, examination of its consequences, focus on mutual guarantee and evaluation of the results achieved. In business negotiations it is advisable to take account of these philosophical final statements in the post-negotiation process: It is important in business negotiation to use the washer ideas, which are in talks like a seesaw, figuring out a direct and indirect task in a such manner closer to the correct understanding of the situation, mainly in the searching new breakthrough ideas. Business powers are strengthened, under the combined negotiation techniques and styles, for permutations and combinations it is created

effective business tools for negotiating in a dynamic Chinese business environment based on a multicultural approach.

1.8. Guanxi in Business

During the 1970s, right after the Cultural Restage over others, to secure a good job, get adequate housing, or gain access to a reputable hospital. Most of these deals were practiced in secret through houmen or “dealing through the back door” did it anyway to further their own interests. As the economy exploded during the prosperous years of the 1990s, both local and foreign firms began to bribe state and local officials in order to gain advantages over their competitors. From a strict Western viewpoint, this can be interpreted as unethical, but in China, these obligations are simply a promise to do something at a later date, and as long as you fulfill this obligation, you are considered Guanxi apart from corruption; it is considered an honor for a Chinese person to show off Journal of Academic and Business Ethics return to Confucian ethics with the ren-yi-li) and relationships (Guanxi). Negotiators view the marketplace as a battlefield and the ultimate complete general—draw from ancient literature that I War, 36 Stratagems, The Three Kingdoms, and The Book of Five strategies situations, that the Chinese view the marketplace as a battlefield, and Revolution, Guanxi was used to gain adva469)”, and while publicly viewed with disdain by society, people aim considered ethical. Corporations, therefore, need to be cognizant of the practice of Guanxi, as well as emerging Chinese business norms and their legal ramifications.

2. CONCLUSION AND FINAL PROVISIONS FOR FURTHER RESEARCH

To avoid a variety of misunderstandings in Chinese business negotiations it is necessary clearly understand Chinese cultural dimensions. China’s growing importance in the global business landscape, and for this reason understanding Chinese business tactics in negotiations are one of the most important factors influencing mutual understanding. Chinese business negotiations are based on these factors: cultural factors and processes, atmosphere, strategic factors, style factors, background factors, and traditions factors. The philosophical foundation of Chinese business behavior and Chinese business culture play a very important role in strategic business negotiations. Knowledge and understanding of the subtleties of Chinese business culture and Chinese business negotiation approaches will be key to successfully deals with Chinese negotiators. When preparing a business partnership or for business transactions, it is advisable to analyze Chinese differences, properties of the culture, and properties of traditions. Differences in cross-cultural dimensions can influence the process of negotiations between representatives of different cultures. The cross-cultural context of negotiating may be conditioned by the legal environment, organizational values, cultural values, and traditional values. In Chinese business negotiations, there are important differences as in other countries which involve these factors: cultural dimensions, cultural philosophies, cultural psychologies, cultural dynamics, global influences, consequences of cultural global influences, negotiation styles and approaches, behaviors, ethics, motivations, and diversity. In the Chinese business negotiation style with foreign negotiators it will be extremely interesting to relate and compare these results to the *Thirty-Six Stratagems* to see if the stratagems will be influential in cross-cultural negotiations with Chinese negotiators to achieve a unified goal and finally win the negotiations.

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B2B Brand Orientation, Customer's Dependence, and Customer–Supplier Relationship Performance

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Abstract

This study investigates the relationship between strategic orientation, customer's dependence, and relationship performance in a business-to-business (B2B) context. Considered from the perspective of component suppliers, we propose that different strategic orientations strengthen relationship performance through customer's dependence; strategic orientations include the B2B brand orientation, relationship orientation, and proactive customer orientation in the relationship between component suppliers and international customers. A questionnaire survey was used to collect data from managers in the electronics manufacturing industry to test the hypotheses in the research model. The conceptual model was tested using 252 returned questionnaires. The results provide evidence that the aforementioned strategic orientations can drive relationship performance through their effect on customer's dependence. This research proposes and empirically tests a model to explain how component suppliers manage customer–supplier relationships through various strategic orientations, leading to stronger relationship performance through customer's dependence.

Keywords: B2B brand orientation, Customer's dependence, Relationship performance, Electronics manufacturing industry

1. INTRODUCTION

Business-to-business (B2B) markets have become more challenging because of the increasing pressure of commoditization and globalization, with B2B firms seeking a competitive advantage through branding (Walley *et al.*, 2007). B2B products are rare and unique, and they are a valuable resource that can create a competitive advantage for customers, especially when customers recognize the B2B brand (Lin and Siu, 2020). In the electronics manufacturing industry, although international customers may be well known and have powerful access to markets, they face an increasing number of challenges when they require new products. To launch a unique and competitive product, international customers usually require an electronics supplier that can offer innovative and market-leading technology for key components. Therefore, international customers are dependent on key component suppliers in the B2B context. For instance, Taiwan Semiconductor Manufacturing Co. (TSMC), Apple's Taiwanese chipmaking supplier, which produces high-quality chips for the iPhone and MacBook by using an advanced manufacturing process, is a key component supplier with a B2B brand in Apple's supply chain.

Studies have considered a firm's strategic orientation, which includes technology, market, and competitor orientations, an essential driver of performance (Gatignon and Xuereb, 1997; Zhou *et al.*, 2005a; Zhou *et al.*, 2005b). Suppliers' strategic orientations can improve relationships with key customers and provide service activities for

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product design, product innovation, and manufacturing (Pete *et al.*, 2005). Electronic component suppliers usually only focus on one specific product line that requires advanced technology because they do not have the resources to diversify into other product lines. Limited resources also make new-generation development challenging. Therefore, component suppliers must focus on their strategic orientation to offer unique products and services to maintain international customers' dependence as part of the customer–supplier relationship. Although some studies have focused on the B2B brand orientation (Keränen *et al.*, 2012; Seyedghorban *et al.*, 2016), empirical studies on the B2B brand orientation in the electronics supply chain context are limited. B2B suppliers are turning to B2B brand-building activities as a differentiation strategy, such as bolstering their B2B brand image and reputation, to achieve a sustainable competitive advantage (Bendixen *et al.*, 2004). In addition, an increasing number of B2B managers believe that the B2B brand orientation should not be related to immediate financial returns but should be allocated sufficient organizational resources (Balmer, 2001). This is why suppliers are willing to make relationship investments to maintain a long-term partnership with customers (Mudambi, 2002). The relationship orientation refers to firms investing in physical and intangible assets to maintain business relationships with customers; such investment is not easily recovered once the relationship has ended (Williamson, 1996). Furthermore, research has verified that a customer orientation is a key driver for improving customer–supplier relationships (Blocker *et al.*, 2011; Lee and Kou, 2014). A proactive customer orientation is defined as the ability of suppliers to discover and address their customers' future needs; this ability may involve their firm culture and behaviors (Fang and Zou, 2009). A customer orientation can also improve suppliers' understanding of their customers' knowledge and skills, making them more sensitive to market changes that affect their customers' future needs. In this study, we focus on the B2B brand orientation, relationship orientation, and proactive customer orientation as the core strategic orientations.

The purpose of this research was to fill the gap between aforementioned strategic orientations, customer's dependence, and relationship performance in customer–supplier relationships. Suppliers' B2B brand orientation could be of value to industrial customers and improve customer perceptions of product quality (Cretu and Brodie, 2007). B2B brands may be able to reduce customers' perceived risk and uncertainty in the purchasing decision process (Bengtsson and Servais, 2005), enhance customer confidence in the decision-making process, and increase customer satisfaction in relation to buying decisions (Low and Blois, 2002). Suppliers with a B2B brand orientation usually focus on long-term rather than short-term returns (Leek and Christodoulides, 2012). Although the B2B brand orientation of component suppliers does not yield immediate financial returns, international customers are more dependent on B2B brand suppliers. Relationship orientation refer to investment in assets dedicated to particular transactions that will lose value if the assets are used for other purposes (Williamson, 1985). Component suppliers that make relationship orientation do so to maintain and improve international customer's dependence. For instance, component suppliers might make relationship investments in customization, such as that of production equipment, tools, and management processes. Their purpose is to lock-in international customers by making the cost of switching suppliers prohibitively high. Suppliers with a proactive customer orientation have an increased ability to identify new solutions for new products and make changes to meet the customer's market needs. They not only understand their customer's latent needs but are also able to develop superior technology (Atuahene-Gima, 2005). Therefore, a proactive customer orientation enhances customer reliance on supplier capabilities. Dependence can establish a need for building relationships on the basis of the initiation of exchange and can enhance customer–supplier relationship performance (Andaleeb, 1995). For instance, a dependent customer might be willing to share information with suppliers regularly, such as their forecast planning and inventory, enabling suppliers to manage production accordingly and thus resulting in strong relationship performance. In general, we expect component suppliers' B2B brand orientation to build strong trust among international customers in the B2B brand and to make relationship investment to maintain business relationships with customers; such firms may also adopt a proactive customer orientation and develop new ideas, solutions, and information to meet further customer needs, which facilitates superior customer–supplier relationship performance.

This paper is structured as follows. First, this study investigate the associations among the strategic orientations, customer's dependence and relationship performance following a literature review. The strategic orientations include B2B brand orientation, relationship orientation, and proactive customer orientation. A conceptual model with four hypotheses is developed based on key constructs. Second, we argue that strategic orientations influence relationship performance through customer's dependence. Third, we use the field data derived from interviews with managers in the electronics manufacturing industry to test the postulated hypotheses. Finally, we present the test results, discuss the findings, and provide suggestions for future research.

2. THEORETICAL BACKGROUND AND HYPOTHESIS DEVELOPMENT

Researchers have highlighted the contribution of the RBV in improving performance through unique, inimitable, and tacit resources and capabilities (Barney, 1991; Srivastava *et al.*, 2001). Barney (1991) discusses how firms use valuable resources to create competitive advantages from an internal perspective. From a theoretical perspective, the RBV treats resources as key factors for improving firm success. On the basis of the findings of a literature review, the present study integrates the RBV to hypothesize that a component supplier can effectively improve its customer's dependence through the application of various strategic orientations as key resources, such that its customer's dependence can help enhance its relationship performance. The detailed relationships among the hypotheses are explained in the subsequent section.

2.1. Component suppliers' strategic orientations and international customers

Strategic orientation refers to the notion that firms conduct business through a set of values and beliefs that guide them to achieve a higher level of performance (Zhou *et al.*, 2005b; Zhou and Li, 2010). Few studies have examined the strategic orientation of suppliers as drivers of relationship performance from the perspective of customer dependence. Teece *et al.* (1997) indicate that from the perspective of the RBV, the resources of a firm can complement each other and be used to develop dynamic capabilities that improve relationship performance. On the basis of the logic of the RBV and the literature on strategic orientation (Barney, 1991; Srivastava *et al.*, 2001; Zhou and Li, 2010), we identify the various strategic orientations of component suppliers as key resources that drive the dependence of international customers in customer-supplier relationships.

Industrial marketing studies have indicated that strategic orientation of suppliers is conceptualized with the inclusion of competitive and customer orientations (Gatignon and Xuereb, 1997). We extend the research on strategic orientations to competitive orientation and examine B2B brand orientation as a strategic orientation for build competitive advantage. B2B suppliers use B2B brand-building activities and adopt differentiation strategies to achieve a sustainable competitive advantage (Bendixen *et al.*, 2004). Although some studies have focused on the B2B brand orientation (Bendixen *et al.*, 2004; Seyedghorban *et al.*, 2016), but empirical evidence related on B2B brand orientation in the international exchange relationship is limited in the literature. Empirical studies have indicated that customer orientation is a key organizational resource that a firm can use to build its competitiveness (Menguc and Auh 2006). Customer-oriented strategies include customer acquisition and retention, which are not mutually exclusive and may be implemented simultaneously (Min *et al.*, 2016). The present study focuses on relationship investment in new technology for production systems (e.g., advanced tools, machines, and production processes). Relationship orientation is a strategy through which suppliers invest in physical and intangible assets to maintain business relationships with specific customers (Williamson, 1996). Based on the literature, in this study, we propose that strategic orientations include the B2B brand orientation, relationship orientation, and customer orientation.

Brand orientation is defined as an approach in which the creation, development, and protection of an organization's brand identity entail ongoing interactions with target customers to achieve competitive advantages for the brand (Urde, 1994). In business-to-consumer markets, the key role of branding activities in building a competitive advantage has been well established (Keller and Lehmann, 2006). In recent years, research has indicated that brands can propel B2B firms to increased success (Chang *et al.*, 2021), and the B2B brand orientation demonstrates that branding is essential to the decision-making process of industrial customers (Bendixen *et al.*, 2004). Customer's dependence is defined as a customer relying on a supplier to provide a large proportion of some input or component (Hart and Saunders, 1998). Customer's dependence is more likely if the supplier provides the customer with unique products and services.

B2B branding is a strategy for building a brand name for a component supplier and attracting customers to adopt their specific component, potentially changing the customer's buying behavior (Ghosh and John, 2009). The B2B brand orientation enables B2B marketers to improve customer satisfaction and loyalty (Cretu and Brodie, 2007; McQuiston, 2004), and B2B branding is the key to building trust with customers, which is critical for exchanges in industrial markets and for maintaining relationships, ultimately affecting a firm's performance (Roberts and Merrilees, 2007). Therefore, we expect customers to respond to B2B brand suppliers in B2B markets.

Hypothesis 1 (H1): A supplier's B2B brand orientation is positively related to customer's dependence.

As stated previously, relationship orientation is defined as a firm's investment in physical and intangible assets to maintain business relationships with customers; the investment cannot be easily recovered once the relationship has ended (Williamson, 1996). Relationship orientation can be property-based relationship-specific investments, including investments in tangible assets, such as warehouses, logistics system, tools, and machines, or knowledge-

based relationship-specific investments, including investments in techniques or skills, such as human resources training (Hoetker and Mellewigt, 2009).

A relationship orientation is an investment that meets the specific requirements of a transaction, and the investment decreases in value if used for other purposes (Williamson, 1985, 1991). Cooperation among supply chains requires different levels of relationship-specific investment between customers and suppliers. Handfield and Bechtel (2002) argue that customers might trust a supplier that has multiple sources because the supplier owns the source that meets the customer's requirements for a unique product or service. Specific investments for transactions can provide incentives to develop long-term relationships between the supplier and customer (Anderson and Weitz, 1992). Because the supplier can make specific resource investments to retain their customer, the customer might reject the benefits offered by other suppliers and decrease the threat from this competing supplier. Therefore, the purpose of suppliers making specific investments is to maintain and improve relationships with customers, and in return, customers will become dependent on these suppliers.

Hypothesis 2 (H2): A supplier's relationship orientation is positively related to customer's dependence.

A proactive customer orientation is defined as the ability of suppliers to discover and address their customers' future needs in response to market trends; such an ability may involve the firm culture and behavior. By contrast, a responsive customer orientation entails responding to customers' current needs (Fang and Zou, 2009). In addition, a proactive customer orientation improves the supplier's understanding of their customers' knowledge and skills, making them more sensitive to market changes that affect their customers' needs through continuous information gathering and analysis (Blocker *et al.*, 2011). Suppliers should not only understand their customers' latent needs but also develop superior technology to meet those needs (Atuahene-Gima, 2005). Moreover, obtaining information on customer preferences may reduce demand uncertainty in relation to a new product (Gatignon and Xuereb, 1997). A supplier with a proactive customer orientation has an increased ability to identify new solutions for new products and address customer needs on the basis of market trends. Hence, a proactive customer orientation enhances customer's dependence on supplier capabilities.

Hypothesis 3 (H3): A supplier's proactive customer orientation is positively related to customer's dependence.

2.2. Relationship performance of component suppliers

Relationship performance refers to the extent to which a supplier's relationships with customers help to increase sales volume and profit and both the supplier and customer are satisfied with the relationship's effectiveness and efficiency (Skarmeas *et al.*, 2002). Dependence can establish a need to build relationships based on the initiation of exchange (Andaleeb, 1995). A study suggested that a supplier can use its market power to obtain a competitive price through negotiation if the customer is dependent on the supplier (Monczka *et al.*, 1995). In addition, customer's dependence on supplier assistance has a significant positive influence on customer compliance (Gassenheimer and Calantone, 1994). A high level of dependence can improve relationship performance in the case of international exchange relationships (Katsikeas *et al.*, 2009). This research proposes that customer's dependence can enhance embeddedness in customer-supplier relationships.

Hypothesis 4 (H4): In customer-supplier relationships, customer's dependence is positively related to a supplier's relationship performance.

2.3. Theoretical model

The theoretical model and all hypotheses for this study are presented in Fig. 1.

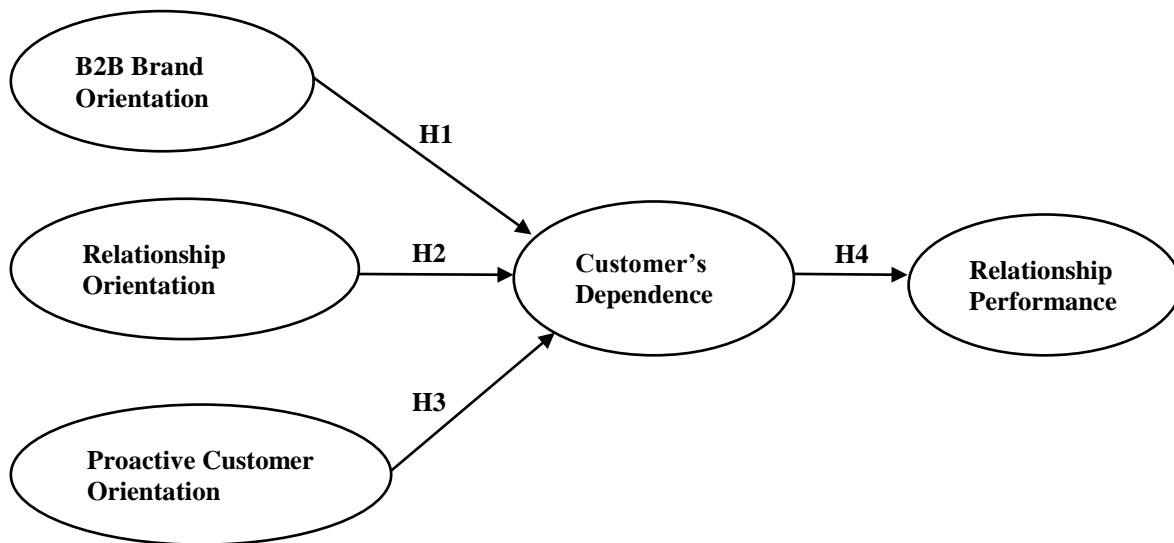


Fig. 1. Theoretical model.

3. METHOD

We chose Taiwanese component suppliers (e.g., TSMC, LARGAN Precision, Delta Electronics, and CATCHER) as the empirical B2B context because they are key players in the electronics manufacturing industry supply chain and service international customers. For example, LARGAN Precision develops optical components, providing approximately 30% of smartphone camera lenses globally in 2020. Its international customers include Apple, Samsung, and Huawei. In addition, electronics component suppliers tend to focus on one specific product line that involves advanced processes and technology because limited resources make diversifying challenging. Therefore, being able to adopt different strategic orientations to enhance international customer’s dependence and improve relationship performance is crucial for such firms.

We used a questionnaire survey to collect data for this study. The survey was distributed to managers working directly with international customers and who had strong market knowledge of the electronics manufacturing industry. After collecting the data, we used a structural equation model to test the conceptual model and AMOS software to estimate the structural coefficients and test the hypotheses.

3.1. Sample size and data

In this study, we collected data from electronic component suppliers listed on the Taiwan Stock Exchange who could provide an evaluation of their strategic orientation and relational performance with international customers. Their product lines include semiconductor chips and memory, panels, camera lenses and modules, chassis, printed circuit boards, and power supply and battery products. First, we targeted managers who were responsible for customer relations, such as account managers and project managers who handle business operations with international customers, to identify the target information. Second, we initiated a large-scale survey of Taiwanese component suppliers. The questionnaire was originally in English but was then translated into Chinese by scholars competent in both languages who had substantial research experience in Taiwan.

Appropriate respondents in the firms selected were contacted. In total, 716 questionnaires were delivered directly to potential respondents by post and email after screening. To improve the response rate, we guaranteed that all responses would be confidential and provided a cover letter explaining the purpose of the research. We received 252 completed questionnaires after two reminders, with a final response rate of 35.2%; 28 could not be used because of missing data. In total, 252 completed questionnaires were collected from 37 component suppliers.

3.2. Measures

The constructs were measured and adapted from relevant studies and refined based on the feedback of experienced practitioners and researchers in the field. Multi-item scales and 5-point response formats were used to operationalize

the constructs. We used four items to measure the B2B brand orientation. The 5-item scale was adapted from that used by Reijonen *et al.* (2015) and contained questions on the extent to which B2B branding is an essential strategy for the supplier and a critical asset for further success. The scale for the relationship orientation was measured using three items adapted from the scale used by Subramani and Venkatraman (2003). It measured the extent to which the supplier’s significant investments for product and production systems helped build relationships with customers. For the proactive customer orientation, we adapted four items from the study by Blocker *et al.* (2011) to understand the extent to which a supplier spends time studying changes and identifying its customer’s future needs. We measured customer’s dependence using four items to capture the extent to which customers depend on their supplier. The scale was adopted from the study by Ryu and Eyuboglu (2007). For relationship performance, we adopted the scale used by Kim, Cavusgil, and Calantone (2006). This scale captures the effect of sales, market share, and profitability performance on a supplier’s relationship with its international customers. Appendix presents the construct measurements.

4. MODEL AND HYPOTHESIS TESTING

AMOS 18 software was used to estimate the model parameters for the proposed conceptual model. Fig. 2 summarizes the estimation results (goodness of fit index [GFI] = 0.940, adjusted GFI = 0.912, root mean square error of approximation = 0.015, P value = 0.301, chi-square = 181.144 [degrees of freedom = 172]). Significance was set at $\alpha = 0.01$.

The path coefficient of B2B brand orientation with customer’s dependence was 0.229 ($P < 0.01$). We identified that B2B brand orientation had a positive effect on customer’s dependence, thus supporting H1. For H2, the path coefficient of relationship orientation with customer’s dependence was 0.555 ($P < 0.01$). Relationship orientation therefore had a direct effect on customer’s dependence, supporting H2. The path coefficient of proactive customer orientation with customer’s dependence was 0.166 ($P < 0.01$), demonstrating that proactive customer orientation had a significant positive effect on customer’s dependence, thus supporting H3.

Finally, the path coefficient of customer’s dependence with relationship performance was 0.717 ($P < 0.01$). H4 was therefore supported, indicating that customer’s dependence has a positive effect on relationship performance.

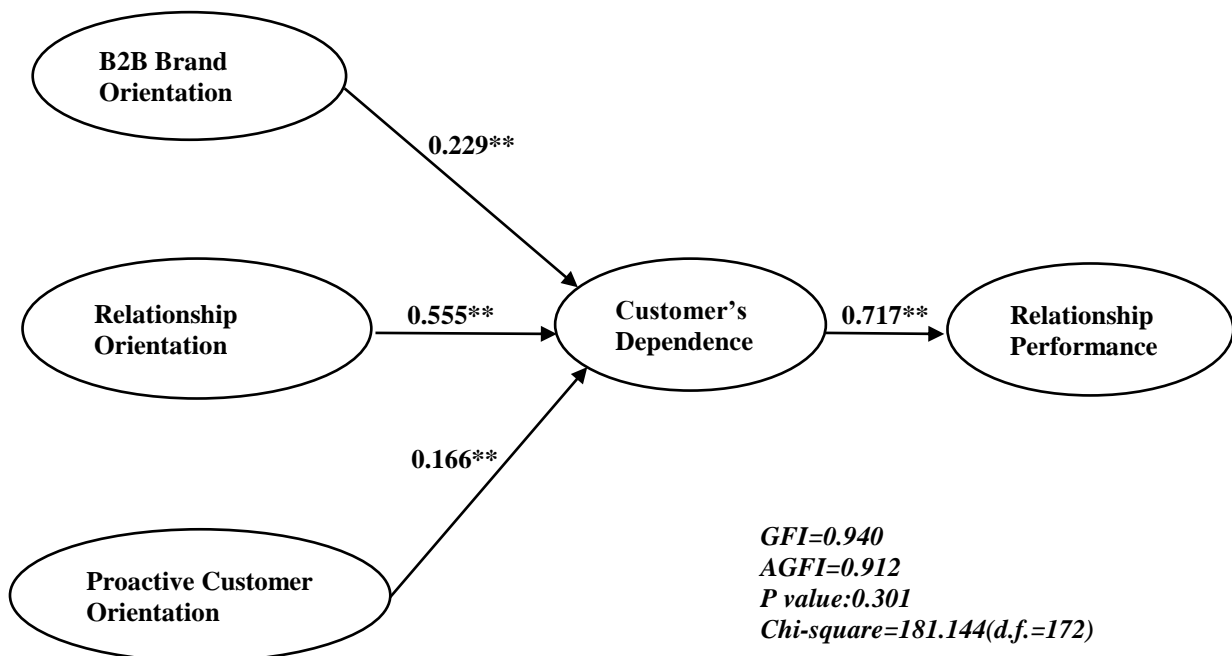


Fig. 2. Analysis results of structural equation model (** p < 0.01).

5. DISCUSSION

This study used the RBV to develop an integrative model and empirically demonstrate the strategic orientations of component suppliers and their performance in customer–supplier relationships; it also explored the moderating effect of technological uncertainty on various strategic orientations and international customer’s dependence. The structural equation model analysis indicated that all of the hypotheses were supported.

First, our results revealed that component suppliers’ B2B brand orientation had a positive influence on customer’s dependence. As Ghosh and John (2009) note, B2B branding is a strategy through which suppliers can build a brand name and attract customers to adopt their components. The B2B brand orientation is a crucial asset for component suppliers because it can help them integrate related marketing activities aimed at international customers and supports long-term relationships. Because customers trust the B2B brand because it can provide market-leading and competitive products, they come to rely on these suppliers.

Second, the results suggest that the relationship orientation has a positive influence on international customer’s dependence on component suppliers. A supplier’s relationship investment is to maintain and improve customer–supplier relationships, as posited by Williamson (1985). Because the investment (for example, in production testing equipment and engineering design) is customized to meet the needs of one international customer, the supplier has a dedicated team and reserved production line for this customer. Component suppliers develop information technology systems in advance and adjust the operation process in terms of design and production systems to build a working model matched to the customer’s needs. These assets can only be applied to the international customer’s unique requirements and therefore cannot be used for other processes, leading to the customer depending on the supplier long term.

Third, this study revealed that a proactive customer orientation had a positive impact on customer’s dependence. Suppliers must spend time understanding the needs of their international customer, providing updated market information and new solutions before the customer asks, and creating a competitive advantage for the customer’s product. Moreover, suppliers should understand their customer’s product specification requirements at the early design stage and seek more information from the customer to improve their product development capability, arranging production in line with the customer’s forecasts. This is why international customers trust and rely on these component suppliers. These results are consistent with the customer orientation literature; suppliers not only understand the customer’s needs but also develop superior technology to give the customer a competitive advantage. Furthermore, a proactive customer orientation is a key driver for international customer–supplier relationships (Atuahene-Gima, 2005).

Finally, we revealed that customer’s dependence had a direct positive impact on relationship performance. B2B brand suppliers offer unique component specifications to meet a customer’s design requirements, ensuring that a relationship investment to support a customer’s product will make the product more competitive. In addition, these suppliers organize production effectively and accurately and ensure that sufficient inventory is available to meet the future needs of the customer. Replacing such suppliers is difficult. In addition, identifying new suppliers and building a new business model is costly and time-consuming. In general, international customers place orders with their original suppliers because of customer’s dependence. Higher customer’s dependence helps to increase suppliers’ relationship performance in terms of sales, market share, and profit. For instance, the Apple iPhone has many key component suppliers in the global supply chain. Apple conducts a quarterly business review to audit suppliers’ costs, quality, product development capability, and fulfillment. If suppliers meet Apple’s requirements, especially with regard to producing sufficient value for the money, Apple will depend on these key component suppliers and continue to place orders with them. Because the demand for Apple products is relatively strong, component suppliers can also benefit from increased sales and a larger market share in the B2B market. In conclusion, the results are consistent with the RBV. This study extends resources into B2B brand orientation, relationship orientation, and customer orientation to clarify how a component supplier can leverage these strategic orientations to provide more value for customer’s dependence and improve its relationship performance.

5.1. Managerial implications

This study provides key insights and implications for practitioners. Regarding the drivers of customer’s dependence and relationship performance in the customer–supplier relationship, the evidence indicates that they could be improved by adopting various strategic orientations. The results reveal that in the B2B market, customers are more willing to depend on B2B brand suppliers. Therefore, managers should use the B2B brand orientation as a strategy to maintain

long-term relationship performance by leveraging customer's dependence. In addition, suppliers could increase their relationship-specific investments, ensuring that customers rely on a relationship based on customized assets. Managers could allocate manufacturing resources, such as production equipment and tools, to increase customer's dependence and create information technology systems to make working models and processes more efficient while keeping costs low. Moreover, suppliers' proactive customer orientation plays a key role in enhancing relationship performance by generating customer's dependence. Managers can identify markets and customer needs in advance and transform customer information and knowledge into new ideas and innovations in anticipation of potential orders. Finally, managers should be aware of the value of enhanced customer's dependence in global supply chains that can be achieved by adopting the different strategic orientations, which can be leveraged to achieve higher levels of performance in relation to the customer-supplier relationship.

5.2. Limitations and suggestions for future research

This research has several limitations. First, we only collected data from Taiwanese electronics suppliers. Our study results regarding the customer-supplier relationship may not be applicable to other industries because of the limited sample size. Further research should collect data from both suppliers and customers and also from other industries. Second, the empirical context of this study is the perspective of component suppliers. The results might not be applicable to other types of electronics suppliers, such as original equipment manufacturers (OEMs). Future research could extend this study and compare the results for component suppliers and OEMs. Third, this study compared the impact of different strategic orientations on customer's dependence to improve relationship performance. Further research could investigate whether other types of strategic orientations influence the customer-supplier relationship, such as the market, innovation, and protection orientations.

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Tourism, Growth, Energy Consumption and Environmental Pollution: Evidence from Turkey

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Abstract

This study investigates the effects of tourism, economic growth, and energy consumption on environmental pollution in Turkey from 2000 to 2020 using an autoregressive-distributed lag model. The findings of the limits test in the ARDL framework model show that population increase, energy use, tourism, economic growth, and carbon dioxide emissions are all cointegrated. According to long-term correlations between components, tourism, economic expansion, energy use, and population have a favorable and considerable impact on carbon dioxide emissions. The outcomes of Error Correction Model (ECM) show that the system is at equilibrium in the long and short term. The long-run equilibrium is represented by the coefficient of one period lag residual, which is negative and substantial. The coefficient denotes a correction of the system's prior phase of disequilibrium to the steady state.

Keywords: CO2 emissions, tourism, energy use, economic expansion, ARDL model, Bounds Test.

1. INTRODUCTION

The issue of pollution is one of the most important issues caused by human civilization among researchers in the world today. The most important causes of increasing global warming and climate instability are the emission of carbon dioxide of human origin (Kiviyiro and Arminen, 2014: 595). In fact, many causes of air pollution and global warming are known, uncontrolled human activities in different stage of economic development, including agriculture, industry, transportation and energy production. Pollution is basically in the result is carbon emission, which is known as CO₂. Carbon emission can be defined as the burning of fossil fuels and the production of cement, which include carbon dioxide produced during the consumption of solid liquid, and gas fuels and the burning of gas. Gaber (2011), found that in the stage of economic growth, industrial development and progress is slower due to more use. In the phase of economic growth, the release of more pollutants from natural resources, of use of inefficient technologies and ignoring the environment consequences can lead to an increase in environmental damage. In addition, at higher levels of development, increasing environmental awareness and implementing environmental regulations can gradually reduce environmental destruction (Ejuvbekpokpo, 2014: 15).

Tourism is another factor in the emission of carbon dioxide gas, which is usually ignored in emission models due to its many positive effects on employment and reducing poverty. Energy for tourism is used in the transportation

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sector to move from the origin to the desired destinations for accommodation and other tourism activities (Camelia et al. 2012: 9988).

Tourism has grown significantly during the last few decades and it is one of the largest industries in the whole world, despite various domestic and international conflicts, political turmoil, terrorist activities, natural disasters, epidemics, energy crisis and economic crisis in different parts of the world. International tourists worldwide from 166 million people in 1970 to 1.33 billion people reached in 2014, while tourism can have many positive effects, since many tourism activities require the use of energy consumption in form of fossil fuels, coal, natural gas and oil directly and the use of electrical energy. In an indirect way there may be harmful effects on the environment with the release of CO₂ gas at the both level is national and international (Paramati et al, 2016:1). In the rest of the article, the theoretical foundations related to the subject will be examined first, and then some related studies will be reviewed. In the following, the introduced model will be estimated and analyzed and the conclusion will be presented.

1.1. Literature and Research Background

In the literature section of the research, the theoretical foundations related to the discussion are examined and the background of the studies related to this field is examined.

1.1.1. Tourism and Environment

There is mutual dependence between the tourism industry and the environment Tourism-related activities rely on a natural resource on the one and artificial environment and natural resource utilization However, the expansion of tourism-related activities with the extraction of natural resources or the resulting pollution affects the environment (Robaina-Alves et al. 2015). Tourist travelers benefit from many infrastructure services including ports, airports, highways, railways and road communication in transportation and accommodation services. It depends on the distance, the creation of infrastructure and the development of side and secondary tourist destinations; including the development of recreational residences and restaurants, cause many different environmental effects both the emission of pollution. Scott et al. (2010) stated that tourism is a serious threat to gas emissions. CO₂ is so that it can eventually develop into a major worldwide emitter of greenhouse emissions. But by changing the policy and creating a policy in air travel, which is the main cause of CO₂ emissions, greenhouse gas emissions can be reduced to a great extent, including these policies, promoting a low-cost economy, implementing modern technology with less pollution, which is both policies. They can help to continuously increase the number of tourists by keeping CO₂ emissions at a low level. Another of these policies is the increase of energy-efficient airplanes or limiting the number of flights that can keep CO₂ emissions at a low level (Lee and Brahmaasrene 2013: 71).

1.1.2. Economic growth and the environment

The connection between the environment and economic expansion is one of the most important relationships in the environmental economic literature. This relationship has been considered since the beginning of 1990 with the concern about climate change, especially global warming, which has worsened the quality of the environment (Narayan and Narayan, 2010: 661). Economic growth also causes it makes more use of natural and environmental resources and causes an increase in undesirable outputs and pollutants that play a role in the destruction of the environment. Therefore, it seems that the two goals of economic impacts and environmental protection are in conflict with each other. To solve this conflict, EKC, or the environmental Kuznets Curve was proposed in 1991. Environmental Kuznets Curve (EKC) shows the relationship between economic growth and indicators of environmental degradation in the form of an inverted U in different stages of development. The increase and as a result the emission of pollution increases, but in the economic cycle's following stages development process, after the economy reaches a certain degree of national income per individual, at the same time as the per capita income increases, it becomes more important to pay attention to the improvement of the environment (Zaman et al. 2016: 276). Regarding the reasons for the reduction of pollution after arriving at a certain income per capita level, various reasons can be stated, if no changes are made in the structure or existing technology in the economy, the expansion of production and economic growth will cause the growth of pollution and harmful environmental effects, which is related to this theory. It is called the scale effect. The traditional view of the conflict between economic development

goals and environmental quality is based on the scale impacts. Proponents of the Kuznets environmental curve argue that at higher levels, the development of structural changes tends towards industries and information services. Also, with the increase in the development of awareness about environmental issues, it leads to the establishment of laws to improve the surroundings, which also causes the use of better and up-to-date technologies and spending more money to preserve environmental factors increase the standard of the surroundings (Falahi and Hekmati Farid 1392:131).

1.1.3. Energy consumption and environment

Indiscriminate use of energy, particularly fossil fuels, to accomplish the goals of economic expansion and poor efficiency in its consumption causes serious problems, including environmental pollution and climate change. Payne and Apergis (2009) examine the connection between economic development and usage of energy. With four testable hypotheses, they have proposed that in the first stage of the growth hypothesis, the most crucial ingredient for growth is energy, and directly and indirectly affects economic growth, in order for labor and capital to intermediate element that are used for energy need and the Real GDP rises as a result of increased energy use. And the considered economy is dependent on energy. Energy is indirectly effective on economic growth through its effect on labour and capital. In the second stage, the survival hypothesis states it means that energy conservation policy is designed to reduce energy consumption and impact savings in real GDP. In the third stage, they put forward the neutrality hypothesis, in which the impact of energy use on real GDP is low or has no effect. Under this hypothesis, energy conservation policies cannot affect the GDP. Finally, they state the feedback hypothesis, which shows that energy consumption and real GDP are related and can complement each other especially fossil fuels, for commercial aims has led to more environmental harm (Zhang and Yuan, 2010: 5–6).

1.1.4. Population and environment

Population expansion is regarded as one of the most significant causes of environmental degradation in the literature on environmental economics. With the expansion and growth of the population, the demand for agricultural lands, energy resources, water resources, etc. increases, and this leads to the destruction and depletion of forests, the reduction of the fertility of agricultural lands, air pollution, etc... (Sadeghi and Saadat 2013: 165). Maurthy et al (1997) also state that population growth has an impact on CO emissions per capita because with the increase in population density, energy demand due to the change in lifestyle from traditional to modern and the use of transportation system infrastructure and materials exothermic increases. Regarding the effect of urbanization on pollution, there are two views. The first view is that with the increase in urbanization, the structure of the economy changes from agriculture to industry and pollution increases. The second view is urbanization results in more effective use of system infrastructure. Getting around and energy and energy use in urban areas are more optimized than in villages both pollution is reduced, so in general, the relationship environmental pollution and urbanization can be either favorable or negative (Alam et al., 2007: 829). In this part, some of the experimental studies conducted on the subject of research in the form of studies conducted abroad and inside the country have been briefly reviewed.

An article by Liu et al (2011) has investigated the required energy and CO₂ emissions from the travel and tourism sector in western China during the duration of 1999-2004. In this article, they used tourism consumption data from the investigation of domestic tourism expenditures in Chengdu, the largest production of the total tourism economy in western China. It has been used by more than 50,000 tourists with an energy intensity of 7, and greenhouse gas emissions from the tourism sector have been based on the methodology developed by the International Climate Change Panel (IPCC). Increased ineffective power requirement both indirect and indirect CO gas emissions dominate of the overall energy consumption and total CO gas emissions are about more than 90%. And transportation is an important factor for energy both emissions and consumption: CO derived from the tourism sector is one of the five elements affecting energy consumption and carbon dioxide emissions in the tourism industry, energy output, government size as well as industry size in general, the main drivers of gas emission growth are CO, while the share of energy and the structure of consumption do not have a significant effect on the expansion of the Additionally, energy intensity has a detrimental impact on an increase in the tourism business. in CO₂ emissions while government size and industry size have a favorable correlation impact on CO₂ emissions.

Lee and Brahma (2013) in an article have looked into the impacts on economic expansion and CO₂ emissions of tourism of Europe's member states during the duration of 1998-2009. In this article, they have looked

into the long-term connection between tourism, CO emissions, economic growth and direct investment. Externally, the co-integration and unit root tests of panel data were used. The outcomes of panel clustering techniques indicate that there is a long-term adjustment connection between these variables. Additionally, economic growth is positively and significantly impacted by tourism, CO₂ emissions, and foreign direct investment. Economic growth itself has a positive and significant impact, while tourism and foreign direct investment have a negative and significant impact on CO₂ emissions.

Robaina-Alves et al (2015) have investigated the alterations in energy-related to emissions of carbon dioxide from Portuguese tourism during the duration of 2000-2008. The outcomes of the research indicate that, in general, tourism activities have the greatest impact on the emission of carbon dioxide gas, and the outcomes also show that the impact of energy composition, carbon dioxide energy intensity as well as intensity important influencing factors. In an article, they investigated the effects of economic growth and energy efficiency on the intensity of CO emissions in industry, the impact of energy efficiency Portuguese tourism is also using the panel method of correction of standard errors (PCSE) during the duration of 2000-2012. The outcomes of the research indicate that the changes in CO emission intensity are basically influenced by the changes in energy and economic efficiency below Different sectors of the tourism industry is located. The outcomes of the (PCSE) method also show that there is an assumed duration of recovery.

Zhang and Gao (2016) in an article investigated employing regional panel data, examine how tourism, economic development, and energy use affect environmental pollution. During time frame of 1995-2011 in China. The outcomes of the research indicate that tourism has a detrimental effect on the emission of CO in the eastern region of China, which was not consistent with the expectations to some extent, and the outcomes of the causality tests also exhibit that there was a causal relationship across the long and short terms among the regions and also the outcomes show that tourism is the cause of Long-term economic expansion and CO₂ emissions and the hypothesis that tourism leads to growth has been confirmed in all three scenarios and also the outcomes indicate that Exists a two-way causal Economic expansion and CO₂ emissions are related. And in general, the outcomes show that tourism should be continuously supported with zero carbon consumption in China, which causes the attention of policy makers at different levels of the government.

Zaman et al., (2016) in an article, investigated the relation between tourism industry Development, energy consumption and environmental Kuznets Curve 20 (EKC) using panel data from three diverse regions of the world, including East Asia and the Pacific, the European Union and high income countries. OECD non-OECD have discussed during the time frame of 2005-2013. . In this article, they have used the use of principal component analysis (PCA) to construct The tourism development index .which is obtained from the number of tourists receiving tourism and international tourism expenditures .the results show it is because the invested U-shaped relation between carbon dioxide emissions per capita income region has been confirmed, as well as the result of causal relationships of carbon dioxide emissions from tourism, greenhouse gas production carbon dioxide emissions from energy from growth investment. It shows that leads to tourism, investment leads to tourism and health leads to tourism development.

Torabi et al. (2014) investigated the effect the impact of energy use, economic expansion, and international trade on greenhouse gas emissions in Turkey during the duration of 1350-1390. The statistics obtained indicate that per capita consumption, real per person gross domestic product energy and the economy's level of openness have an effect that is both favorable and considerable on the amount of carbon dioxide emissions per person. The result shows that the imbalance in the level of carbon dioxide emissions after about two years has been adjusted due to the changes in the energy consumption level of GDP and degree of openness of the economy .considering in the increasing trend of carbon dioxide emissions per capital. In Turkey, there is a need to apply new environmental regulations preserve the environment.

Hatami and Esadi (2015) examined how tourism affects CO₂ emissions using the Fully Adjusted Least Squares (FMOLS) method during the duration of 2013-2014. The outcomes of the research indicate that the long-term relationship between the quantity of visitors as well as the volume of CO₂ emissions has been confirmed. Also, the outcomes show that the indicators of CO₂ emissions are positively and significantly impacted by economic expansion and energy use.

Rasakhi et al. (2015) examined how tourism affects the environment using a panel data method in 55 developing countries during the duration of 2005-2010. The research results indicate that the outcomes of tourism on the surroundings of developed countries is positive, while this impact is negative in developing countries, and also the outcomes show that the intensity of population density, the energy of the urban population and the added value of

the industrial sector have a major and negative impact on the degree of trade openness and the human development index have a favorable effect on the environment performance.

In line with the above, one could argue that the results of energy usage tourism and economic expansion in environmental pollution exist in Turkey, but this relationship has not been considered in most studies, so both environmental and economic tourism economic development, environmental pollution need empirical investigation. In Turkey, for this purpose, the present study investigates the impact of tourism, energy consumption and environmental impact of economic expansion pollution during the duration of 2000-2020. In this regard, first the model will be introduced, then estimation and analysis will be done and the conclusion will be presented.

2. METHODOLOGY

In this research, the effect of economic expansion on the environment emissions and Turkish tourism are investigated using annual data from the duration of 2000-2020. The variables used in this research are carbon dioxide emissions, tourism income, average gross domestic product, usage of energy, and total population statistics. Emissions of CO2 data were extracted from Pollution Emission Database for Global Atmospheric Research (EDGAR), income from tourism from Statistics and Information Centre of Turkey's cultural heritage, handicrafts and tourism organization and other data used by World Bank (WDI), analyzed and the data analysis is done using the ARDL approach. Table (1) describes some basic characteristics and simple correlation of these variables. The correlation matrix between the variables of carbon dioxide emission and tourism shows that carbon dioxide emission has a positive correlation with tourism. Of course, it should be noted that this correlation is a simple measure and does not fully reflect the dynamics between the variables, and it is necessary to check the relationship between these variables using more valid methods.

Table 1 Description of data and correlation relationship between tourism and carbon dioxide emissions.

Tourism and carbon dioxide emissions are correlated	
Mean	3/84x10 ⁻¹⁵
Median	5/1x10 ⁻⁴
Maximum	9/594x10 ⁻⁴
Minimum	-1/01x10 ⁻²
Std. Dev.	5/708x10 ⁻³
Skewness	-0/123244
Kurtosis	1/976285
Jarque-Bera	1/432133
Probability	0/48671
Observations	31

According to the theoretical and empirical research literature, the specified model of study can be introduced as follows (1)

$$LCO2_t = \alpha_0 + \beta_1 LGDP_t + \beta_2 LPOP_t + \beta_3 LENERGY_t + LTOU_t + U_t \tag{1}$$

In this model LCO2 is the carbon dioxide logarithm gas emissions caused by the use of fossil fuels and the manufacturing of cement. LGDP is average gross domestic product in millions of dollars and at constant 2005 prices. LTOU is the income from tourism in millions of dollars and at the constant price of 2005. LENERGY is the logarithm of Egypt's energy per capita, which is measured in kilograms of oil equivalent, and finally LPOP is the logarithm of the total population after ensuring that the variables are stationary using the test Generalized Dickey-Fuller unit root (ADF), the presence or no sustained link between the variables is investigated. In this research, to investigate the lengthy relationship between the model's parameters, the method of auto regression with distribution breaks (ARDL) and the border test approach 28 are used. This method is highly efficient when the order of accumulation of variables is not the same. After estimating the short-term dynamic pattern the long-term link

between the factors is investigated. based on the approach of Pesaran et al. (2001). In this method, two critical values of the maximum and minimum values (1) (0) are determined based on the number of explanatory variables and the worth of the F value of the F test comparing a statistic to them. If the statistic's value is If F is bigger than the upper bound's critical value, regardless of the order the accumulated of the variables, the co-accumulation relationship between the model's components will be confirmed. That is, in this case, the claim that there isn't any long-term relationship between the variables is rejected. On the contrary, if the value of the test statistic is less than the critical value of the lower border. The null hypothesis cannot be rejected, and finally, if the statistic value is between the two edges, the result of the test will be uncertain.

In the next step, if the existence of a long-term correlation between the model's variables is confirmed, the long-term equation or the co-accumulation between the variables can be estimated and finally the error correction model's coefficients (ECM) can be obtained to check how to adjust the short-term error towards a balanced long-term relationship.

3. RESULTS

Now, in order to estimate the model, testing the variables' stationarity is required and their order of accumulation. In Table (2), the outcomes of the generalized Dickey-Fuller the results of the model's variable's unit root test are presented.

Table 2: The outcomes of stationarity test of variables using the generalized Dickey-Fuller test (ADF)

Variables name	With the width of the origin		With the width of the origin and trend variable	
	In level	With one time differentiation	In level	With one time differentiation
LCO2	-0/24 (0/92)	-6/34 (0/00)	-3/49 (0/05)	-6/30 (0/00)
LGDPP	-1/12 (0/69)	-5/45 (0/00)	-2/01 (0/57)	-5/52 (0/00)
LPOP	-0/45 (0/98)	-7/36 (0/00)	-8/15 (0/57)	-2/94 (0/16)
LENERGY	-0/25 (0/92)	-8/25 (0/00)	-3/24 (0/38)	-8/12 (0/00)
LTOU	-2/59 (0/10)	-5/69 (0/00)	-3/74 (0/03)	-5/88 (0/00)

Note: the values inside parentheses represent the probability value of the test

As the outcomes of the ADF test show, most of the model factors are at the non-significant level, but their first-order difference is significant, of course, it should be noted that one of the advantages of the ARDL boundary approach compared to Johansen's approach is that the model variables do not need to be aggregated. That is, regardless of the order of accumulation of the variables, the model is estimated, but care should be taken that the factors are not accumulated of the 2nd order, that is, they are not I (2) and the maximum degree of uncertainty is 1. Therefore, according to the above, the conditions for using the ARDL method of reaching the edges are available.

In the following, the short-term dynamic pattern of ARDL is estimated and shown. In this model, with consideration of 4 for the dependent variable and explanatory variables, the ARDL model (1,444,0) has been selected as the optimal dynamic model based on the Akaike criterion.

In chronological order to ensure the validity and accuracy of the outcomes of the estimated patterns of diagnostic tests of serial correlation, 32 tests of heterogeneity of variance and 33 tests have been investigated, and the outcomes of diagnostic tests of model 1,444,00 (ARDL) published by Di. Carbon dioxide and tourism are given in a desk (3).As seen in the table. In the estimated model, there is no heterogeneity of variance and serial autocorrelation among disturbance components.

Table 3: Diagnostic tests

Variance heterogeneity test			Serial autocorrelation test		
	Statistics	Probability		Statistics	Probability
F-statistic	1/44	0/25	F-statistic	0/78	0/73
Obs*R-squared	20/24	0/26	Obs*R-squared	27/87	0/00

Source: Calculations and researcher findings

To be able to check the stability of the predicted coefficients over time in the following model, Brown-Durbin and Evans (1975) criteria have been used. CUSUM is used in these tests, the value of the test statistic is plotted against two critical boundaries, if the test statistic's value is does not go beyond these two critical values, it can be claimed that the coefficients of the estimated model are stable at the 5% level, as shown in the diagram (1) and (2) it can be seen that the estimated model is stable at the level of 5%, so based on the outcomes of diagnostic and stability tests, the validity of the obtained results can be ensured.

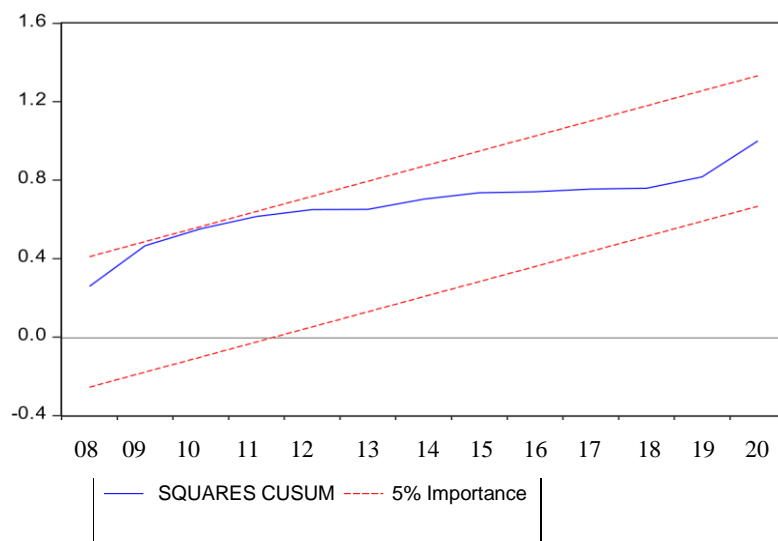


Figure 1: the result of the model stability test (CUSUMQ)

نمودار (۲): نتایج آزمون پایداری مدل (CUSUM)

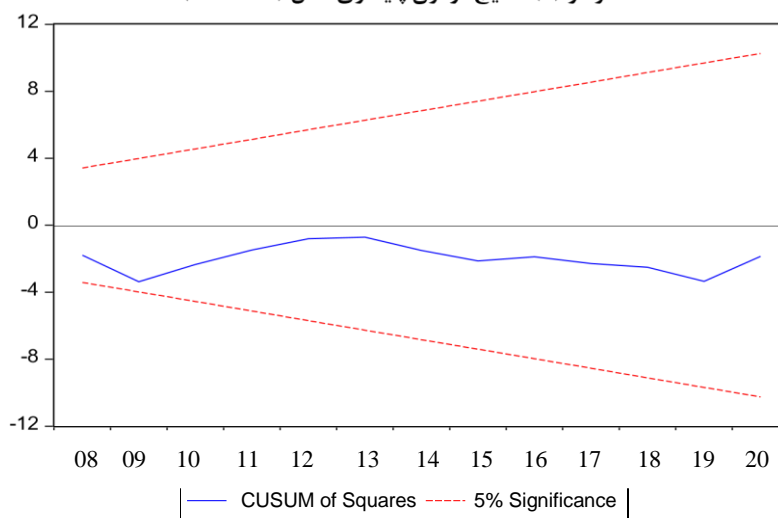


Figure 2: the outcome of the model stability test (CUSUMQ)

In the next step, bounds testing, which is founded on estimation of the Unconstrained Utilizing the Ordinary Least Squares (OLS) estimator, the Error Correction Model (UECM), is employed to determine whether there is a long-term correlation between the variables.. The F statistic obtained from the test and the critical values of the edges are shown in table (4).

Table 4: Results of the Bounds test

The value of the F Bounds test is: 12/44		
I(1)	I(0)	Critical values of Pesaran
3/49	2/56	Significance at the 5% level
4/37	3/29	Significance at the 1% level

Source: Calculations and researcher findings

According to the above table, the value of the estimated F statistic is equal to 12.44, which compared to the critical values of the bounds which exceeds the value of the upper bank at the level of 1%, hence the rejection of the null hypothesis that there is no long-term link between the variables. Therefore, it can be concluded that there is co-accumulation and long-term connections between the study model's variables. The coefficients of the mentioned long-term relationship are estimated and shown in table (5).

Table 5: The outcomes of estimating long-term coefficients using the ARDP model

Variables name	Coefficient	Standard Deviation	t-statistic	Probability value
c	-11/70	1/43	-8/12	0/000
LENERGY	0/84	0/05	16/55	0/003
LGDP	-0/14	0/03	3/78	0/002
LTOU	0/018	0/009	1/94	0/075
LPOP	-0/93	0/087	10/675	0/000

Source: Calculations and researcher findings

According to the outcomes of the variable estimation, the per capita logarithm income has a favorable effect on the emission of Oxygenated air gas, which is also statistically significant because economic growth leads to greater utilizing natural and environmental resources and increases undesirable outputs and pollutants. It is said that they participate in the destruction of the environment, so if there is no change in the existing structure or technology in the economy, the expansion of production and economic growth will cause the growth of pollution and destructive environmental effects.

This theory is called scale effect and our results are consistent with this theory. Energy consumption is a factor that significantly and favorably affects the spread of environmental pollution, that is, with the increase in energy consumption, especially fossil fuels, to achieve the goals of economic growth and the lack of efficiency in its consumption, environmental pollution increases; hence, one of the key causes of air pollution is the emission of carbon dioxide gas, which is one of the most important types of greenhouse gases and is the result of the use of fossil fuels in manufacturing, commercial, service and household sectors.

The logarithm of income from tourism also has a favorable impact on carbon dioxide emissions is significant at a level of less than 10% because tourism activities such as transportation and accommodation require the use of energy, energy consumption in the form of fossil fuels directly and use It indirectly leads to the emission of other greenhouse gases as well as the creation of carbon dioxide, which is one of the reasons for global warming and other climate changes, and is compatible with theoretical expectations.

Finally, the logarithm of the population variable has a favorable and significant a direct impact on carbon dioxide emissions and causes the deterioration of the quality of the environment. Because with the increase in population, the energy demand of the electricity sector and the transportation industry increases and causes an increase in harmful emissions of gas.. The error correction model related to the long-term equation is also estimated and the error correction coefficient in the table shown below. As the outcomes show, the coefficient of error correction of the model is (-1.34) and it is statistically significant. Therefore, the lasting connection obtained in the previous step is confirmed and the short-term equilibrium error is 1.34 units in each period towards the relationship a long-term equilibrium is adjusted.

Table 6: Error correction coefficients estimation results

Variables name	Coefficient	Standard Deviation	Probability value
ECM	-1/34	0/07	0/000

Source: Calculations and researcher findings

4. CONCLUSION

The main goal of the current research is to investigate the impact of tourism, economic growth and energy consumption on environmental pollution in turkey during 2000-2020. Therefore, in this regard, the research model is based on the auto regression model with distributive breaks (ARDL) and the edge test approach. It was estimated according to the findings of the research, it was determined that the effect on the coefficients of all the variables are expected based on the theoretical foundation so that in the long term, the increase in economic growth has a positive and significant effect on the emission of the carbon dioxide gas and causes the deterioration of the quality of the environment which is consistent with the scale effect theory. The population variable has a positive and significant impact on the emission of carbon dioxide gas, this result is consistent with theoretical expectations and show that with the increase in population density, the demand for energy due to the change in lifestyle from traditional to modern and the use of transportation system infrastructures and heat-generation materials increased and lead to the destruction of the environment. Also, energy consumption has positive and significant impact on the emission of carbon dioxide gas. This result is consistent with theoretical expectations and shows that with the increase in energy consumption, the emission of greenhouse gases, especially carbon dioxide, worsens the quality of the environment .the income from tourism has a positive impact on carbon dioxide emissions and should be at a level of less than 10.this increasing trend of carbon dioxide emissions in Turkey there is a need to apply new environmental policies to preserve the environment. The result related to the error correction model indicate that in each period 1.34 units from short –term imbalance to the long-term equilibrium relation becomes a significant percentage adjustment .

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A Novel Adaptive Model for Overall Equipment Effectiveness Prediction

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Abstract

In the manufacturing and assembly industries, including in the automotive industry, it is particularly important that the monitoring of production efficiency takes place in real-time mode, and that the related data-based forecasting also works quickly, in detail and reliably. With the support of various modern technical and Information Technology (IT) tools, the recording, storage and processing of large amounts of data is now a routine activity. Based on machine learning, efficiency metrics, including Overall Equipment Effectiveness (OEE), can be partially predicted, but industrial companies need more accurate and reliable methods. This paper presents a new adaptive predictive model through assembly line example to predict efficiency by discovering patterns and generating prediction functions. In addition, the operation of the suggested algorithm is also demonstrated in practice with Multiple Linear Regression (MLR) as supervised machine learning. The presented model can be used in general for all production units or machines where production data is recorded by Manufacturing Execution System (MES) or other Enterprise Resource Planning (ERP) systems are available.

Keywords: OEE, prediction, machine learning, multiple linear regression

1. INTRODUCTION

In the automotive industry, as part of a business plan, annual financial, budget or profit planning is primarily based on order set in contracts, predetermined or forecasted estimations. This strategic plan includes the company's finances, cash flow, savings, investments and costs. Thus, it is extremely important that the forecasting systems of companies operate as accurately as possible, as even small differences can mean significant financial changes and risks. Forecasting systems are used in many areas amongst other sales (e.g., expected order quantity, gross sales), finance (e.g., profit forecast, cost elements), logistics (e.g., stock size, freight cost, premium freight), engineering and maintenance (e.g., equipment functionality, consumables), quality (e.g., scrap, rework, containment), human resource (e.g., direct, indirect, salaried headcount).

In addition, measuring and monitoring the efficiency of production machines and assembly lines is an essential key process for most industrial companies. Monitoring the performance of production units on a shift level, daily, weekly and monthly basis is important in several aspects. On the one hand, it is one of the input information sources of production control, and on the other hand, it facilitates the accurate fulfillment of complex logistics and sales

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processes. Beyond measuring and monitoring effectiveness, there are also serious predictive needs. Accurate Overall Equipment Effectiveness (OEE) prediction may best affect the following areas:

- Financial results (e.g., increasing OEE percentages induces increasing profits);
- Production scheduling (e.g., manufacturing and assembly sequences);
- Inventory management (e.g., raw material, intermediate stock, finished product);
- Investment planning (e.g., required new equipment or identification of redundant machines);
- Maintenance planning (e.g., required time and spare parts);
- Continuous improvement (e.g., process optimization, line balancing, efficiency improvement).

Based on these characteristics, the most accurate and reliable forecast of OEE is a real requirement in the industrial environment. In addition, it is not necessary to make a one-time forecast, but rather a cyclical prediction with a rolling window. The aim of this paper is to present a novel adaptive predictive model with rolling window through assembly lines to estimate efficiency by discovering patterns and generating prediction functions.

2. LITERATURE REVIEW

Within the literature review, the authors focus on three sub-areas. The first is OEE as a metric, the second is machine learning methods for estimation, and the third is machine learning possibilities for OEE prediction.

2.1. Overall Equipment Effectiveness as Key Performance Indicator

According to Egri et al., industrial manufacturers use three types of Key Performance Indicators (KPI's) such as financial indicators (e.g., profit), manufacturing indicators (e.g., scrap rate) and service-related indicators (e.g., lead time) [1]. Among the company's KPI's, one of the most frequently used primarily efficiency indicators is OEE, which clearly shows current status of production [2]. In addition to OEE, there are many similar and derived metrics (e.g., Overall Equipment Efficiency of a Manufacturing Line, Overall Line Effectiveness, Total Equipment Effectiveness Performance, Global Process Effectiveness, etc.). OEE is a KPI widely used to measure machines and assembly lines productivity and shows a ratio between real manufacturing and what could be ideally manufactured [3]. According to Nakajima the basic formula for calculation Overall Equipment Effectiveness is written as:

$$OEE = a p q [\%] \tag{1}$$

where,

- a—availability [%]
- p—performance [%]
- q—quality [%] [4].

Fig. 1. shows the OEE calculation and expectations by main three elements.

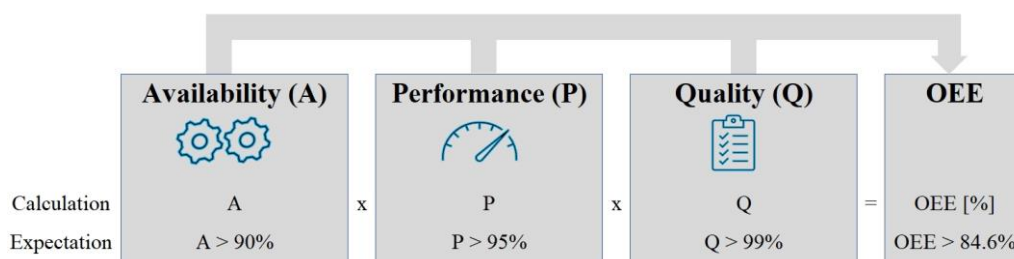


Fig. 1. OEE calculation and expectation of OEE percentage

100% OEE score means perfect production, given equipment or production line produces only good products without stop at maximum performance [5]. Consequently, it is not possible to achieve 100% OEE within an industrial context [6]. OEE values are ordinarily found to be between 30 and 95 percent [7].

In order to obtain the percentages of availability, performance and quality for any period of time, it is necessary to use automatic data collection systems. Smart factories apply digital manufacturing tools and software such as Manufacturing Execution System (MES) to improve performance and quality [8]. MES can continuously, real time, in digital format provide an extensive database to make complex analysis [9]. In general, MES has several functionalities among others production data collection, machine data collection, control station, tool and resource management, information management and transmission of machine settings [10].

2.2. Machine learning methods for estimation

The group of machine learning methods can be divided into three parts, as supervised, unsupervised and reinforcement learning [11]. Each method is generally used for prediction or estimation in the field of production.

Fields of data mining and machine learning at the domain of manufacturing:

- Quality analysis, control and estimation;
- Machine and tool failure detection, analysis and prediction;
- Maintenance analysis;
- Production planning and scheduling optimization;
- Design;
- Waste reduction;
- Decision support system;
- Production and assembly process optimization, monitoring, prediction;
- Optimization, control, troubleshooting [12-16].

Manufacturing industry firstly focused on using data for production analysis, process monitoring and quality control, secondly used six sigma and other data-analysis concepts [17]. Nowadays estimation and prediction based on data is an important part of smart manufacturing. As a result of Lean production, where improvement and problem solving are still proactive in the standard case, and reactive in the case of abnormality, a predictive approach based on data-based learning is typical for Industry 4.0 [18].

Numerous machine learning algorithms are used among others decision trees (e.g., Classification and Regression Tree, ID3, C4.5, C5.0, Chi-squared automatic interaction detection, Conditional Decision Tree, M5, etc.), Clustering (e.g., K-means, K-medians, Hierarchical Clustering, etc.), Bayesian methods (e.g., Naïve Bayes, Gaussian Naïve Bayes, Multinomial Naïve Bayes, Bayesian network, etc.), Regression (e.g., Linear Regression, Logistic Regression, Stepwise Regression, Locally Estimated Scatterplot Smoothing, etc.), Regularization (e.g., Least Absolute Shrinkage and Selection Operator, Elastic Net, etc.), Instance Based tool (e.g., K-Nearest Neighbor, Locally Weighted Learning, etc.), Ensemble methods (e.g., Gradient Boosting Machines, Random Forest, Boosting, AdaBoost, Bagging, etc.), Neural Networks, (e.g., Perceptron, Radial Basic Function Network, etc.) and Deep Learning (e.g., Deep Belief Networks, Convolutional Neural Network, Deep Boltzmann Machine, etc.) [19-26].

A predictive control concept was suggested by Heutman et al. for a synchronized individual production with the support of disturbance detection and prediction. Risk Priority Number (RPN) components as severity, occurrence and detection were applied to predict different effects which influenced the production [27]. Subramaniyan et al. proposed a data-driven algorithm to estimate throughput bottlenecks in a manufacturing system based on active periods of production equipment. The applied algorithm had higher and significant mean accuracy and precision

compared to naïve method [28]. Identifying the bottleneck at the assembly lines can play an important role in OEE forecasting.

Öztürk et al. used regression tree analysis for lead time estimation in make to order manufacturing [29]. Simulated four shop types as Shop-V, Shop-A, Shop-I(100) and Shop-I(125) and compared linear regression to Cubist, Ruben and Mahmoodi, Hopp and Sturgis methods. Szaller et al., also when predicting the lead time, applied machine learning tools as linear regression and tree-based methods and found that boosted trees give the lowest error [30]. Lingitz et al. used and evaluated eleven various statistical learning tools among others linear models and Artificial Neural Network (ANN) regression for lead time prediction at semiconductor manufacturing by using R and R Studio [31].

Bachus et al. predicted cycle time with a data mining approach. Numerous methods among others KNN (k=5, k=10), CART, Cluster (n=5, n=10) and Neural Network were compared in terms of median absolute error and mean absolute error [32].

At the domain of production, an adaptive assembly support system was evaluated by classification and regression trees, random forest, gradient boosting decision trees, and adaptive boosted decision trees. Sorostinean et al. highlighted that the gradient boosting decision trees was the best performing among all the applied tree-based methods [33].

Gellért and Zamfirescu proposed an adaptive assembly assistant system which is using Markov predictors to estimate the next assembly step [34]. Shaheen and Németh used different artificial neural networks, e.g., Neuron-by-Neuron, to model and predict the degradation path of a machine's mechanical component [35].

2.3. Possibilities for OEE prediction

In general, the goal of prediction is to minimize the possibility of error emergence and performance deviations [36]. According to Choudhary et al. data mining has two primarily goals as description and prediction. The aim of predictive data mining is determining future values based on available datasets [37]. The purpose of the OEE forecast is to determine in advance what percentage value can be expected on a given production machine or assembly line and with what probability. Several free and open-sources data processing tools are for supporting to predict OEE value from the side of informatics among others RapidMiner, KNIME, Orange, WEKA, R. Rattle GUI [38].

A conceptual framework was presented by Accorsi et al., where the implementation of condition-based maintenance and real-time fault prediction was supported with decision trees, Random Forest (RF) and Neural Networks (NN) [39]. According to Nemeth et al., to predict the future behavior of production equipment components, the determination of proper technique and the estimation of its parameters (e.g., MTBF, MTTR, failure type and rate, etc.) are essential [40]. The time and duration of component failure strongly influence the OEE value, so it is important to predict these as accurate as possible.

Changeover time as process part of OEE calculation was estimated by Multiple Decision Tree combined with RUS Boosted Tree is an Ensemble Classifier [41]. Bergman et al. suggested a method to the in-line quality check. Compared several models as DeepInsight X Isotonic Regression, Logistic regression, XGB Classifier, Decision Tree Classifier, LGBM Classifier, Random Forest Classifier and K-Neighbors Classifier, although the absolute best model does not exist [42]. Quality effect as a component of Overall Equipment Effectiveness was predicted by Lieber et al. Different supervised and unsupervised machine learning methods was applied among others clustering and decision tree at the steel industry production [43]. Soto and Gyulai proposed a discrete-event simulation (DES) based approach for early detection of product failures. With the proposed method, an OEE value increase of 1.5 % can be achieved. By estimate errors, the quality part of OEE can also be predicted [44].

Meidan et al. suggested a data-driven methodology as neural networks and C5.0 decision tree to predict cycle time in semiconductor manufacturing [45]. Anusha and Umasankar used simple moving average and Holt's double exponential smoothing method for OEE prediction, and a self-learning program was developed to predict the OEE percentage using python [46]. A Long Short-Term Memory Network (LSTM) as a Recurrent Neural Networks (RNN) model was applied at time series data for prediction of future operational data trend at the field of manufacturing [47]. Based on research work of Brunelli et al., a new deep learning-based method was proposed for predicting the future values of manufacturing performance. The Temporal Convolutional Network (TCN) and Long Short-Term Memory (LSTM) approach were applied for forecasting [48]. Okpala et al. used descriptive statistics analysis, Person correlation, one-sample test for to write a new OEE estimation formula by Design Expert software. This formula considers availability, performance and quality with different weights [49]. Acosta et al. proposed

Support Vector Machines (SVM) in intelligent manufacturing system for optimization of production cost and overall effectiveness of equipment [50]. Most commonly applied machine learning methods and algorithms used in OEE analysis is summarized in Table 1.

Table 1. Machine learning methods and algorithms used in OEE analysis

Method or algorithm	Complexity
Logistic Regression	low
Gaussian Naïve Bayes	low
K-Nearest Neighbour	low
Bayesian Ridge Regression	low
Decision Tree Regression Algorithm	low
Random Forest	low
Random Forest Cross Validation	low
Support Vector Machine	medium
Support Vector Regression	medium
Support Vector Regression Cross Validation	medium
Support Vector Regression Genetic Algorithm	medium
Extreme Gradient Boost	medium
Extreme Gradient Boost Cross Validation	medium
Artificial Neural Network	high
Deep Learning	high

This paper seeks to a new predictive model through assembly lines to estimate efficiency by discovering patterns and generating prediction functions.

3. MATERIALS AND METHODS

To emphasize the importance of prediction, it is necessary to know exactly what the cost impact of a 1% increase in OEE for semi-automatic or hybrid assembly lines will be on the operation of the organization.

One percent improvement or deterioration of Overall Equipment Effectiveness has a significant impact on conversion costs and thus financial results. Conversion cost among others includes the labor costs (for direct staff) and machine costs (maintenance and depreciation). From the automotive industry, conversion costs were analyzed at 114 different equipment. With similar sample amount, pressing machines, testing stations, different welding machines and assembly lines conversion costs are shown in Fig. 2. These data are real and validated, scaled with no factor. Based on these, the semi-automatic lines have the highest value, so it is really worth focusing on this area. With one percent increase of OEE, the savings available are € 3,600 to € 9,600 for 3-7 people per line and € 8,400 to € 16,800 for 7-15 people per line, assuming five days of production per week with 3 shifts per day. Based on Q4 2022 data collected by the authors involving a Hungarian automotive manufacturer.

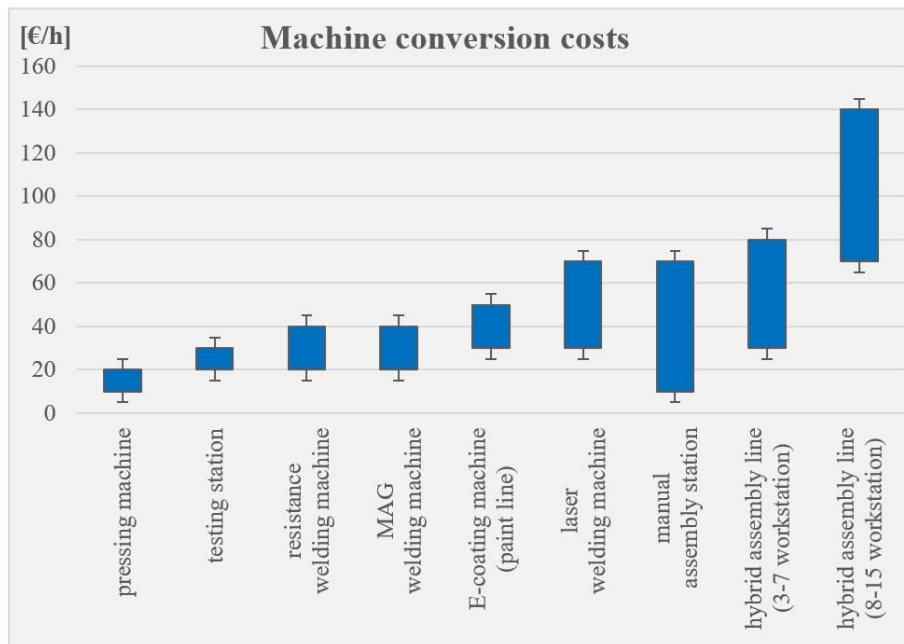


Fig. 2. Machines conversion cost based on real industrial example

Based on these, it is undoubtedly worth dealing with the OEE prediction as accurately as possible in the case of semi-automatic assembly lines. The adaptive model presented in the next chapter is primarily based on data recorded, collected and processed by Manufacturing Execution System (MES) and Enterprise Resource Planning (ERP) systems used by companies. Manufacturing enterprises are increasingly using barcodes, sensors, vision systems, wireless smart technologies, cloud-based solutions and communication interfaces to collect data at all phases of product’s life cycle. The production data, among others number of assembled pieces, cycle time, downtime, is recorded automatically, so the prediction is based on reliable and consistent data. During the research and data analysis, the authors used supervised learning.

4. PREDICTIVE MODEL WITH ROLLING PLANNING HORIZON

In this chapter, a complex model that predicts the value of Overall Equipment Effectiveness in an adaptive way is presented and described. In order to ensure that the predicted OEE during capacity utilization and production planning is as accurate as possible and that the entire planning process is as close to reality as possible, a model is needed which takes past and present parameter values with their continuous changes in an adaptive way at the micro level into account.

The main goal is to predict the OEE values of the given production unit within a predetermined range of error with the support of the essential influencing factors. The presented model is primarily designed for semi-automatic assembly lines used in mass production, but it can also be interpreted for individual machines. Fig. 3. shows the model of identification, adaptive development and validation of patterns for OEE prediction.

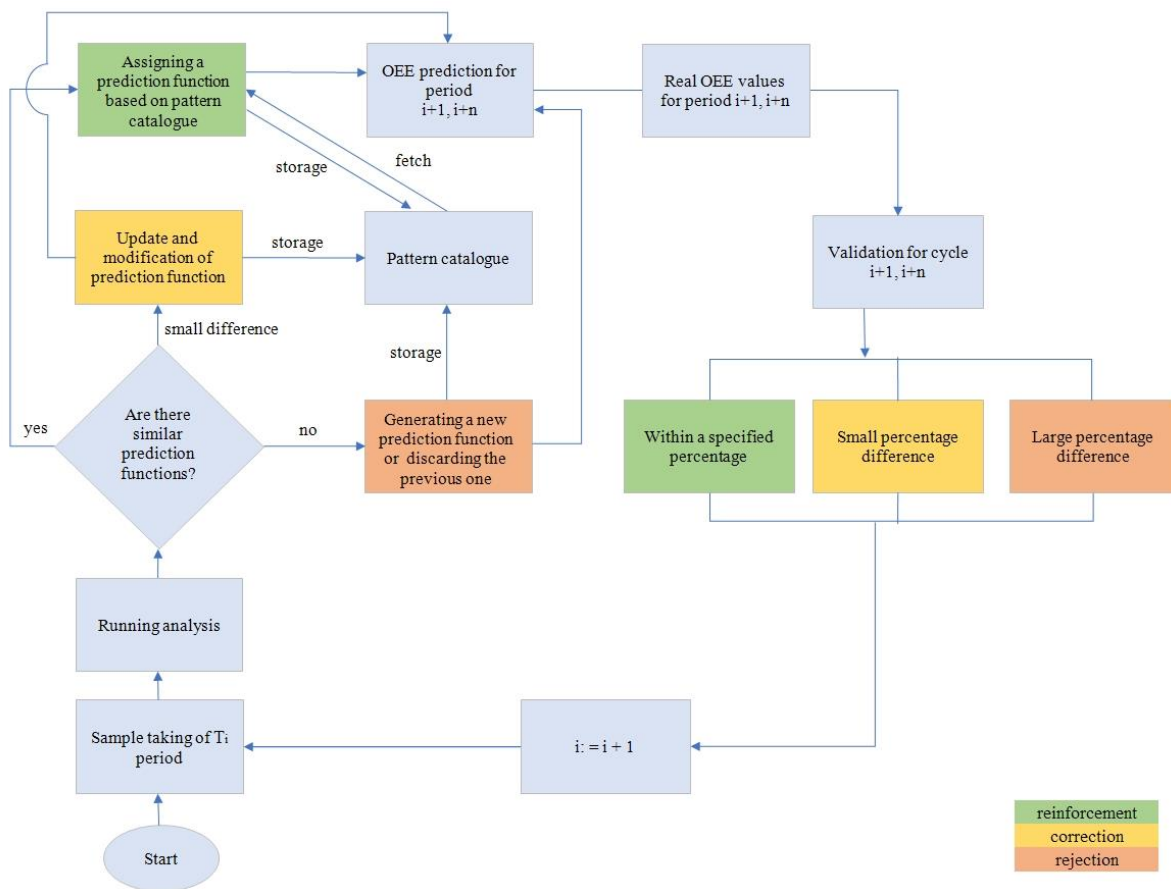


Fig. 3. Identification, adaptive development and validation of patterns for OEE prediction

The most important expectations for the model are that it adaptively identifies, modifies, and discards patterns during the entire OEE prediction process. In the following sections, the adaptive prediction model and its functionality is presented and detailed.

4.1. Start

The first use of the model begins at the start and the production unit for which the OEE value should be predicted is determined. Prediction of OEE values by related area can be:

- Factory or production network OEE (includes all machines, production lines, assembly lines, usually without weighting);
- Production unit or area OEE (includes all machines, production lines, assembly lines in one separated production area);
- Group of homogeneous machines, lines OEE (in case of similar technology);
- Individual machines, lines OEE (general focus on the bottleneck machine or workstation).

As previously mentioned by the authors, the article primarily focuses on the semi-automatic assembly lines, so it can be considered as primary. It is necessary to mention that a significant amount of data is needed which is extracted from the MES system. These data are accurate and consistent due to the sensors and other systems (e.g., visual systems, measurement systems, etc.) that provide the data automatically.

4.2. Sample taking of T_i period

Sample means the values that are taken into account when creating the prediction function and consists of a set of data extracted from the MES system. The sample itself usually does not automatically exhibit regularity, but the raw data set, organized into these records, contains time-series data, including duration, exact time values and technical information. (e.g., time stamp and duration of technical downtimes, logistics downtimes, number of scrap pieces, etc.). In terms of OEE, the scope of the prediction can be as follows:

- Hourly OEE (used for general follow-up by team leaders and during critical periods);
- Shift OEE (used for general follow-up by shift leaders);
- Daily OEE (used for general daily follow-up by managers);
- Weekly OEE (used for performance follow-up and predictions);
- Monthly OEE (used for strategic planning).

From the scientific point of view, weekly OEE prediction has relevance, because there is already enough data in this range for statistical examinations, and the effects and disturbances in production can be well perceived. For daily OEE analysis and forecasting biasing short-term effects can be misleading. On a monthly basis, the effect of smoothing out the disturbances is already high, so certain factors are no longer visible.

In the case of using the adaptive prediction model, selecting the T_i period is essential as initial condition, but it is advisable to keep the selected period consistent. For each cycle, the selected period must be defined.

4.3. Running analysis

During the analysis, the first step is to query and process the MES and ERP data for the selected period. After complete data preparation and processing (data cleaning, filtering, sorting, etc.), the patterns are searched using supervised machine learning. Pattern recognition is the automated recognition of OEE patterns and regularities in production data. During the creation of the mathematical multivariate prediction function, the main determining parameters affecting the OEE components (availability, performance, quality) are taken into account, among others downtime, scrap parts, cycle time, etc. As a result of the analysis, the prediction function is generated in such a way that it contains the discovered real regularities (patterns) besides the original data sets. The detailed function designed to predict the value of OEE, and the patterns revealed in practice. This paper describes the model with Multiple Linear Regression (MLR) in general way.

4.4. Similar prediction functions

The model contains a branch where the question arises: Is there a similar prediction function? The evaluation of prediction function can move in three different directions:

- No similar prediction function at all;
- There is a completely similar prediction function;
- There is a prediction function with little similarity.

The prediction function can be considered similar if:

- The value of the adjusted R-squared has a smaller deviation than 5% (after examining several cases, empirical value);
- The composition of the significant independent variables do not changes.

4.5. Generating a new prediction function or discarding the previous one

There is no prediction function in the model during the first cycle, so this is the initial state, therefore a new prediction function must be generated. These are stored in the pattern catalogue and the OEE value for the next period is predicted based on it.

Starting from the second cycle, if there is no similar prediction function, the discovered ones have to be recorded and stored in the pattern catalogue as new ones. In addition to these, there is the option to discard the previously used prediction function.

4.6. Update and modification of prediction function

In case if the current function needs only to be modified based on a small deviation, the prediction function will be modified, and this must be stored in the pattern catalogue and the sample must also be assigned to it. It is also necessary to preserve the previous sample, it is not necessary to throw it away, but to store it, plus the new expanded sample and patterns must also be stored with the new prediction function. In the following, the OEE prediction is made with the modified function.

4.7. Assigning a prediction function based on pattern catalogue

If there is a completely similar sample and prediction function, then it should be interpreted as active from now on without any changes, and the OEE value can be predicted for the given period. In the model, this is the smoothest path from the point of view of easier execution of the prediction.

4.8. Pattern catalogue

The samples, the patterns and the prediction functions are recorded and stored in the pattern catalog. Storage can be done in three directions, when generating new elements, updating or modifying and assigning. In addition to these, the prediction function can be extracted from the catalogue any number of times. By increasing the number of cycles, the number of data stored in the pattern catalogue increases continuously. The schematic diagram of the pattern catalogue is shown in Fig. 4.

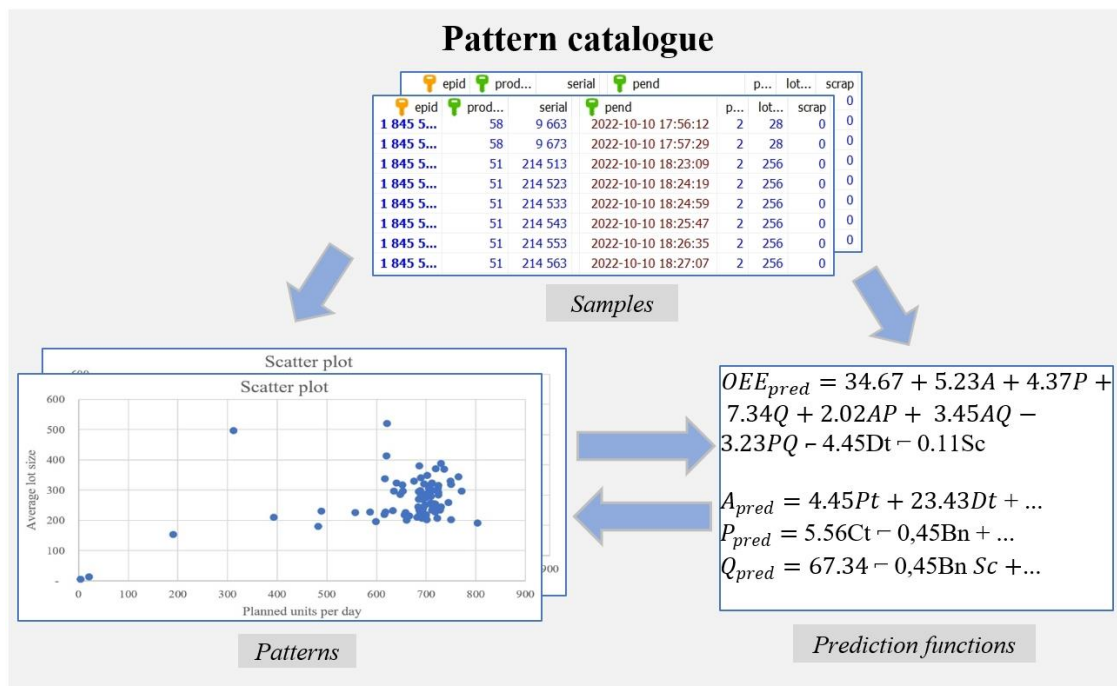


Fig. 4. Schematic diagram of the pattern catalogue

4.9. OEE prediction for period $i+1$, $i+n$

One of the main elements of the model is the prediction of the OEE value for the next period. Depending on whether a new, a modified or already assigned prediction function is used, three inputs to the prediction are possible. The prediction is done using the prediction function so that the output is an OEE value together with a probability value (e.g.: 82% OEE value, with 95% probability). Each cycle results in a predicted OEE percentage, which may show low or close to zero deviation from the previous period for several consecutive cycles – the system is in a balanced state of operation.

4.10. Real OEE values

After the predicted OEE percentages, the real OEE values obtained on the semi-automatic assembly line provide the basis for comparability. It is important that the predicted and real OEE values refer to the same period, e.g., if an OEE value for a shift is estimated, then the measured value must also apply to that specific shift.

4.11. Validation for cycle $i+1$, $i+n$

It is necessary to validate the value of the predicted OEE for the next cycle, in order to be able to predict the percentage of OEE as accurately as possible in the following. When comparing predicted and real results, three cases are possible:

- The deviation of predicted and real OEE value is within a specified percentage range, in this case the prediction was correct;
- Small difference, in which case the prediction is still acceptable with a small deviation;
- Large difference, the prediction did not meet expectations.

The relationship between the validation and identification of proper prediction functions is shown by the colors in Fig. 3. In the case of a large deviation, a new prediction function is required and the used one must be discarded (rejection: red). In the case of a small deviation, it is necessary to update or modify the prediction function (correction: yellow), while the deviation is within the specified range, the prediction function was defined correctly (reinforcement: green). The value of the deviation can be measured by different metrics such as Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE) and Mean Squared Error (MSE).

4.12. Next cycle, $i=i+1$

After validation, other periods can be examined, or the same period can be re-examined and fine-tuned. Examining the next period is possible by moving the time window forward.

The following must be taken into account when making prediction: If the norm on the assembly line is modified – usually upwards – then without changing the influencing factors the value of OEE will decrease. This article and presented model primarily focus on the fact that there is no change in norms. In industrial environment, it is common practice that the OEE target is not changed when the norm is increased, but the higher efficiency is shown in cost savings.

5. PRACTICAL IMPLEMENTATION AND APPLICATION OF THE PRESENTED MODEL

5.1. Data sources

In this chapter, the previously presented model is applied in practice through a real life industrial example. Data from the seat structure semi-automatic assembly line of a Central European automotive company from the years 2021 and 2022 were used. In addition to MES, the company also operates an SQL database system as summarized in Table 2.

Table 2. Used databases and its sources and formats

Data name	Data source	Data format
Downtime data	MES	xlsx
Product timestamp data	SQL database system	csv
Quality data	MES	xlsx
OEE data	MES	xlsx

The records of the four different databases contain the following main data:

Downtime data:

- Downtime reason (e.g., breaks, technical issues, changeover, quality problems, logistic, process settings, unscheduled equipment downtime, other, etc.);
- Machines (all machines and assembly lines are linked to MES);
- Start of downtime (e.g., 01.12.2022. 09:22:15);
- End of downtime (e.g., 01.12.2022. 10:02:11);
- Downtime duration (equal to the difference between the end timestamp and the start timestamp in the following format: hh:mm:ss).

Product timestamp data at the assembly lines:

- Unique palette identifier (the ascending identifier of each product on the palette);
- Product type (identifier of the assembled product type or group);
- The time to start the last assembly operation (e.g., 01.12.2022. 10:18:05);
- The end time of the last assembly operation (e.g., 01.12.2022. 10:19:25);
- Serial numbers, lot numbers, shift identifiers, but these are not relevant.

From these data, the takt time of the assembly line also follows, since this is determined by the last station. (The cycle time of the last station is variable over time and identical to the takt time of the line.)

Quality data:

- Machines (all of machines or assembly lines linked to MES);
- OK quantity in selected time period(accepted assembled products);
- Scrap quantity in selected time period (not accepted assembled products);
- Timestamp of good and scrap products (e.g., 01.12.2022. 11:22:56).

OEE data:

- Machines (all machines and assembly lines are linked to MES);

- Availability percentages;
- Performance percentages;
- Quality percentages;
- OEE percentages;
- OEE target.

The four databases can be linked in a combined database based on the timestamps and unique identifiers of the records. In the followings, the data of the combined database will be processed with the help of machine learning. The process is illustrated in Fig. 5.

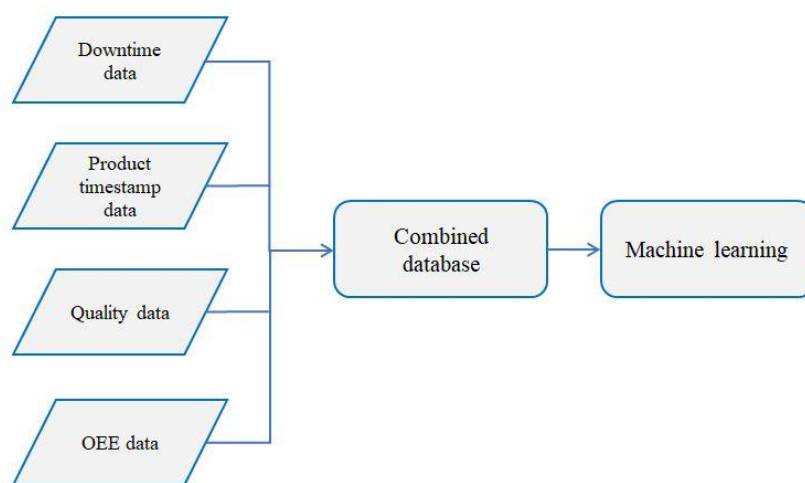


Fig. 5. From basic data to machine learning

The combined database will be used for prediction during machine learning, it contains the following columns: observation identifier, process failure downtime, break downtime, technical downtime, changeover downtime, quality reason downtime, logistics reason downtime, not planned downtime, other downtime reason, number of changeover, average cycle time, number of assembled units, number of scrap units, OEE percentage, availability percentage, performance percentage, quality percentage. This database contains more than 750 records. Each record covers one shift (8 hours) of data. The examined mass production took place in two shifts (morning and afternoon shift) with five workdays per week. Fig. 6. shows the original OEE percentages at the examined semi-automatic assembly line.

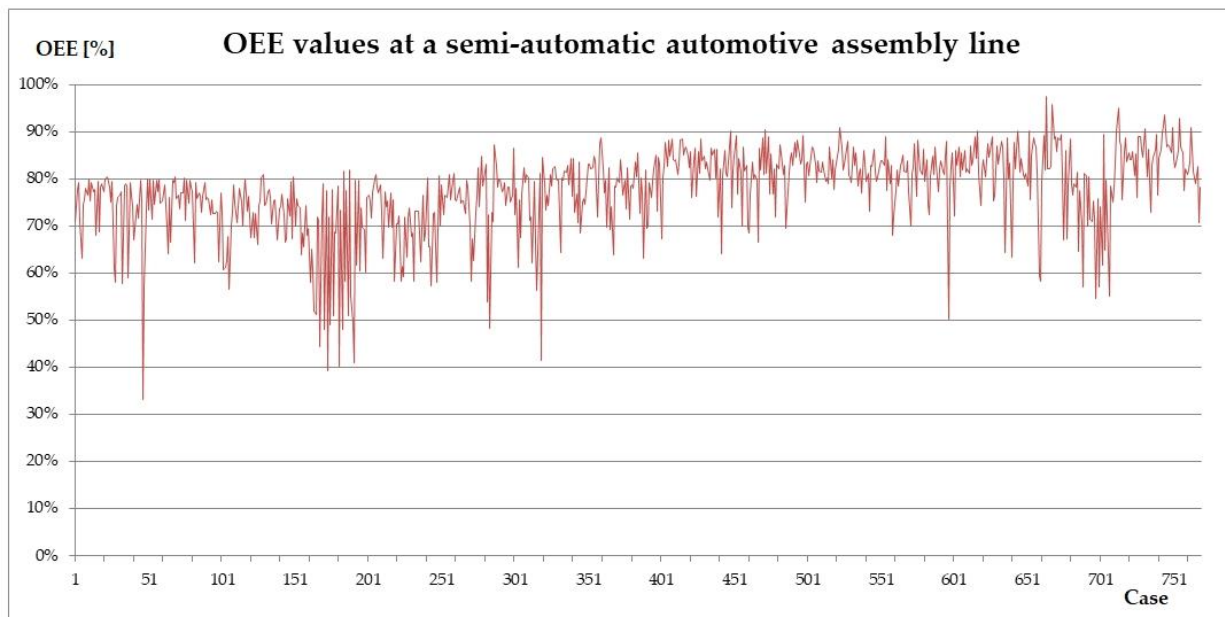


Fig. 6. Original OEE data at a semi-automatic automotive assembly line

5.2. Practical demonstration of the model

In practice, the application of the model will be presented in parallel in two cases, the first one for production planning for a shorter period, the second one for industrial investment for a longer period on the same semi-automatic assembly line and for the same time period. When applying the model, the authors used Multiple Linear Regression (MLR) as supervised machine learning for the analysis periods presented in Table 3.

Table 3. Periods for analysis

Case	Sample T_i period	Predicted period	Cycle step
Production planning	40 records (4 weeks)	60 records (6 weeks)	10 records (1 week)
Industrial investment	150 records (3 months)	150 records (3 months)	50 records (1 month)

The periods selected during the analysis follow the general industrial assembly practice, according to which the production planning is reviewed on a weekly basis and the investment is reviewed on a monthly basis. During planning, 4-8 weeks are usually taken into account, while in the case of investments, a period of 3 months may be optimal.

The authors used R program for the entire analysis, in addition to the rolling horizon data cumulative data series are applied, so the sample T_i period increased continuously without changing the predicted time. In the rolling approach, the scope and start time of the time windows can vary, while in the cumulative approach the start time of the time window is always the first cycle. Simply, rolling planning pushes the time window, cumulative does not. The cumulative approach is not part of the prediction model, but an investigation into the possibility of a particularly bad value occurring and being handled.

After running the analysis, several patterns and correlations were revealed thanks to the many factors taken into account. Fig. 7. shows a scatter plot example where the average cycle time and OEE value presented as a revealed pattern.

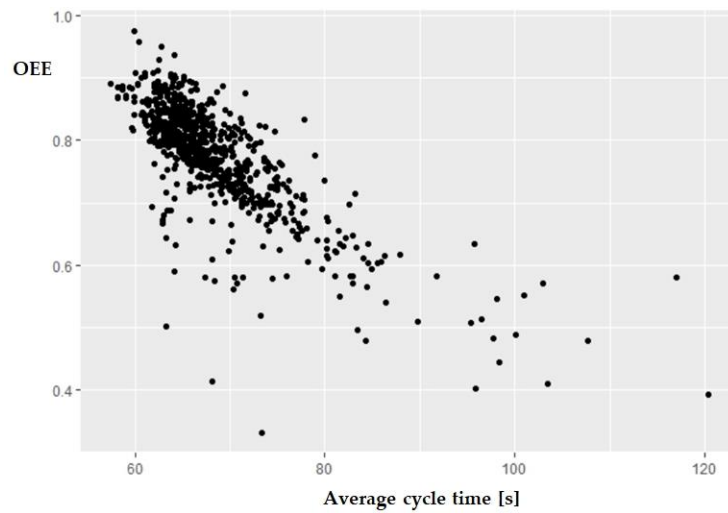


Fig. 7. Average cycle time and OEE values as a revealed pattern

In addition to the patterns, the prediction function (regressor) is also defined, in the following form:

$$OEE = Y + a Pf_{dt} + b B_{dt} + c T_{dt} + d C_{dt} + e Qr_{dt} + f Lr_{dt} + g Np_{dt} + h O_{dt} + i N_{co} + j A_{ct} + k N_{au} + l N_{su} \quad (2)$$

where,

Y – intercept

a – factor for process failure downtime

Pfdt – process failure downtime

b – factor for break downtime

Bdt – break downtime

c – factor for technical downtime

Tdt – technical downtime

d – factor for changeover downtime

Cdt – changeover downtime

e – factor for quality reason downtime

Qrdt – quality reason downtime

f – factor for logistics reason downtime

Lrdt – logistics reason downtime

g – factor for not planned downtime

Npdt – not planned downtime

h – factor for other downtime reason

Odt – other downtime reason

i – factor for number of changeover

Nco – number of changeover

j – factor for average cycle time

Act – average cycle time

k – factor for number of assembled units

Nau – number of assembled units

l – factor for number of scrap units

Nsu – number of scrap units

The value of each factor is usually different from cycle to cycle. The obtained prediction functions are compared with the previous values and a decision is made whether they can be used for OEE prediction, used with small modifications or stored as a new prediction function in the pattern catalogue. Fig. 8. shows rolling horizon Multiple Linear Regression for OEE values at production planning where training set was 541-580 and test set was 581-640. Fig. 9. shows cumulative Multiple Linear Regression for OEE values at industrial investments planning where training set was 1-300 and test set was 301-450. In both figures, the blue line represents the predicted values, and the red line represents the actual OEE values.



Fig. 8. Rolling horizon multiple linear regression for production planning

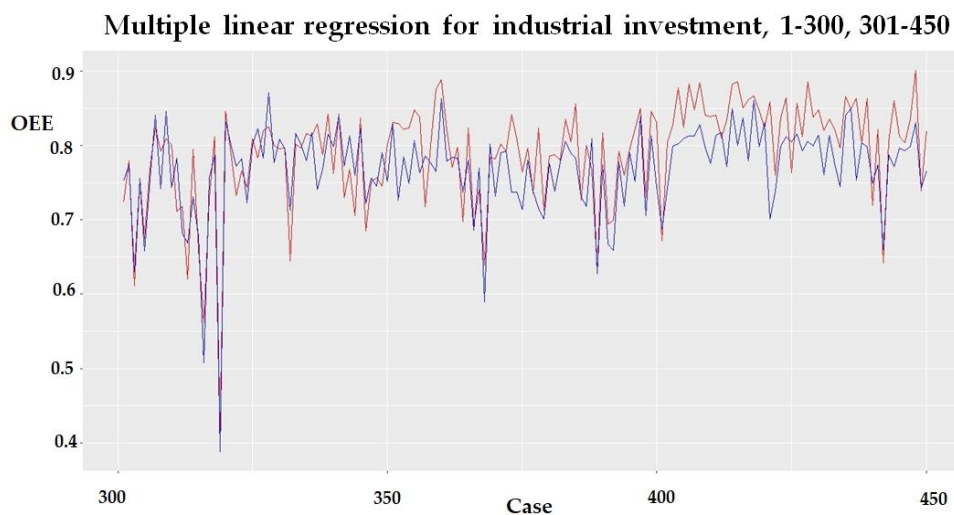


Fig. 9. Cumulative multiple linear regression for industrial investment

During forecasts, the predicted values are usually lower than the real values, due to the fact that the extreme values were not excluded from the original datasets. However, lower values are much more typical than percentages close to 100%. The authors tried to make the prediction conditions as close as possible to real industrial environment.

5.3. Validation and evaluation of the model

The evaluation of the predicted results were done using three metrics: Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE) and Mean Squared Error (MSE) based on the following equations:

$$MAE = \frac{1}{n} \sum_{i=1}^n (y_i - \bar{y}) \tag{3}$$

$$MAPE = \frac{100\%}{n} \sum_{i=1}^n \left(\frac{y_i - \bar{y}}{y_i} \right) \tag{4}$$

$$MSE = \frac{1}{n} \sum_{i=1}^n (y_i - \bar{y})^2 \tag{5}$$

where,

n – number of fitted points

y_i – actual value

\bar{y} – predicted value.

Fig. 10. shows Average Error values for rolling horizon Multiple Linear Regression at production planning where training set was 371-410 and test set was 411-470.

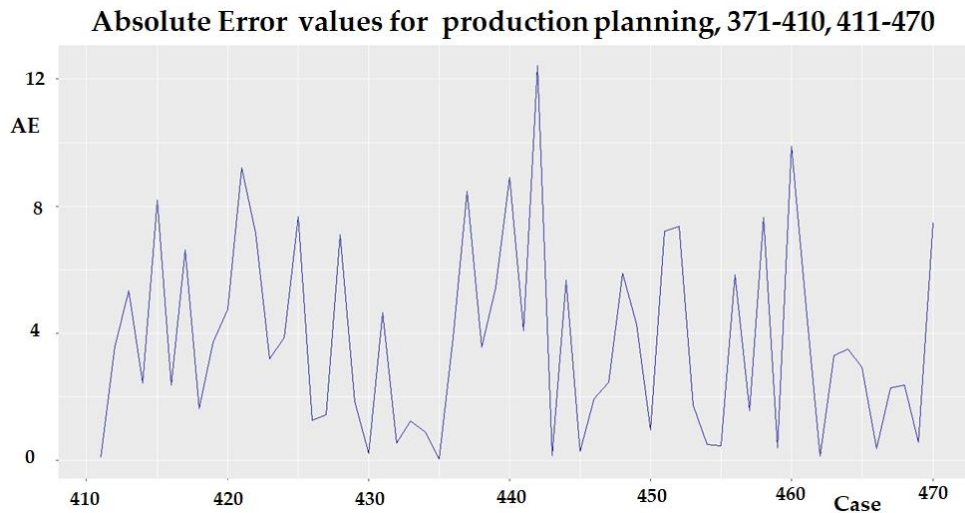


Fig. 10. Absolute Error values for rolling horizon multiple linear regression

Table 4. shows the average MAE, MAPE and MSE values at the case of production planning and industrial investment. At production planning the number of predicted cycles were 67, at industrial investments 10. Due to the variety of prediction options, the authors presented the data in this article by forming a new prediction function in each prediction cycle. The aim of ongoing research is to find the optimum decision point regarding the proposed model.

Table 4. Average MAE, MAPE, MSE values

Case	Method	average MAE	average MAPE	average MSE
Production planning	MLR rolling horizon	0.040695	5.592969	0.003511
	MLR cumulative	0.038892	5.168815	0.002506
Industrial investment	MLR rolling horizon	0.036853	4.772282	0.002594
	MLR cumulative	0.040573	5.179066	0.002643

The basis for the primary qualification of the accuracy of the prediction cycles is the magnitude of the MAPE value. Based on observations made on several similar semi-automatic assembly lines, the rating was determined in a practical way:

- MAPE value $\leq 5\%$, then within a specified percentage;
- $5\% < \text{MAPE values} > 6\%$, then small percentage difference;
- MAPE value $\geq 6\%$, then large percentage difference.

When evaluating the presented model, it is advisable to take into account Multiple R-squared, Adjusted R-squared and p-value. Table 5. shows the values related to the demonstration. This is the basis for comparing the other prediction algorithms in ongoing research.

Table 5. Average multiple R-squared, Adjusted R-squared and p-values

Case	Method	average Multiple R-squared	average Adjusted R-squared	average p-value
Production planning	MLR rolling horizon	0.7554	0.6800	0.00061
	MLR cumulative	0.7937	0.7826	2.2e-16
Industrial investment	MLR rolling horizon	0.7374	0.7178	2.2e-16
	MLR cumulative	0.7916	0.7829	2.2e-16

The analysis so far suggests that in some cases there may be a potential advantage of the cumulative method over the rolling method. Further way of more accurate prediction of OEE is to combine Multiple Linear Regression rolling horizon and Multiple Linear Regression cumulative method in each cycle.

6. DISCUSSION AND CONCLUSIONS

At the domain of automotive industry, it is particularly important that the monitoring of production performance and efficiency takes place in real-time mode, and that the related data-based forecasting also works quickly, in detail and reliably. Based on machine learning, efficiency metrics, such as Overall Equipment Effectiveness (OEE), can be partially predicted, but industrial companies need more accurate and reliable tools or methods. Monitoring and evaluation the performance of production units on a shift level, daily, weekly and monthly basis is important in several aspects.

In order to emphasize the relevance of prediction, it is necessary to know exactly what kind of cost impact one percent OEE increase has on the operation of the given organization in the case of semi-automatic assembly lines or hybrid assembly lines. The authors revealed different machines conversion costs based on real industrial example.

This paper presented a new adaptive predictive model through assembly lines to predict efficiency by discovering patterns and generating prediction functions. The model can be used in general for all production lines or individual machines where production data is recorded by Manufacturing Execution System (MES) or other Enterprise Resource Planning (ERP) systems. The main elements of the demonstrated model were the sample taking for T_i period, running analysis, generating a new prediction function and discarding the previous one, update and modification of prediction function, update and modification of prediction function, assigning a prediction function based on pattern catalogue, OEE prediction and validation of chosen time period. In addition to all this, the schematic structure of the pattern catalog was also presented.

This article presented in detail the operation of the adaptive predictive model through a practical example using Multiple Linear Regression as supervised machine learning. The application of the model was demonstrated parallel with two cases, the first one for production planning for a shorter period, the second one for industrial investment for a longer period on the same semi-automatic assembly line and over a similar time period. The experiment is based on real numbers at the area of seat structure assembly. The model was evaluated by three main metrics as Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE) and Mean Squared Error (MSE). The main

conclusion is that the model works reliably in terms of OEE prediction however the combination of rolling horizon and the cumulative prediction method could be a more accurate estimation.

The authors plan to further develop the adaptive predictive model with applying other supervised machine learning methods amongst other polynomial regression and support vector machine prediction. Future research could be comparing the prediction function and sample catalog of different production areas and exploring regularities.

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Recommendation System Algorithms for Different Sizes of Datasets

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Abstract

In this paper, we provide an in-depth analysis of various recommendation system algorithms used for movie datasets. With the surge in digital media consumption, personalized recommendations have become critical in enhancing user experience and engagement. We begin by reviewing traditional collaborative filtering techniques, content-based filtering, and hybrid methods, highlighting their strengths and weaknesses in dealing with scalability, sparsity, and cold start problems. In particular, we perform a comparative study of three recently proposed algorithms on a popular movie dataset, MovieLens. For the comparison purpose, we use two versions of this dataset: One with 943 users, the other one with 6040 users. We evaluate their performances based on the accuracy of the recommendations done by the model. The recommendation system studied in this article is shown to work with both small and large datasets. The numerical results of different models can be used in recommendation systems in smart city applications that are expected to work on datasets of different sizes.

Keywords: Recommendation system, movie recommendation, KNN, SVD, knowledge-based algorithm

1. INTRODUCTION

Recommendation systems can play a crucial role in the development and functioning of smart cities, impacting various sectors and services to improve the quality of life for residents. They can provide personalized travel suggestions based on user preferences, real-time traffic conditions, and public transportation schedules. It can be utilized to suggest personalized health and wellness advice to residents based on their health data. They can also be used to optimize healthcare resource allocation, such as recommending the nearest available health facilities or doctors based on a patient's condition. Recommendation systems can help tourists and residents discover local attractions, events, and businesses tailored to their interests, which can boost local economies and improve visitor experiences. It can suggest optimal energy usage patterns to households and businesses based on factors like usage history, weather forecasts, and peak demand times. The local government services may be prioritized based on residents' feedback and needs, improving the quality and efficiency of public services. It can propose optimal waste collection routes or schedules based on real-time data, improving the efficiency of waste management. By integrating recommendation systems into these various sectors, smart cities can enhance the personalization and efficiency of their services, ultimately leading to improved quality of life, sustainability, and urban efficiency. Smart city applications often deal with vast amounts of data. These datasets stem from a wide range of sources, including IoT devices, sensors, surveillance systems, transportation systems, and citizen-generated data. All these datasets, often collected in real-time, are of considerable size due to the large number of data points and the continuous nature of data generation in a smart city context.

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The performance of recommendation system algorithms is significantly influenced by the size of the datasets they process. When working with small or medium-sized datasets, simpler algorithms such as user-based or item-based collaborative filtering can yield satisfactory results. They operate well within a manageable computational space and can effectively capture the relationships between users and items. However, as the dataset size increases, these algorithms face challenges related to scalability and sparsity. Large datasets often lead to increased computational complexity, making it difficult for these algorithms to process data efficiently. They also tend to be sparse, with users interacting with only a small subset of items, which can result in less accurate recommendations. Hence, the choice of recommendation system algorithm should be tailored to the dataset size for optimal performance.

In this paper, we compare the performance of three types of recommendation system algorithm on two size of movie datasets, MovieLens [10]. We evaluate their performance based on the accuracy of the movies recommended. The results provide valuable insights into algorithmic performance, offering guidelines for selecting suitable recommendation system algorithms for datasets with similar characteristics.

The rest of the paper is organized as follows: Section 2 presents the details of the used datasets, main types of recommendations systems and used algorithms in this paper. After giving the numerical results in Section 3 and discussing the results, the paper is concluded in Section 4.

2. METHODOLOGIES

In this section, the datasets and methodologies that are used in the numerical applications are presented. The code samples are presented to guide those, who require replicate our study.

2.1. Dataset

The MovieLens dataset is a collection of movie ratings and reviews that has been widely used as a benchmark dataset for recommendation system research [10]. GroupLens Research at the University of Minnesota gathered the dataset across a range of time in 1998 and it has undergone numerous updates since then. It consists of a number of datasets of various sizes. The size of the MovieLens dataset is one of its advantages because it enables researchers to create and analyse recommendation systems on an enormous scale. Numerous research papers have utilized it, including those looking at collaborative filtering, content-based filtering, and hybrid recommendation systems as well as machine learning, and deep learning algorithms.

The first dataset created in 1998 was called MovieLens 100K (ML-100K). It has been used as a benchmark dataset for many works in literature. It involves 1682 movies and 943 individuals along with 100,000 ratings. Despite being significantly smaller than the dataset’s more recent forms, it is still popular among researchers. It is also one of the benchmark datasets used for comparison purposes. Two datasets used in this project are downloaded in a zip format, with the following files (Table 1 and Table 2). The comparison of two datasets in terms of the number of users, movies and giving ratings is summarized in Table 3.

Table 1. Detailed dataset information (ML-100K)

Folder Name	Content	Shape
u.data	UserID, MovieID, rating, timestamp	(100000, 4)
u.info	Info about dataset (number of users, items, ratings)	3x1
u.item	MovieID, movie title, release date, video release date, IMDB URL, movie genre	1682x24
u.genre	Movie Genre List	19x1

Table 2. Detailed dataset information (ML-1M)

Folder Name	Content	Shape
ratings.dat	UserID, MovieID, rating, timestamp	(1000209, 4)
users.dat	UserID, Gender, Age, Occupation, Zip-code	(6040, 4)
movies.dat	MovieID, title, genres	(3883, 3)

Table 3. Summary of datasets' characteristics

Dataset	Users	Movies	Ratings
MovieLens 100K (ML-100K)	943	1682	10 ⁵
MovieLens 1M (ML-1M)	6040	3706	10 ⁶

2.2. Main Recommendation Techniques

The algorithms and methods used by recommendation systems are numerous. Because of their ability to enhance the user experience, these systems have recently grown in popularity. In literature, there are three main classes of recommendation systems: collaborative filtering, content-based filtering, and hybrid filtering. Before moving onto the approaches used in this paper, this section explains briefly the main methods of recommendation systems to understand their differences. The figure below illustrates the types of recommendation systems.

Collaborative filtering recommends items based on user behaviour and patterns [3, 8]. It examines user activity to find comparable users and their preferences. Once the similar users are identified, the system then proposes items that previous customers, who have similar preferences have enjoyed or bought. The collaborative filtering recommendation systems can be divided into three groups: Memory-based, model-based, and hybrid methods. Memory-based filtering analyses the commonalities between the target user and other system users. Different algorithms can be used to integrate the interests and preferences of neighbours or past behaviour of users to obtain product recommendations once the neighbour or the group of users has been identified. Memory-based filtering can be divided into two in itself: *user-based* and *item-based*. User-based filtering recommends items based on the preferences of users who are similar to the target user. It considers the similarity between users and searches for patterns. On the other hand, item-based filtering deals with the similarities of items and recommends similar items that are similar to the user's previous interest. Thus, item-based is interested in the similarity between items, whereas user-based deals with the similarity of users.

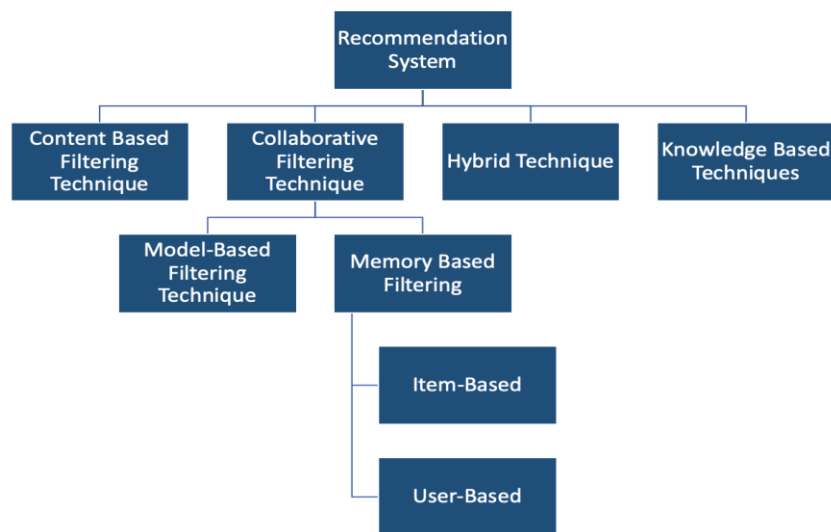


Fig. 1. Recommendation systems

Content-based filtering techniques analyse the items and a user's behavior [4, 5, 8]. User's previous preferences are stored in a user profile. An item is analysed to determine the similarities with the user's profile and previous choices so that the system can recommend items that the user has already liked.

Hybrid filtering technique combines recommendation techniques to leverage the strength of different approaches to obtain better recommendation and to overcome the setbacks one algorithm [8]. There are different means to merge different methods to create a hybrid filtering technique.

2.3. Algorithms used in the Numerical Applications

2.3.1. Singular Value Decomposition (SVD)

Singular value decomposition (SVD) is a method for data reduction [6]. In mathematics, SVD is the factorization of one matrix into three different matrices [7]. It is a matrix factorization technique, where A is a $m \times n$ shape rectangular utility matrix, where m rows are the movies, and the n columns are the users. The utility matrix is created in a way that it would be consistent and compatible for SVD calculations [11]. The algorithm reduces dimensionality, while providing the important latent features. For computing SVD, for the prepared matrix we used NumPy library (Figure

```
##Singular Value Decomposition
U, S, V = np.linalg.svd(filled_matrix)
```

2) [7]:

Fig. 2. Code piece to compute SVD

In the code piece (Figure 2), U stands for the relationship between the users and latent factor, S is the strength of each latent factor, and V is the similarity between movies and the latent factors. The algorithm reduces the dimension of the matrix A by extracting its latent factors.

2.3.2. K -Nearest Neighbors (KNN)

Collaborative filtering is a well-known algorithm, which aims to suggest products to users having similar interests by filtering out content based on the user's similarity of interest with other users [3]. Both item-based collaborative filtering and user-based collaborative filtering methods are frequently used for recommendation systems. In this paper, a user-based collaborative filtering approach was applied on MovieLens data. The approach works with the KNN algorithm to calculate the distance between users. The KNN is a semi-supervised learning approach that uses distance calculations to discover the k nearest data [1]. It is a popular algorithm in fields like medicine, data mining, and financial modelling. Fix and Hodges created the KNN rule, a non-parametric pattern categorization algorithm, in a 1951 US Air Force School of Aviation Medicine study that was never published [9]. It calls for training data and a predetermined k value [2]. It is relatively simple but efficient and adequate supervised machine learning algorithm. Generally, it is used for classification tasks where the main objective is to group the labelled elements into consistent groups or clusters so that the new data would be assigned to relevant groups. In other words, the class to which the input belongs is determined by its closest neighbours. The process can be divided into two steps; where the first step is learning, and second step is assessment. To begin with, the algorithm needs training data to build a classifier. Once the classifier is ready, KNN algorithm determines in which cluster the new, unlabeled input will be put [2].

In this paper, after the dataset is prepared for modelling, we pivot the data frame, where rows represent users, columns represent movies, and the cell values are ratings. Since not all users watch all movies, there will be lots of zero cell values. Besides, the matrix is transformed into a SciPy sparse matrix, and it is fed into the KNN model. Once the model is ready, we are able to find the Top n similar users to any given input user. For instance, if we give the model the user 5, as in Figure 3, the algorithm will return Top n (5 in this case) users with similar interest and minimum

distance to the input user.

Fig. 3. Code piece to compute KNN for giving the Top 5 movies for the user

```
Few of movies seen by the User:
['Amityville Horror, The (1979)',
 'Angels in the Outfield (1994)',
 'Apocalypse Now (1979)',
 'Apollo 13 (1995)',
 'Austin Powers: International Man of Mystery (1997)',
 'Babe (1995)',
 'Back to the Future (1985)',
 'Blues Brothers, The (1980)',
 'Chasing Amy (1997)',
 'Clerks (1994)']
Top 5 users who are very much similar to the User- 778 are:
1 . User: 124 separated by distance of 0.4586649429539592
2 . User: 933 separated by distance of 0.5581959868865324
3 . User: 56 separated by distance of 0.5858413112292744
4 . User: 738 separated by distance of 0.5916272517988691
5 . User: 653 separated by distance of 0.5991479757406326
```

In the dataset ML-100K, the weights are assigned to all ratings by similar viewers depending on their distance from the given user. Doing this, the movies that were already seen by the input user were eliminated. The model functions as in Figure 4 and Figure 5. A movie name and the needed number of movie recommendations are entered as input. The model recommends n similar movies to the user.

```
Enter the Movie name: titanic
Entered Movie name is not matching with any movie from the dataset . Please check the below suggestions :
['Chambermaid on the Titanic, The (1998)', 'Raise the Titanic (1980)', 'Titanic (1953)', 'Titanic (1997)']
Enter the Movie name: Raise the Titanic (1980)
Enter Number of movie recommendations needed: 5
Top 5 movies which are very much similar to the Movie- Raise the Titanic (1980) are:

Killer: A Journal of Murder (1995)
Shadow Conspiracy (1997)
Topaz (1969)
Amityville II: The Possession (1982)
Better Living (1998)
```

Fig. 4. 1M Code piece to compute

```
Enter the Movie name: titanic
Entered Movie name is not matching with any movie from the dataset . Please check the below suggestions :
['Titanic (1997)']
Enter the Movie name: Titanic (1997)
Enter Number of movie recommendations needed: 5
Top 5 movies which are very much similar to the Movie- Titanic (1997) are:

Good Will Hunting (1997)
Contact (1997)
Apt Pupil (1998)
Tomorrown Never Dies (1997)
Air Force One (1997)
```

Fig. 5. 100K Code piece to compute

2.3.3. Knowledge-based algorithm

Knowledge-based recommendation systems (KBRS) utilizes information about both users and products to adopt a knowledge-based strategy for providing recommendations. This system makes use of reasoning to determine which products fulfil the user's specific needs and preferences [4]. The recommendations produced by a KBRS are based on the domain knowledge. The conduct of other users will not be considered at all, or if it is, it will not be used as the primary factor in determining the recommendation. Instead, a user will receive recommendations based on his specific profile. Therefore, it could be a simple solution for the cold-start problem [5]. In this paper, we make recommendations by using the item and rating data. The movies are listed in decreasing order to see the highest rating movies. The

movies that have more than 300 viewers are treated as ‘popular’. For a new user the best movies to recommend are the ones with the highest ratings and the ones we considered popular. For this work, we consider the movies with 300 viewers that have more than 4 ratings and suggest them to a new user. Moreover, we consider the movie genre and ask the user to give the genre of movie they want to watch as input. For instance, if a user were to select ‘Comedy’ as the movie genre, they will get movie recommendations based on rating, number of users watched and both.

2.3. Proposed Recommendation Framework

In the data pre-processing step, the dataset files mentioned in Section 2.1 were analysed and transformed. Since the Movielens datasets were thoroughly cleaned by GroupLens, we worked on preparing the final dataset. First, by using the necessary files, data frames were formed, and several data frames were merged by unique *user_id* or *movie_id* fields. There were some instances, where one user have different ratings to the same movie in different timestamps This caused duplicate values in the ML-100K dataset. For eliminating this issue, the average of the ratings were taken by the same user for the same movie. An example can be found in Figure 6. As seen, the user 13’s ratings were 4 and 5 for the same movie in different times and it resulted with one movie getting to ids. Since it would cause problems in the future calculations the average rating was calculated (Figure 7).

user id	movie id	rating	timestamp	movie title
13	305	4	881514811	Ice Storm, The (1997)
13	865	5	882141425	Ice Storm, The (1997)

Fig. 6. Duplicated data example

user id	movie title	rating
13	Ice Storm, The (1997)	4.5

Fig. 7. Merging duplicated data

3. NUMERICAL RESULTS

For the KNN model, the results for ML-100K dataset recommend movies that are created in years that are close to each other. On the other hand, when the recommended movies and their cosine distances were analysed, we realised that the cosine distance of recommendations are considerably small. One reason for this is that the movie-user matrix involves many zero values, hence there is a data sparsity problem. The distance between similar and opposite items is bigger than expected. The same issue exists with the ML-1M dataset, however its effects are smaller. In many examples from the ML-1M dataset, the distances between similar items are usually slightly smaller and the recommended movies are more diverse in terms of creation years.

```

Enter the Movie name: back
Entered Movie name is not matching with any movie from the dataset . Please check the below suggestions :
['Back to the Future (1985)', 'Backbeat (1993)', 'Best of the Best 3: No Turning Back (1995)', 'Empire Strikes Back, The (1980)', 'Hunchback of Notre Dame, The (1996)', 'Switchback (1997)']

Enter the Movie name: Empire Strikes Back, The (1980)
Enter Number of movie recommendations needed: 6

Top 6 movies which are very much similar to the Movie- Empire Strikes Back, The (1980) are:

Star Wars (1977)
Return of the Jedi (1983)
Raiders of the Lost Ark (1981)
Man Who Would Be King, The (1975)
Ghost in the Shell (Kokaku kidotai) (1995)
    
```

Fig. 8. ML-100K dataset for SVM model with the movie The Empire Strikes Back (1980)

SVD models for both datasets include matrix factorization. Even though it is considered as an effective method for recommendation, this method is weak against the cold start problem, since it did not have a feature vector or embedding for the new objects. Another problem with this approach is that for both dataset the recommended items are usually the movies that are very popular in general. For some cases, the model recommends movies that are popular instead of recommending specific user interests. Figures 8 and 9 show the recommendation made for the movie ‘The

Empire Strikes Back (1980)’. The recommended Top 3 movies are the same for both datasets. Those movies can be considered as relevant to the input movie. However, it is undeniable that those movies are also very popular movies and often recommended. This issue is considered as one of our future work for handling.

```

Enter the Movie name: Empire Strikes Back, The (1980)
Entered Movie name is not matching with any movie from the dataset . Please check the below suggestions :
['Star Wars: Episode V - The Empire Strikes Back (1980)']

Enter the Movie name: Star Wars: Episode V - The Empire Strikes Back (1980)
Enter Number of movie recommendations needed: 6

Top 6 movies which are very much similar to the Movie- Star Wars: Episode V - The Empire Strikes Back (1980) are:
Star Wars: Episode IV - A New Hope (1977)
Star Wars: Episode VI - Return of the Jedi (1983)
Raiders of the Lost Ark (1981)
Man from Down Under, The (1943)
Bonheur, Le (1965)
    
```

Fig. 9. ML-1M dataset for SVM model with the movie The Empire Strikes Back (1980)

movie title	rating
Close Shave, A (1995)	4.520548
Wrong Trousers, The (1993)	4.507937
Wallace & Gromit: The Best of Aardman Animation...	4.426941
Grand Day Out, A (1992)	4.361522
Creature Comforts (1990)	4.335766
Toy Story 2 (1999)	4.218927
Princess Mononoke, The (Mononoke Hime) (1997)	4.147826
Toy Story (1995)	4.146846
Ghost in the Shell (Kokaku kidotai) (1995)	4.089172
Iron Giant, The (1999)	4.047478

Fig. 10. ML-100K dataset for knowledge-based model with the movie genre: Animation

movie title	rating
Close Shave, A (1995)	4.491071
Wrong Trousers, The (1993)	4.466102
Wallace & Gromit: The Best of Aardman Animation...	4.447761
Faust (1994)	4.200000
Grand Day Out, A (1992)	4.106061
Toy Story (1995)	3.878319
Aladdin (1992)	3.812785
Winnie the Pooh and the Blustery Day (1968)	3.800000
Beauty and the Beast (1991)	3.792079
Lion King, The (1994)	3.781818

Fig. 11. ML-1M dataset for knowledge-based model with the movie genre: Animation

The third approach, a knowledge-based recommender system, proposes recommendations by using the items and their rating without any user data. Movies are recommended firstly by simply using the ratings. The system recommends the highest rated movies, while grouping them by the genre. Since we have not used any additional data, the recommended movies in both datasets are mostly very similar or same for many genres. Figure 10 and 11 illustrate the knowledge-based recommendation systems results. Both models suggest very similar movies, since the model aims to recommend movies to the new users and it is based on top average ratings.

4. CONCLUSION

This paper has explored the performance difference of three algorithms proposed for recommendation systems through the analysis of small and large-scale datasets. We highlighted the direct correlation between the size of the dataset and the performance of the recommendation system algorithms. Our comparative study uses the MovieLens dataset of two different sizes. The datasets were prepared by the same group, hence it can be considered as very similar.

The results reveal that for the knowledge-based approach both datasets gave quite similar results. On the other hand, for KNN model, in the ML-1M dataset the distances between similar items are usually slightly smaller and the

recommended movies are more diverse in terms of creation years. KNN is a user-based or item-based collaborative filtering algorithm. It works by finding the users who are most similar to the targeted user (user-based) or items that are most similar to the targeted item (item-based), and recommends items based on these similarities. KNN performs moderately well because the dataset is relatively dense (many movies have a good number of ratings), which is favorable for a KNN approach. However, it may still suffer from the cold start problem like SVD, where it struggles to provide recommendations for new movies or users that have little to no ratings.

The results offer valuable insights into algorithmic performance, providing guidelines for selecting appropriate recommendation system algorithms for datasets with similar characteristics. In the broader perspective of smart cities, these insights can help enhance the personalization and efficiency of services, leading to improved quality of life, sustainability, and urban efficiency. We anticipate that these findings will foster further research into refining recommendation algorithms and their applications within smart city frameworks, contributing to the continued evolution of smarter, more responsive urban environments.

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Direct and Indirect Effects of Governance Indicators on Economic Performance: MIMIC Model Estimation

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Abstract

In the applied economics literature, many models and theories have been created from past to present to explain economic changes and developments. When examined historically, it is noteworthy that these models sometimes try to explain economic events by isolating them, while sometimes they try to explain by including other branches of science such as political science, sociology and law. In this study, economic performance was examined by taking into account the governance indicators indicated by the institutional economic approach. To this end, the direct and indirect effects of control of corruption, government effectiveness, political stability and absence of violence, regulatory quality, rule of law, and voice and accountability indices on economic growth, inflation and exchange rate were analyzed by structural equation models. In this context, two different MIMIC models were estimated for Turkey by using the series covering the period 1996-2021. According to the results of the first model estimation with six governance cause variables and three economic indicators, it has been determined that the latent governance indicator has a positive effect on inflation and exchange rate, while it has a negative but not statistically significant effect on growth. When the indirect effects were examined, it was seen that inflation and exchange rate are negatively affected by government efficiency and corruption control, and positively by regulatory quality. The results of the second model with three governance cause variables (control of corruption, government effectiveness, and regulatory quality) and three economic indicators revealed that the latent governance indicator has a positive effect on inflation and exchange rate and negatively affects economic growth. The indirect effects for the second model, different from the first model, showed that government effectiveness and control of corruption positively affect economic growth, while regulatory quality negatively.

Keywords: governance indicators, economic indicators, mimic model, bootstrap

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Using Economic Fitness and Economic Complexity Indices to Evaluate the Economic Development of BRIMC-T Countries

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Abstract

A countries economic performance production technologies and development processes cannot be evaluated by using only economic growth data. The newly developed criteria measure the quality of industrial systems, their ability to produce complex products and their technological structure necessary to produce them. Economic complexity index and economic fitness index are among them. While an increase in a country's economic fitness means more growth and further development, an increase in the economic complexity index indicates higher production capacity of a country. These economic indices show the ability of countries to diversify products and produce complex products competitively on a global scale. The aim of this study was to determine whether the rule of law and political stability, which are important determinants of institutional structure, as well as economic growth, high technology exports, foreign direct investment, number of patents and population density had an effect on the economic fitness and economic complexity indicators of countries. In this context, the interaction between the annual frequency series between 2006-2019 in Turkey and emerging market economies in Brazil, Russia, India, Mexico and China were investigated using panel data econometrics. According to the results of the random effects model in which unit and time effects were valid, GDP, population density, rule of law, foreign direct investments affected economic fitness significantly and positively. However, no statistically significant relationship was found between high technology exports, political stability and number of patents and economic fitness indicator. On the other hand, according to the results of the second model in which the unit effect was random, while GDP and number of patents affected the economic complexity index positively, high technology had a negative effect and no statistically significant interaction was found between other remaining variables and the economic complexity index.

Keywords: Economic fitness, economic complexity index, panel data.

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Police Legitimacy in Relation to Equality, Diversity and Inclusion: An Analysis of a Strategic Plan

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Abstract

It has been argued that the legitimacy of criminal justice is not static but rather operates in a state of flux in terms of a dialogue between power holders and their relevant audiences Bottoms and Tankebe (2012). This dialogic perspective has recently been the subject of empirical investigation with respect to the use made of social media by the police service in Scotland (Ralph, 2022). This paper reports on a study that also examine the way in which police legitimacy is dialogical with a wider public. However, in this case that public is much more amorphous in terms of being the public-facing nature of a strategy document on equality, diversity and inclusion (EDI). Here the public nature of the document sets out how the police service itself will incorporate EDI into its own internal operations as well as how it will adopt this in policing within communities. This is set within the context of a legitimacy crisis in policing in the UK and specifically in this case in Scotland. Several high profile cases have been reported in the media that have raised serious concerns about the culture of policing in terms of racism and sexism. The response to this has been to formulate a strategic plan to tackle this culture. The paper examines the ways in which this strategic plan seeks to repair or overcome that legitimacy crisis in terms of the rhetorical deployment of particular discourses within the document. The result is a document that seeks to reassert the power-holder status of the police with respect to their authority over citizens.

Keywords: police, equality, diversity, inclusion, legitimacy, strategy

1. INTRODUCTION

Organisations depend upon legitimacy for their maintenance and continuation (Dowling & Pfeffer 1975; Meyer & Rowan 1977; Ashforth & Gibbs 1990; DiMaggio & Powell 1983, 1991; Oliver 1991). Suchman (1995: 574) provides useful definition of legitimacy as “a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions”. As Ogden and Clarke (2005: 314) point out legitimacy is very much related to issues of perception by an organisation’s public and is therefore a subjective construct.

In terms of policing, legitimacy is vital to the way which citizens accept police authority and compliance with the law (Tyler 2011, Mazerolle et al. 2013). The police are a highly visible organisation in terms of their presence in citizens’ lives and their legitimacy depends upon the public’s perception that they operate in a fair and impartial manner. Moreover, they are also expected to uphold this through adopting the principles of equality, diversity and inclusion.

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Bottoms and Tankebe (2012) have suggested a dialogic approach when considering criminal justice. They argue that is an ongoing dialogue between power-holders in the system and their audience. In terms of policing police officers can be considered as the as power-holders and citizens as the audience. Bottoms and Tankebe (2012) theorise that power-holders will seek to produce and justify their own legitimacy prior to engaging with their audience. This constitutes the discursive process in which legitimacy may change over time in terms of the acceptance of police by citizens. Ralph (2022) drew upon Bottoms and Tankebe's (2012) dialogic approach to legitimacy in a study of how the police utilise social media. This study found that police officers construct legitimacy on social media through drawing upon the twin pillars of the credibility and expertise of the police. Citizens evaluate police legitimacy on social media in terms of their understanding of encounters with the police and if this leads to a challenge to their authority then police officers at times seek to reconstruct and re-establish their legitimacy. This study reveals the dynamic interplay between the police and citizens in mapping out the shifting terrain of legitimacy and police authority.

However, it is also possible to study this dialogic process at play within the ways in which the police construct their legitimacy through the public-facing documents they produce. As with most large-scale public organisations, the police produce documents in the form of plans and strategies designed to communicate the basis of their legitimacy. As Sklansky (2005: 1829) has pointed out, police internal policies and procedures provide an insight into how they view themselves. This can be thought of as their sense of self-legitimacy (Bradford & Quinton, 2014) in terms of how they wish to present the basis of their authority.

This paper examines the discourse of the current Police Scotland Equality, Diversity and Inclusion (EDI) Strategy document (2022) in order to show how this reveals the dialogic process at play as the basis for constructing legitimacy. It does so by looking at the internal and external drivers presented in formulating EDI policy at a time when police legitimacy is under question and public confidence in the police at a low point due to revelations about racism and sexism within the service.

The next section examines further the dialogic approach of Bottoms and Tankebe (2012) to policing, and in particular, the way in which the police service seeks to engage legitimate their power and authority through appealing to their engagement with the communities they serve. Following this the discursive analytic methodology undertaken in the study is explained as applied to Police Scotland's EDI strategy document. The findings are presented in terms of the ways in which the police seek to construct and communicate their legitimacy, and indeed draw attention to it, through their own internal procedures for EDI as well as external drivers from wider society. In this sense a dialogue can be seen as operating in the document as both internal and external discursive constructions of legitimacy are deployed.

2. POLICE LEGITIMACY

The legitimacy of the police service, in terms of their authority over citizens, is important given that it rests on public co-operation (Rix et al. 2009, Jackson & Bradford, 2010). If confidence is low, then citizens may not assist the police in their work leading to a lack of intelligence and consequent effects upon resourcing (Bradford & Jackson 2010a). On the other hand, a high level of confidence leads to greater engagement from the public thereby enabling the police to conduct their work more effectively.

Legitimacy and confidence, while being separate from one another, are nonetheless intertwined. (Bradford & Jackson 2010b). Police legitimacy confers the right to authority over the public but this in turn rests on trust. In situations where confidence in the police service is eroded, then this can lead to a lack of trust and ultimately a questioning of legitimacy. One of the main influences on legitimacy is procedural justice in terms of aspects such as police neutrality (Mazerolle et al. 2013). The police service can seek to improve confidence through improving community engagement and communication with the public (Tuffin et al., 2006). Ultimately, legitimacy is therefore rooted in a shared sense of values between the police and the public (Myhill & Quinton 2011). It is also the case that police operational effectiveness has less of an impact on public confidence than a sense that they act to defend and support societal norms and values (Jackson & Bradford 2009: 499). Some of these norms and values can become part of police policy and in turn be used to alter internal practices as well as how the police conduct their operations externally with the public (Macauley & Rowe 2020).

In recent times, confidence in policing in the UK and in Scotland has been eroded through a series of high-profile media cases where police officers have been convicted of committing serious sexual offences, including rape and murder, or where there have been inquiries into a culture of racism and misogyny in certain forces. For example, the

BBC reported on the 4th May 2023 a news story with the headline “Women describe Police Scotland 'boys club' culture”. The story goes on to report that:

“Four women have spoken to BBC Newsnight about allegations of a "boys club" culture at all levels of Police Scotland, the UK's second largest force. The women, who include a former assistant chief constable, described a culture of misogyny that failed to properly address their concerns. They say other women, still working in the force, are too frightened to come forward. Three of the women have spoken before about their experiences but have banded together because they feel their stories have been lost and there has been no measurable change in attitudes towards female staff in Police Scotland.” (BBC News Website, 4th May, 2023)

Another report by the BBC later in the month (23rd May, 2023) had the following headline: “Police Scotland: Racism, sexism and homophobia uncovered in review”. The story goes on to report that:

“A review of the culture within Police Scotland has uncovered first-hand accounts of racism, sexism and homophobia by serving officers. The review group, set up in 2021, heard instances of people being "punished" for raising concerns. It also heard the force's efforts to improve its culture are being held back by financial issues and pressure on frontline resources.”

“The independent review group was established by Police Scotland two years ago to examine its record on equality, diversity, inclusion and human rights. [...] It heard of poor behaviour being known and seen "in plain sight" with no action being taken, as well as a "vicious circle" of the personnel affected not having the confidence to report concerns, peers not speaking up and managers not taking action.” (BBC News Website 23rd May 2023)

The interim report (Scottish Police Authority, 2023) referred to in the media makes the point about police culture among those who have been in service for some time:

“There is a perception that attitudes within the service are still ‘catching up’ with society. Incoming probationers were said to be both more enlightened and more likely to speak up and challenge a traditional command and control culture. However, it was reported to us that this willingness to speak up and challenge ebbed away the longer officers stayed in the service.” (Section 4.2, p.7)

Against this backdrop of a serious risk posed to public confidence in the police and its legitimacy is an attempt by the service to address concerns that it must align itself with the values of EDI. In Scotland this has led to various strategic policy initiatives, more of which will be mentioned in the next section. Suffice to say at this point that the dialogic approach to criminal justice offered by Bottoms and Tankebe (2012) has been used as a key touchstone for the research reported in this paper. Their theorising covers the breadth of the criminal justice system, and this paper focuses on how their approach can be applied to examining EDI as a strategic direction for the police service and both internal and external discourses are apparent in the documents that address this.

Bottoms and Tankebe’s position is that legitimacy of criminal justice agencies takes place in a dialogic manner between power-holders and their audience. In considering policing, there are a range of power-holders in terms of the officers who comprise the force. The audience are the citizens of a liberal democracy who are subject to police control and authority but who nonetheless must grant the police the right to such authority. The power-holders must therefore justify their claim to legitimacy for citizens to respond to, either agreeing or disagreeing to such claims. The police must then in turn respond to the judgments offered by citizens and offer a response to them.

Bottoms and Tankebe (2012) go on to argue that understanding the self-legitimacy of those operating within the criminal justice system is also important. Power-holders engage in a process of justifying their legitimacy to themselves as well as their audience. This enables them to situate the rightness of their claim of authority within the system. Such claims to authority may change depending on how the audience responds. With respect to the police service, it is therefore important to understand how it seeks to justify its right to authority over citizens, particularly where public trust has been eroded. Bottoms and Tankebe (2012) also point to understanding audience legitimacy. In other words, this involves examining how the public perceive agencies within the criminal justice system and the judgments made concerning power-holder legitimacy. For the police this is vital given the need for trust and confidence in the service to operate fairly for all citizens.

The study reported on this paper considers how Police Scotland's EDI strategy is founded upon wider public audience given the recent erosion of trust and confidence in policing in general in the UK. A strategy document is examined in terms of its rhetorical construction to reveal the ways in which a public audience is kept in mind as the basis for police legitimacy.

3. METHODOLOGY

Reports and plans can be considered in terms of belonging to genres of communicative purposes Bhatia (2004). Police reports belong to a wider reporting genre while strategic plans can be considered as part of a colony of planning genres. It is of course possible that there is a combination of both in each document. Genres can be considered in terms of their communicative purposes and involve a set of rhetorical forms that reflect normative expectations associated of their intended audiences in terms of content and format (Bhatia, 2004; Swales, 1990). Cornut et al. (2012) point to the ways in which strategy documents have key features such as tone and grammatical construction. The legitimacy of the police service, in terms of their authority over citizens, is important given that it rests on public co-operation (Rix et al. 2009, Jackson & Bradford, 2010). If confidence is low, then citizens may not assist the police in their work.

In producing documents, organisations, in producing documents, do not have single author, although there may be an opening statement by the chief executive. Neither do they address an audience that is singular in manner or co-present audience (Cheney, 1992). Given that this is the case the rhetorical analysis of these documents requires an adaptation of dialogic forms of analysis, and most notably when organisations are 'faced with a challenge to their legitimacy' (Kuhn, 1997: 200). In such cases an analysis of the rhetoric deployed can analyse how discourses can be drawn upon flexibly to address an audience that is public but also generic, hypothetical or implied. It is here that there may be traces or vestiges of actual or assumed audience discourses that are being responded to.

It is also possible to combine this kind of analysis with a concern with the framing of issues and problems, in this case EDI. This requires a more critical analysis of discourse. I draw upon the work of Bacchi who argues that we need to direct "attention to the ways in which particular representations of 'problems' play a central role in how we are governed" (2009, p. xi). This is useful in considering how Police Scotland frame EDI issues and police responses. Taking up this critical discourse analytic perspective I consider the following questions: (i) How is EDI problematised in Police Scotland's EDI strategy document? (ii) What assumptions underlie the representation of problems associated with EDI? (iii) What rhetorical forms are drawn upon in the representation of these 'problem' and their 'solutions'? (iv) What is omitted or left unproblematic in these discursive representations? (v) What power effects are produced by representations of these problems and solutions?

This paper examines Police Scotland's Equality, Diversity and Inclusion Strategy (2022 – 2026) document. The analysis represented in the questions outlined above is undertaken through a focus on two sources of validation for police legitimacy vis a vis the EDI policy: (i) the first of these is what can be considered as internal sources of validation stemming from what the organisation itself sets as the basis of its strategy; and (ii) the second addresses what Police Scotland reflects from its audience or external factors that drive its focus on EDI. In this way the document can be considered as a reflection of Bottoms and Tankebe's (2012) claim regarding the dialogic nature of police legitimacy.

Police Scotland was established on 1 April 2013 as the single body responsible for policing across Scotland. It is the second largest police force in the UK after the London Metropolitan Police. It is comprised of thirteen local divisions with each being responsible for meeting local needs and priorities, although the overall strategic direction is centrally governed. Apart from the EDI strategy document, Police Scotland also provides an annual police plan which aligns with the strategic document. The analysis undertaken in this paper is part of a larger study of how Police Scotland is engaging with 'seldom heard communities'.

4. ANALYSIS

The analysis below is in two sections; one dealing with internal sources of validation for Police Scotland's EDI strategy, the other dealing with external sources based on the wider public audience. The analyses presented are given as exemplars that address the key questions outlined above.

4.1 Internal Statements of Validation

4.1.1 The listening organisation

In presenting itself as being in touch with its audience, the EDI strategy document presents Police Scotland as being engaged with its public as a ‘listening’ organisation but also one that can confront its own shortcomings:

“We have listened to our communities, including our own officers and staff, and of course all of us know policing is not immune from the challenges of racism, sexism, homophobia and discrimination.” (p.3)

This kind of statement has the rhetorical effect of offering the audience an admittance that policing has on occasion had problems with behaviour from its officers that fails in terms of police neutrality and indeed failure to embrace and promote EDI. Note the use of “all of us know” pointing to such failings as common knowledge. While such failings are acknowledged no specific instances are presented and the statement operates at a general level.

4.1.2 Legitimacy as an explanatory resource

Another form of internal voicing of EDI intent is to explicitly point to the need for confidence in the police service by the public and how this is related to legitimacy. In effect Police Scotland draw upon the concept of legitimacy as an explanatory resource for seeking to validate its own legitimacy with respect to EDI. Consider the following extracts from the strategy document:

“Effective policing is enabled and enhanced when all our communities have confidence in the police. Confidence to come forward; trusting that they will be listened to and treated fairly, with dignity and respect; assured that we will respond professionally, with high levels of operational competence.” (p.3)

“Police legitimacy is drawn from the bond of trust with our communities. Building and maintaining that relationship with all our communities is vital.” (p.3)

“Those with racist views do not belong in Police Scotland and they do not represent our organisation. Public trust and confidence are the central measures of our success and legitimacy – we will seek to strengthen these through developing the organisational culture we describe in this strategy and will not hesitate to act where racism takes place.” (p.11)

“Significant value is placed on policing in Scotland, and we have a strong bond with the public we serve. We stand in a unique position of trust where the onus is on our people to build and maintain the confidence of diverse communities. By remaining receptive to scrutiny and feedback from our partners, citizens and the communities we serve we can demonstrate ongoing transparency.” (p.15)

The above extracts demonstrate how Police Scotland rhetorically deploy the key terms such as “legitimacy”, “trust” and “confidence” that mirror academic work on police legitimacy. This kind of discourse sets out in an apparently open manner the basis for the power-holder status of the police and their authority over the public through the notion of legitimacy. Note how this is reinforced in these statements through reference to the close relationship between police and public in terms of a “bond” (“bond of trust”, strong bond with the public”).

4.1.3 The use of possessive pronouns

One of the most prominent ways of referring to legitimacy as deriving from an internal focus on EDI is through the use of possessive pronouns. This type of rhetorical construction can be found in the following examples:

“Our Policing Together strategy outlines the action we are taking to champion equality and inclusion so that we tackle sexism and misogyny and we become an actively anti-racist organisation.” (p.3)

“Our position on racism is, and always will be, that it has no place in society or in policing. We will be firm and progressive as we become an anti-racist organisation. Those with racist views do not belong in Police Scotland and they do not represent our organisation. Public trust and confidence are the central measures of our success and legitimacy – we will seek to strengthen these through developing the organisational culture we describe in this strategy and will not hesitate to act where racism takes place.” (p.11)

References to “our” strategy or position imply an internally-driven ownership of the drive to promote EDI in policing. Note also again the reference to legitimacy which is strengthened through the claim of not hesitating to act on racism. There is also an explicit avowal of an anti-racist stance which moves beyond police neutrality towards an active position against racism which is in alignment with the moral stance in other organisations and wider society.

4.1.4 Constructing culture

There are also broader statements about the nature of workplace culture, something that as has been noted has attracted media attention. The following is an example of this kind of statement:

“Police Scotland commits to building and maintaining a supportive workplace culture throughout our organisation where individual contributions and different perspectives are celebrated and valued. Our people should feel safe to express their full selves at work without fear of discrimination or other damaging consequences. Pockets of unacceptable conduct must be eradicated so that each and every division, department and team delivers a consistent experience for all colleagues.” (p.17)

What is notable about this statement is the focus “individual contributions” and the expression of “full selves” which is interesting for an organisation where discipline and procedural rules are key to operations. Note also the minimising rhetorical form deployed in relation workplace culture in terms of “pockets of unacceptable conduct”. This discursive construction plays down any wider concern about the overall culture of the organisation. The net effect is one of creating the impression of an organisation that values its workforce and that there is a concern with the “experience” of staff. This kind of internal focus could be considered as seeking to strengthen confidence in the police as they seek to put their own house in order, so to speak.

This view is further supported when considering how the document presents its case in relation to EDI and the representative nature of its police officers. In the following extract concerning the percentage of female police officers in the force there is a contrast rhetorical structure deployed:

“There is a similar drive to recruit female officers. Over the last five years, recruitment intake for females averaged 44.8% however, retention continues to be a problem. Of officers with five to ten years’ service, 33% are female compared to 67% male. We must do more to support people from under-represented groups past initial recruitment stages and throughout the life cycle of their careers.” (p.19)

What this kind of discursive construction achieves is to first point to the almost but not quite near parity of recruitment of female officers when compared to male recruits. Note that this is presented in terms of being an average over five years and therefore lacks specific detail on improving or declining levels of female recruitment. The next part of the statement is where the contrast structure becomes apparent by pointing the problem of retention of female recruits between five and ten years of service (“33% are female compared to 67% male”). Although this draws attention to the problem of female officer retention no specific reason is given for this situation. Instead, there follows a statement of intent that focuses on offering support at a wider level of “from people from under-represented groups” rather than specifically female officers. This kind of internally driven statement therefore manages to convey the impression of an organisation that is seeking to recruit more female officers but that the problem is one of “retention”. Retention is therefore placed as being the issue of concern without any further level of information and this leaves the way for this to be attributed to something other than a problem of organisational culture. It is worth noting the BBC report mentioned earlier in the paper of an alleged ‘boy’s culture’ within Police Scotland. Police culture has traditionally been known for being associated with hegemonic masculinity (Prokos & Padavic, 2002). This term was originally outlined by Connell (2005) in drawing attention to practices that maintain male domination and reproduction of inequality. Prokos and Padavic (2002) argued that a mythology is perpetuated in policing that masculine

characteristics are required for what is presented as a physically demanding and dangerous role to the exclusion of other aspects.

4.2 References to external drivers

The Police Scotland EDI strategy document contains several references to the public audience of the police in what can be considered as a means of addressing issues of trust and confidence in the police service, and ultimately its legitimacy. This external audience is included in several ways but in effect represents a way for the police to acknowledge that audience and its concerns. Thus while there is not an overt dialogic framing of the discourse in the document there is nonetheless vestiges of public discussion that impact upon EDI strategy as well as discursive constructions that externalise it rather than drawing from the police service's own motivation.

4.2.1 Responding to the media

Recent high profile media cases are cited where trust and confidence in the police service in general has been shaken and its legitimacy called into question. Example of this kind of discursive construction can be found below:

“The Black Lives Matter movement, which rose to prominence following the death of George Floyd, has highlighted the lack of trust some minority ethnic groups and individuals have in the police and called into question the legitimacy of actions taken by police officers across the world.” (p.11)

“The culture within policing has been the subject of widespread media coverage and in some cases criticism in recent years. Much scrutiny arose following the murder of Sarah Everard in the south east of England in 2021 by a serving officer from the Metropolitan Police Service. This event led many women to share their experiences with male officers and staff who not only hold misogynistic and sexist views but acted upon them.” (p.12)

There are several interesting features when considering the rhetorical construction of these statements. The first is that they refer to very high-profile cases that have attracted considerable media attention and have also social movements in reaction to both. In other words, these are extreme examples that are presented as a way into discussing EDI strategy. They are presented as touchstones for wider expressions of disquiet about racism and misogyny in the police service. In other words, they serve as examples that have circulated widely in public discourse and therefore are known to have been discussed and debated. The second point is that they are not directly related to Police Scotland but rather examples drawn from other police forces. Although they do represent instances of serious breaches of police conduct they effectively sidestep any consideration of a culture of poor police behaviour with respect to EDI issues. Finally, attention is drawn to how a lack of trust in the police by some ethnic minority groups has challenged “the legitimacy of actions taken by the police across the world”. This claim draws attention to the police service being aware of the associated point that power-holder legitimacy is under threat in terms of their authority over the public.

4.2.2 Constructing the ‘problem’ of wider society

One way referring to external discourses that affect EDI strategy is to point to wider societal issues such as misogynistic attitudes and behaviour by males in society. This can have the effect of deflecting and diluting the problem as it relates to the police service. An example of this Police Scotland's EDI strategy can be found in the following statement:

“Our external campaign, That Guy, launched with the focus on men accepting a greater amount of responsibility for their actions and the language they and other men around them use to help contribute to a culture change. To support the cultural changes our organisation requires, we will deliver an internal facing campaign to challenge and address unacceptable views and behaviour within the workplace.” (p.12)

What is striking about this statement is the way it points to an external concern in society with misogyny but then points to a campaign initiated by the police service to tackle this. The claim that “an internal facing campaign” is being adopted serves to situate the problem as being one that has been imported into the police service from wider society.

This points to wider concerns and conversations about misogyny in society and so does draw into the document external concerns. However, in so doing it diverts attention away from the legitimacy of the police service through their ability to uphold the moral values of that wider society.

4.2.3 Externalising EDI through pointing to statutory and regulatory frameworks

One way of drawing in external drivers on police conduct is to point to legal frameworks that proscribe their actions. An example of this can be seen in the following statement:

“We have a duty under the Equality Act 2010 to identify and work towards Equality Outcomes for our staff and the communities we serve. They provide a focus on key areas of Equality, Diversity and Inclusion to eliminate discrimination, advance equality of opportunity and foster good relations. In 2021 Police Scotland and the Scottish Police Authority set Equality Outcomes for 2021-23, and these have been embedded within the Strategic Outcomes set out within this strategy.” (p.6)

This kind of justification for adopting an EDI strategy externalises the source of this at the level of a statutory requirement. While this is indeed the case, it does not point to the agency of the police service in initiating this action but rather that they are acting in accordance with what is required of them.

A further example of this appeal to a regulatory framework can be found in relation to a statement made about the conduct of police officers in the service:

“Police officers take an oath of office, adhere to a code of ethics and must adhere to the Standards of Professional Behaviour. They are subject to a strict regulatory framework which is essential for the preservation of public confidence and the proper discharge of their duties as police officers.” (p.14)

“The Standards of Behaviour include the obligation to “report, challenge or take action against the conduct of other constables which has fallen below the Standards of Professional Behaviour.” Officers are expected to challenge colleagues who breach the standard of equality and diversity and exhibit racist or discriminatory behaviour, as are our staff.” (p.14)

We can again see how responsibility for police conduct is explained in terms of an “oath of office”, “code of ethics” and “Standards of Behaviour”. The effect of this is to set police conduct within codified rules, something external to them but which they must adhere to. Moreover, police officers are expected to “challenge colleagues who breach the standards of equality and diversity”. In effect officers must hold the code in mind when considering other officers’ conduct if it falls short of what is required.

Finally, another example of pointing to legislation as an external driver and justification for the EDI strategy can be found in the document through a recent citing Hate Crime Act:

“The HMICS report on Hate Crime said police officers and staff who have not been subjected to hate crime themselves do not understand the cumulative impact of multiple “minor” incidents on their colleagues. It was found that little support is offered to victims and repeat victims are not routinely identified. We must address these issues urgently if we are to truly understand the impact incidents of hate crime have on our people.” (p.19)

“The Hate Crime and Public Order (Scotland) Act 2021) will see updates to training programmes for officers and staff. A new curriculum was introduced for probationer training in December 2020 and will be updated to reflect wider training provision.” (p.20)

It is interesting to note that prior to mentioning the Act, reference is made to the effects of “multiple “minor” incidents” and its effects on officers. While stating that the must be addressed “urgently” it is interesting to note that it is framed in terms seeking to “understand the impact of hate crime on our people”. There is an incongruity between claiming that these are “minor” incidents and then applying the more serious term “hate crime”. Furthermore, the issue is framed as one of understanding rather than seeking to adopt a tone more in line with the adoption of morality and values. It only after this prefacing paragraph is given that the Hate Crime Act is introduced as a means of offering “updates to training programmes for officers and staff” with the introduction of a “new curriculum” for probationers.

Again, we see how this externalises the justification for introducing these changes rather than being constructed in terms of treating all officers as worthy of respect no matter what their gender, ethnicity, or sexuality.

5. SUMMARY OF FINDINGS

The findings presented through the above analysis show how the Police Scotland EDI strategy document is rhetorically constructed in terms of a dialogue between internally generated statements of intent and initiative, and external public audience concerns regarding the force. Both centre on the legitimacy of policing. The internal statements of validation make use of discursive constructions that refer to the police as a listening organisation; that make use of the notion of legitimacy as an explanatory resource for their focus on EDI; that use possessive pronouns to construct ownership of various EDI initiatives; and that point to a supportive workplace culture that values individual differences. The external drivers presented as address high profile media cases of police crime and misconduct as impacting on the public perception of EDI problems in the police service; that wider problems in society have permeated police culture or led to complacency; and that point to statutory and regulatory frameworks where EDI is externalized in some codified manner as the basis for action.

6. CONCLUSION

This foregoing analysis has highlighted how Police Scotland's EDI strategy document draws upon discursive constructions that seek to bolster their own power-holder authority through directly drawing upon the concept of self-legitimacy as a lay theory that is applied within the document. There is also a sense in which a dialogue between the police service and the public is apparent in the rhetorical construction of the document. Given recent events in which police officers have been found to have committed serious racist and misogynistic crimes, it is inevitable that trust and confidence the policing has been eroded. Moreover, press reporting of a racist and misogynistic culture in policing has also challenged its legitimacy to authority over citizens. It is little wonder therefore that the police service is well aware, and particularly at senior levels, of the threat posed to their legitimacy and that this should be addressed in their EDI strategy document. In some sense there is an ever-present audience: the wider public. These kinds of strategy documents are public-facing in the sense that the police service is accountable to the public they serve. As with any public body they are required to produce reports, plans and strategies that inform their audience of their aims, actions and issues in terms of being held accountable.

However, what is also apparent in the document is the way in which the rhetorical style deployed operates in such a way as to deliver statements of intent that appear to be firm and driven by the desire to attain EDI but nonetheless elides any acknowledgement that the culture of the institution is one where racism and misogyny thrive. In pointing to recent events where the police have been found to have officers who have committed serious sexual and racist crimes, Police Scotland draws upon extreme cases rather than a pernicious culture. The EDI strategy document also externalises the source of action by invoking statutory and regulatory legislation rather than seeking to tackle head on any failings of police culture at a wider institutional level. The net result is a document that is strong on the rhetoric of EDI and the police as part of the communities they serve but which nevertheless minimises the lack of progress on the issue by pointing to failings in terms of pockets of "unacceptable conduct". In the final analysis, it can be argued that Police Scotland's EDI strategy document is, in Bottoms and Tankebe's (2012), terms an attempt by the force to reassert its power-holder authority and legitimacy.

There is, however, a somewhat ironic postscript to this paper. As I am writing the final section there is a high-profile BBC report (25th May 2023) in which the Chief Constable for Police Scotland has given a press conference on racism and misogyny in the force. The headline is as follows: "Police Scotland chief says force is institutionally racist" and goes on to quote the Chief Constable:

"Speaking at a meeting of the Scottish Police Authority on Thursday morning, Sir Iain said: "It is the right thing for me to do, as Chief Constable, to clearly state that institutional racism, sexism, misogyny and discrimination exist."

"Police Scotland is institutionally racist and discriminatory. Publicly acknowledging these institutional issues exist in our organisation is essential to our absolute commitment to championing equality and becoming an anti-racist service."

"It is also critical to our determination to lead wider change and support wider change in society." (BBC News website, 25th May, 2023).

The irony in coming forward with this statement is that firstly, the Chief Constable is due to retire later this year on 10th August 2023 and so could arguably speak more candidly about this issue; and secondly that the EDI strategy document is just that: an exercise in writing in order to rhetorically construct a basis for the police service as a power-holder in terms of self-legitimacy. By complying with the genre of strategy reporting and its rhetorical construction, Police Scotland effectively create a public-facing edifice that maintains their legitimacy. Perhaps the last word should be given the Scottish Police Authority (2023) independent review who point to the growth of 'initiativitis', in terms of "a constant stream of initiatives, projects, activities, and communications" (Section 5.5, p.9). Writing policies and strategies is one thing, but a concerted will to tackle institutional police racism and misogyny is another. To do so requires that the police relinquish their efforts to maintain their power-holder status and to seek to change the culture of policing in the knowledge that legitimacy is earned and not simply asserted.

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Capturing Innovation and Inclusive Development Performance of European Countries

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Abstract

This study was performed to analyze the interactions and dependencies existing among the measures of innovation represented by the European innovation scoreboard and sustainability represented by the transitioning performance index. The results showed strong correlations within innovation measures whereas weak correlations were observed with transitioning measures, especially the interdependencies between environmental measures and other indicators for both performances. Also, based on the analysis, four combined and salient factors were determined for both measures as human capital, research and ICTs, financial capital, and linkages. However, again, indicators for environmental issues functioned as outliers not directly influenced by the factors. Using the initial combined variables, 4 clusters were developed and the movement of the means within individual cluster was observed. The results showed cluster 2 with more developed countries and higher count of countries and higher means of variables as opposed to cluster 4 with lower count of countries. Furthermore, cluster 3 was observed with more negative variable means. The results when combined with other cultural and geographical parameters and policies will provide more conclusive and responsive deductions.

Keywords: Inclusive development, Transitioning performance, Innovation performance, Europe

1. INTRODUCTION

Due to the growing interests in innovation and sustainability issues in most parts of the globe and especially Europe, as evidence in the various reports and databases dedicated to the area, it is relevant for studies to continuously investigate and expand the repertoire of discourse and arguments related to the fields. This increasing importance for European countries has sparked discussions on the relevance of National Systems of Innovation (NSI) and Regional Innovation Systems (RIS) as they relate to sustainability on innovation performance, and the various derivatives for these studies, and how to advance these desired results in the various territories. Previous studies have thus served as the milestones for development in this aspect Dworak, (2022). Because of technological developments and globalization, the content of economic development has shifted in the direction of competitiveness and innovation. Also, due to the positive effects of these changes, in particularly developing countries such as a significant increase in productivity and easier access to new resource markets, remarkable risks started to appear such as unemployment and recession UNCTAD (2003). Moreover, applied studies point to a high relationship between economic development and innovation performance because of factors such as globalization, increase in competition, rapid progress in information and communication technology, rapid scientific and technological developments, that propel companies towards innovating at a higher degree.

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According to the OECD handbook, an index looks at several separate indicators together for the purpose of summarizing multi-dimensional issues. Hence simply put, an index is a tool for understanding complex data quickly and efficiently and can be useful for both decision-makers and the general public. Moreover, indices constructed with a stable methodology can track progress over time. For this reason, the purpose of this study is to examine the relationship between the various markers for innovation and sustainability development by making use of the proxy indicators for the European Innovation Scoreboard and the Transition Performance Index. By examining the interactions between the indicators, the study aims to determine commonalities existing within the indices, with the intent to understand the innovation and transitioning interactions for European countries and establish a tentative grouping for the countries using a combination of these performance indicators. The study is organized as follows: a literature review on innovation and sustainability, particularly the European innovation scoreboard and the transitioning performance index which are the focus of the analysis. Next analysis of interdependencies existing among the measures and examining the common salient factors that may exist within the variables. Finally, an attempt to group countries using clustering methods to investigate the movement and interactions within specific clusters and finally draw conclusions on the study.

2. LITERATURE REVIEW

In literature, the notion of competitive modern economies is often referred to as knowledge economies where the production, distribution and use of knowledge and information is prevalent Dworak & Grzelak, (2017); Kostygova et al., (2019). In this vein, knowledge is referred to as human and technical capital, which are central to economic development. This importance ascribed to knowledge has been conducive to the emerging role of universities in literature. Sustainable development plays a central role in the creation of international and local strategies for most public and private organizations as well as countries and local governments Pawlonka (2019); Jones (2006) and as such, using sustainable development as a planning goal would require indicators that can assist policymakers in identifying appropriate policies as well as monitoring the effectiveness of said policy actions Gustavson et al. (1999) in Coelho et al. (2010). Indicators in themselves are becoming powerful tools with varying applications Parris & Kates, (2003) in Coelho et al. (2010), such as helping in assessing progress towards targets, highlight key policy initiatives needed, raising public awareness on target areas, educating the public and most importantly, ensuring transparency in different objectives Horvath et al. (2012); Satrovic & Muslija. (2019). According to Weingaertner and Barber (2011) a multi-dimensional approach of the term sustainable includes environmental sustainability as well as human welfare, and an economic understanding of man-made, natural, and human capital, and also coupled with social sustainability related to participation, equality and cohesion. There are notable studies attempting to investigate the level innovation and economic development for territories. Among which the work by Dworak (2022) uses the Hellwig synthetic measure together with in the Oslo Manual 2018 methodology to examine the level of innovation in the economic system for the years 2014 and 2019 is an example. This was a multidimensional statistical analysis to assess innovation and create a ranking system for countries belonging to 3 different innovation systems. Another relevant repository of innovation and development performance work is The European Commission's research and innovation platform. The main performance indicators include the European Innovation Scoreboard (EIS), Regional Innovation Scoreboard (RIS), the Science, Research, and Innovation Performance of the EU report (SRIP) and the Transitions Performance Index Research and Innovation Performance Indicators, (2023). Scoreboards and composite indicators are powerful tools for informing and mobilizing citizens in the EU and for monitoring the impact of national policies EU. (2020, 2022).

The study makes use of the European Innovation Scoreboard which comprises of a list of 32 indicators as of 2021 and provides a comparative analysis for countries in terms of innovation performance. It therefore enables countries to assess their strengths and weakness by targeting the indicators European Innovation Scoreboard, (2023). The Transition Performance Index (TPI) on the other hand uses four main dimensions namely economic, social, environment and governance that are deemed to accurately capture inclusiveness and sustainability. These dimensions finitely add up to a total of 28 comparable indicators that effectively capture the priorities of the European Commission towards meeting the Sustainable Development Goals Transitions Performance Index (TPI), (2023). With the advent of globalization, countries have begun to compete and have come to understand the importance of innovation in element of economic growth is and are beginning to allocate more resources to R&D investments. As such, those that want to achieve sustainable economic development and growth need to use all their resources effectively and efficiently. Sustainability has been one of the most issues in the formulation of policies, programs, plans, and projects. This is in part because of concerns about environmental quality and social exclusion in international political and scientific debates Zadoroznaja. (2010). Most of the indicators for this index are outcome-oriented to present a combined impact of the policy mix implemented in each country and does not present

geographical predetermination therefore there is no clear-cut North-South, East-West divide. Scoreboards have proved to have a powerful influence for informing and for monitoring the impact of national policies. EU. (2022). It uses comparable international data and covers countries which in total represent approximately 76% of the total population and provides a ‘beyond GDP’ approach that enables a comparison of country performances.

3. METHODOLOGY AND ANALYSIS

For the analysis, data for the year 2020 and 27 European countries are used. Innovation measures information is derived from the European Innovation Scoreboard and on the other hand, sustainability and transitioning measures are derived from the Transitioning Performance Index. The R data software is used for all analysis and hence all subsequent results are contingent on the above methodology premises.

3.1 Examining correlations among variables.

Table 1 examines the correlation coefficients observed among the variables. There are 16 variables in total used for the study. Higher interactions are observed among the variables for innovation measurement. The following are the abbreviations for the variables used in the correlation matrix; HR is human resources, ARS is attractive research systems, D is digitalization, F&S is finance and support, FI is firm investments, UIT is use of information technologies, I is innovators, L is linkages, IA is intellectual assets, EI is employment impacts, SI is sales impacts, ES is environmental sustainability, ET is economic transition, ST is social transition, ET is environmental transition and GT is governance transition. Particularly higher positive interactions are observed between human resources and attractive research systems and use of information technologies, as well as attractive research systems and use of information technologies. On the other hand, environmental sustainability and environmental transition has weaker correlations with the other measures of innovation and transitioning performance (except for environmental sustainability and intellectual assets of about 0.5). It can be inferred that variables with higher correlations experience higher interactions and interdependencies with each other and vice versa. Hence variables measuring environmental issues have low or almost negative associations with other measures of innovation and performance (e.g., economic and financial dimensions and their associations). Moreover, the measures for environmental sustainability have weaker interdependence with that of environmental transition.

Table 1: Correlation matrix for innovation and transitioning measures

	HR	ARS	D	F&S	FI	UIT	I	L	IA	EI	SI	ES	ET	ST	ET	GT
HR	1															
ARS	0.86 5948	1														
D	0.81 5598	0.75 565	1													
F & S	0.67 7263	0.74 3544	0.70 8376	1												
FI	0.53 2809	0.62 1715	0.40 4551	0.67 7066	1											
UI T	0.82 1179	0.83 5805	0.66 9069	0.62 2526	0.66 6276	1										
I	0.39 3608	0.50 2755	0.10 4598	0.52 4441	0.61 4235	0.47 6273	1									
L	0.75 6697	0.77 6653	0.53 5219	0.73 7709	0.63 4885	0.75 7232	0.75 4554	1								

IA	0.61 7002	0.72 7275	0.55 2705	0.67 2031	0.53 318	0.65 4296	0.47 4604	0.65 1379	1							
EI	0.66 5892	0.74 8604	0.40 6373	0.65 3848	0.66 6603	0.75 2297	0.88 0837	0.86 3879	0.69 09	1						
SI	0.37 4527	0.55 742	0.21 4034	0.39 2558	0.56 6525	0.62 1238	0.38 7606	0.39 8204	0.35 2466	0.56 3528	1					
ES	0.37 9299	0.48 8271	0.45 0732	0.33 7408	0.44 4369	0.44 061	0.22 2665	0.27 8999	0.51 4806	0.40 2684	0.42 0353	1				
ET	0.25 1615	0.32 9413	0.28 4066	0.26 7797	0.36 083	0.39 1224	0.11 7224	0.33 7689	0.29 4129	0.21 4994	0.32 3895	0.35 1984	1			
ST	0.08 1412	0.11 5323	0.18 2294	0.31 8809	0.36 5332	0.23 6609	0.11 751	0.16 9683	0.22 3285	0.11 6158	0.30 8087	0.28 416	0.73 2846	1		
ET	0.03 6048	- 0.03 193	0.16 1676	0.04 7834	- 0.08 865	- 0.00 558	- 0.23 86	- 0.02 644	- 0.04 224	- 0.16 916	- 0.14 233	- 0.10 802	- 0.08 397	- 0.22 452	1	
G	0.26 9194	0.30 5344	0.26 4124	0.25 8961	0.23 5072	0.30 6207	0.08 3967	0.30 9216	0.49 8785	0.22 3922	0.24 1517	0.28 604	0.82 2995	0.69 9776	- 0.2	1
T															934	

Source: Author’s own calculation with data from EU. (2020) and Transitions Performance Index (TPI) 2023.

Fig. 1 shows a color plot of the correlation matrix for better representation. Blue represents positive correlation and red represents negative correlation. The darker the color, the higher the score for the correlation. The figure makes it possible to clearly observe the positive correlations existing among the innovation measures and the negative correlations existing between most of the transitioning measures. Especially, negative interactions between measures of environmental transition and the innovation measures. Particularly weak interactions are observed between sales and employment impacts, transitioning measures and the rest of the innovation measures.

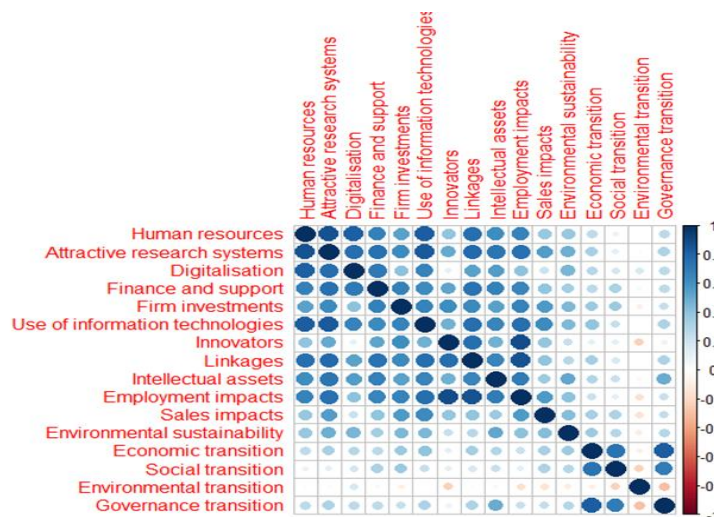


Fig. 1: Color plot of correlation matrix. Source: Author’s own calculation

3.2 Determining the underlining factors for both innovation and transitioning performance.

In the next sub-section, the study would like to investigate if it will be possible to find a set of common macro factors relative to both measures of innovation and sustainable transitioning using the proposed variables of the European innovation scoreboard and the transitioning performance index. Hence to determine the number of appropriate hidden factors, we will use the methodology of principal component analysis since the number of desired

factors will be considered equal with to desired principal components. Therefore, we will determine the appropriate number of first k principal components this way.

Table 2: Summary for principal components analysis

	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12	PC13	PC14	PC15	PC16
S	2.81	1.50	1.24	0.95	0.92	0.80	0.75	0.63	0.52	0.45	0.34	0.30	0.28	0.23	0.14	0.13
D	744	69	357	682	014	130	424	25	31	999	333	923	142	102	646	732
P. of V	0.49	0.14	0.09	0.05	0.05	0.04	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
C	0.49	0.63	0.73	0.79	0.84	0.88	0.92	0.94	0.96	0.97	0.98	0.98	0.99	0.99	0.99	1.00
P	61	80	470	192	483	496	052	55	26	585	322	920	415	748	882	00
a	7.93	2.27	1.54	0.91	0.84	0.64	0.56	0.40	0.27	0.21	0.11	0.09	0.07	0.05	0.02	0.01
	801	06	645	550	666	208	887	00	365	158	787	562	919	337	144	885

Source: Author’s own calculation

Based on the results for the principal components and the lambda values, it is determined to select 4 factors instead of 3 because we will want the cumulative proportion of explained variance (cumulative proportion) for the total original variance to account for more than 75%. With this selection, the first 4 components account for 79.19% of cumulative proportion instead of the first 3 components, which account for 73.47% cumulative proportion. The study will now analyze these factors to determine if there can be common hidden factor commonalities between the two measures of innovation and transitioning. SD stands for standard deviation, P.of. V stands for proportion of variance, CP stands for cumulative proportion and using the lambda values represented by the values for “a” shown in Table 2, we get the following results: $\lambda_1=7.9380 >1$, $\lambda_2=2.2706 >1$, $\lambda_3=1.5464 > 1$, $\lambda_4=0.9155 <1$, $\lambda_5=0.8466 <1$. The values for the first 3 lambda (λ_1 to λ_3) are greater than 1 and the principal components related to this 3 is what should theoretically be accepted.

Table 3: Standardized loadings (pattern matrix) based on correlation matrix for 3 factors.

	ML1	ML3	ML2	h2	u2	com
Human resources	0.93	0.03	0.09	0.87	0.125	1.0
Attractive research systems	0.91	0.10	0.22	0.88	0.117	1.1
Digitalization	0.88	0.11	-0.21	0.82	0.176	1.1
Finance and support	0.73	0.13	0.29	0.64	0.363	1.4
Firm investments	0.54	0.22	0.47	0.56	0.442	2.3
Use of information technologies	0.84	0.17	0.25	0.80	0.205	1.3
Innovators	0.33	-0.03	0.92	0.96	0.044	1.3
Linkages	0.72	0.11	0.55	0.84	0.160	1.9
Intellectual assets	0.68	0.23	0.30	0.60	0.402	1.6
Employment impacts	0.64	0.02	0.73	0.95	0.054	2.0
Sales impacts	0.42	0.23	0.32	0.33	0.665	2.5
Environmental sustainability	0.42	0.27	0.10	0.28	0.716	1.7

Economic Transition	0.24	0.88	0.07	0.83	0.168	1.2
Social transition	0.06	0.81	0.11	0.68	0.323	1.1
Environmental transition	0.11	-0.21	-0.30	0.15	0.852	2.1
Government transition	0.23	0.86	0.05	0.79	0.209	1.2

Source: Author’s own calculation

Tables 3 and 5 show the results of the factor analysis by setting the extraction method to be “maximum likelihood” and using the rotation method “varimax” which is normalized. We compare the loading results for 3 and 4 factors and determine which composite factors have the least number of outliers (thus, variables not explained by the 3 or 4 factors or with unexplained proportion of variance above the accepted theoretical margin of 0.3). ML1, ML2 and ML3 and ML4 represent both the correlation coefficient between the new factors and the variables as well as the proportion of the variables explained by the factors determined. H2 represents the proportion of the original variables explained by the new factors (ML1 to ML3 or ML4) while u2 represents the unique proportion of the original variables not explained by the new factors, with both summing up to 1 or 100% if expressed in terms of percentages. As a rule of thumb, we would like the h2 to be as high as possible and the u2 as low as possible. For the study, we set the maximum u2 value as below 0.3, which would mean at most 30% of the proportion of variance will be allowed to be unexplained by the new factors. Tables 3 and 4 will show the factor loadings and variables representations for 3 factors and tables 5 and 6 will show these results for 4 factors respectively.

According to table 3, in the case of the variable human resources for instance, the first factor, ML1 is the correlation between this factor and the human resources variable which is 0.93 as well as the proportion of the human resources explained by the first factor ML1 which is also represented by 0.93. The correlation between the second factor ML2 and human resources is 0.03 and this also represents the proportion of the variable human resources explained by factor ML2. The same can be inferred for all the other 15 variables and the 3 factors represented by ML1, ML2 and ML3. Environmental transition is an outlier not explained by any of the 3 factors with total explained proportion by the 3 factors as only 0.15. Environmental sustainability is also an outlier not explained by any of the 3 factors because total explained proportion by the 3 factors is only 0.28.

Table 4: Original variable representation for 3 factors

Variables with highest proportion explained by 1st factor (ML1)	Variables with highest proportion explained by 2nd factor (ML2)	Variables with highest proportion explained by 3rd factor (ML3)	Variables with explained proportion by dominated by 2 factors	Outliers (variables not specifically explained by any of the 3 variables or proportion below margin)
Human resources	Innovators	Governance transition	Firm investments	Environmental sustainability
Attractive research systems	Employment impacts	Social transition	Employment impacts	Environmental transition
Digitalization		Economic transition	Linkages	Finance and support
Use of information technologies				Firm investments
Finance and support				Intellectual assets
Finance and support				Sales impacts
Linkages				Social transition
Intellectual assets				

Source: Author’s own calculation

Based on the results of Table 5 and Table 6, the use of 4 factors is preferable because it has the least number of outlier variables that are either not explained by the 4 ML factors or with explained proportions below the set margin.

Table 5: Standardized loadings (pattern matrix) based on correlation matrix for 4 factors.

	ML3	ML4	ML1	ML2	h2	u2	com
Human resources	0.93	0.03	0.12	0.10	0.88	0.117	1.1
Attractive research systems	0.87	0.09	0.24	0.28	0.89	0.106	1.4
Digitalization	0.90	0.10	-0.16	-0.01	0.84	0.161	1.1
Finance and support	0.71	0.14	0.32	0.11	0.65	0.354	1.5
Firm investments	0.48	0.20	0.47	0.32	0.59	0.408	3.1
Use of information technologies	0.79	0.15	0.23	0.36	0.83	0.170	1.7
Innovators	0.29	-0.01	0.95	0.10	1.00	0.005	1.2
Linkages	0.72	0.13	0.57	0.06	0.86	0.139	2.0
Intellectual assets	0.67	0.25	0.29	0.07	0.61	0.394	1.7
Employment impacts	0.59	0.04	0.72	0.26	0.94	0.062	2.2
Sales impacts	0.27	0.18	0.23	0.92	1.00	0.005	1.4
Environmental sustainability	0.40	0.25	0.08	0.27	0.31	0.695	2.6
Economic Transition	0.23	0.86	0.05	0.10	0.81	0.188	1.2
Social transition	0.04	0.81	0.10	0.14	0.68	0.321	1.1
Environmental transition	0.12	0.23	-0.28	-0.08	0.16	0.842	2.6
Government transition	0.24	0.88	0.03	0.01	0.83	0.169	1.2

Source: Author’s own calculation

Based on table 5, the regression function for the variable “Human resource” will be determined by $0.93*ML3 + 0.03*ML4 + 0.12*ML1 + 0.10*ML2 + 0.117e$. The same reasoning can be used for determining the regression function for all the other variables until Governance transition. This provides a method for expressing the original variables in the newly expressed 4 factors.

Table 6: Original variable representation for 4 factors

Variables with highest proportion explained by 1st factor (ML1)	Variables with highest proportion explained by 2nd factor (ML2)	Variables with highest proportion explained by 3rd factor (ML3)	Variables with highest proportion explained by 4th factor (ML4)	Variables with almost equal explained proportion by all 4 factors	Variables with highest proportion explained by two factors	Outliers (variables not explained by any of the 4 variables or proportion below margin)
Innovators	Sales impacts	Human resources	Economic transition	Firm investments	Linkages	Environ. sustainability
Employment impacts		Attractive research systems	Social transition		Employment impacts	Environ. transition
		Digitalization	Governance transition			Finance and support

Finance and support	Firm investments
Use of info tech.	Intellectual assets
Intellectual assets	Social transition
Linkages	

Source: Author's own calculation

Table 7: Factor weights for original variables at k =4.

Variables	ML3	ML4	ML1	ML2
Human resources	0.29128965	-0.100254475	-0.0917638961	-0.045282258
Attractive research systems	0.26531872	-0.072909126	-0.0709969427	-0.036047669
Digitalization	0.22497850	-0.032007251	-0.0783013049	-0.045524719
Finance and support	0.06030119	0.005787099	-0.0147409139	-0.015636719
Firm investments	0.01944140	0.022137883	-0.0009900304	-0.006651273
Use of information technologies	0.14042059	-0.013442108	-0.0424392524	-0.019792827
Innovators	-0.29748172	-0.025724534	1.11017137122	-0.192918793
Linkages	0.13292437	0.029816359	-0.0197155898	-0.044480799
Intellectual assets	0.04715036	0.034850688	-0.0103921007	-0.019279479
Employment impacts	0.19170664	-0.073521619	-0.0076188045	-0.028354448
Sales impacts	-0.19908523	-0.023454505	-0.072206633	1.157812933
Environmental sustainability	0.01371205	0.017839060	-0.0041016156	-0.004791864
Economic transition	-0.02786127	0.386774625	0.0190612553	-0.072740592
Social transition	-0.04027413	0.219098027	0.0192989122	-0.034840099
Environmental transition	0.01540218	-0.028011389	-0.0073306734	0.002383289
Governance transition	-0.02456210	0.446777658	0.0198679183	-0.089164225

Source: Author's own calculation

For the factors determined we need to find the weights of the various variables that will be used to calculate the factors. Table 7 shows the corresponding weights of all the variables for the new k factors where k is 4 new factors. Hence each individual factor will be determined by the sum of the variables multiplied by their weights correspondingly to get the new factors. On the other hand, based on table 7 for instance, ML3 can be determined as equal to Human resources*0.29428956 + Attractive research systems*0.26531872 + + Governance transition*-0.024565210. The same reasoning can be followed to determine the weights for ML4, ML 1 and ML2. Based on the scores and weights, the factors score for each county under the study can be determined and the countries can be represented and replaced by the original 16 variables for innovation and transition with the new 4 factors represented by ML1 to ML 4.

3.3 Clustering Countries based on measures of both innovation and transitioning performance.

Using the combined 16 variables for innovation from the European Innovation Scoreboard and sustainable development from the transitioning performance index, the study will attempt to cluster the countries into 4 groups and observed the movement/ performance of variables in the specific clusters. The aim is to regroup countries into 4 main clusters according to the methodology for innovation and transitioning measures by the European Union. First off, based on Euclidean distance of the countries, Bulgaria is similar to Poland, Romania, Croatia, Portugal, Lithuania, Latvia, Slovenia, Czechia etc. Austria on the other hand is most similar to Belgium, Germany, Finland, Luxembourg, Estonia, Sweden, Malta, Netherlands, and Denmark, based on distance. In the same vein, Belgium is similar to Sweden Austria Finland, Germany Netherlands, and Luxembourg. Czechia is similar to Slovenia, Italy France, Croatia, Greece, and Lithuania.

Next, we plot the cluster of Countries using 7 preliminary methods to answer the question of which clustering method is the best to be used by employing the reasoning of maximum cophenetic coefficient. The methods used include ward, single, complete, average, mcquitty, median and centroid. The result points to the number 4 method as the one with the maximum value, which represents the “average” method. This is shown in table 8 and means that this is the ideal method to use for the clustering of the data while using the median method will be the most detrimental for the clustering based on same coefficient value. We also note that the object Euclidean distance (euclid. dist) represents the matrix of distances between particular pairs of countries.

Table 8: Cophenetic Coefficient Table

Number	Cluster method	Cophenetic Coefficient
1	Ward.D	0.5747600
2	Single	0.5224603
3	Complete	0.6014280
4	Average	0.6431205
5	Mcquitty	0.6395183
6	Median	0.1442634
7	Centroid	0.3711914

Source: Author’s own calculation

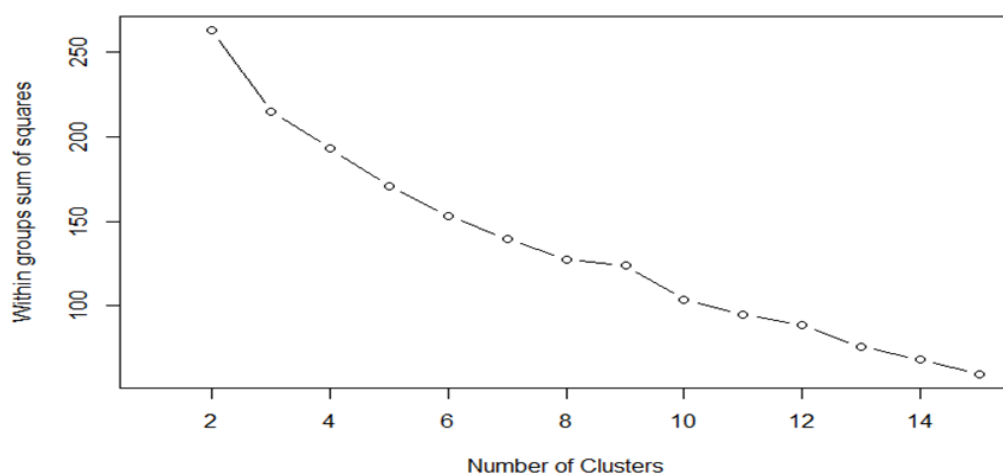


Fig. 2: Determining number of steps and clusters. Source: Author's own calculation

We would like to determine when to stop clustering (thus at which distance) for selected “average” method by finding the ordering number of steps for the method “average”. To find the best stop point, we need to take note of

the following: the clustering should be stopped when the steps move steeply. However, this reasoning is true only for some methods such as single, complete, average, ward, etc. and would not work for the method centroid but in our case, we use the average method and so it would suffice. In determining the number of clusters, we can also use the K-means method. With this method, as the number of clusters increases, the within-group sum of squares decreases. For the analysis, we set the seed as (1234) and set the number of centers as 4 as well as the number of iterations as 25. We will then have 4 clusters and then we can find the individual countries that belong to each cluster. Table 9 below shows the clusters the countries will belong to if we set the number of clusters as 4.

Table 9: Clusters for countries

CLUSTER 1	CLUSTER 2	CLUSTER 3	CLUSTER 4
Cyprus	Austria	Bulgaria	Czechia
France	Belgium	Hungary	Greece
Spain	Germany	Poland	Croatia
Italy	Denmark	Romania	Lithuania
Ireland	Estonia	Slovakia	
Portugal	Finland	Latvia	
Slovenia	Luxembourg		
	Malta		
	Netherlands		
	Sweden		

Source: Author’s own calculation

Finally, the means of the variables in each of the clusters are also observed through Figure 3. The means of variables in the individual clusters show the performance of the countries by observing the original 16 variables. However, it should be noted that the countries do not have an equal number of countries and hence that could influence the movement for the means, but it can be used as a tentative measure supplemented by other socio-economic conditions.

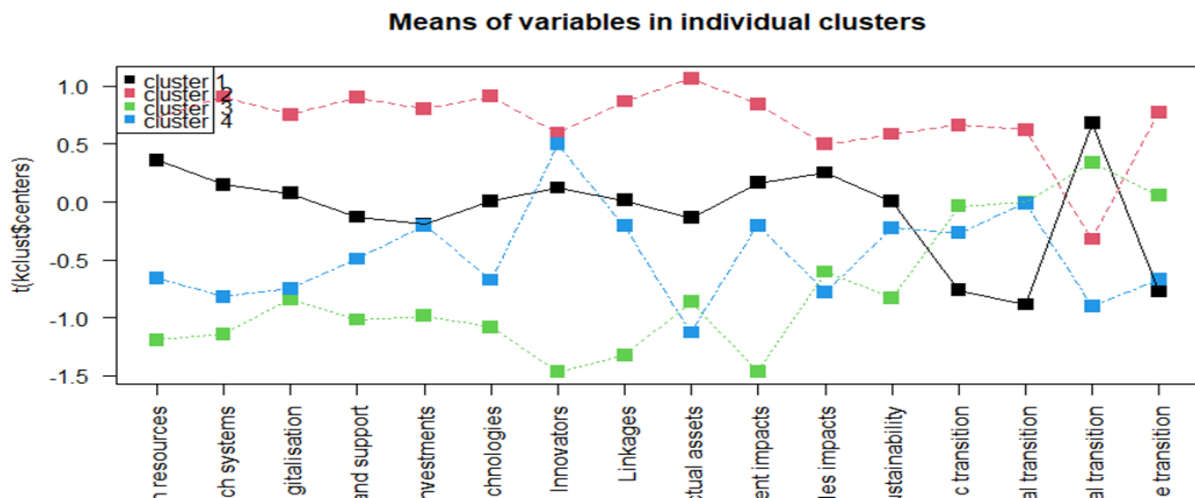


Fig. 3: Means of variables in individual clusters. Source: Author’s own calculation

4. CONCLUSION

The study aimed to primarily examine the interactions between variables for innovation and transitioning performance by drawing on the 2020 European Innovation Scoreboard and the Transitioning performance index for 27 European countries. Based on the correlation matrix derived from the initial variables, we observed that positive interactions were observed with the measures of innovation with higher values between human resources, attractive research systems and use of technologies. On average, higher positive interdependence is observed within the measures of innovation, implying that the increase in one tends to trigger increases in the others and vice versa. However, majorly, negative correlations were observed between measures of environmental sustainability and transition and other innovation and transition measures (see Figure 1 and Table 1). Which would then imply that increases in these measures will have adverse effects on these environmental measures and vice versa. This can in part be explained by the fact that the various proxies used for measuring issues of the environment are skewed towards reducing negative impacts and ensuring lesser consumption of resources even as economic activities increase. The same can be true for efforts towards finding alternative sources of environmental consumption for human, economic and social activities. Furthermore, we investigated if common factors hidden can be determined between the two measures. With a cumulative proportion of variance of approximately 79% of original variables, we derived 4 factors for the total set of innovation and transitioning measures using maximum likelihood and varimax methodology and a seed set of 1234. Based on these factors, we determined outlier variables as well as proportion of explanation and correlation between the original and the new factors and observed the variables and the countries in terms of the new derived variables. The first composite factor was related to issues of innovators and impacts of employment and the second factor was related to impacts of sales. The fourth factor was related to issues of sustainability and inclusive development as measured by the transitioning performance index minus environmental aspects. The third factor was related to human capital (human resources), research and ICT (attractive research systems, use of information technologies, digitalization, intellectual assets), financial capital (finance and support) and linkages. Three of the final four factors are related to innovations and the other is related to sustainability and inclusion. There were six outliers that were either not explained by the four factors or the total proportion of these variables that could be explained by the final four were very low (60% and below). These variables were environmental sustainability and transition, sales impacts, firm investments. Finance and support, social transition, intellectual assets only had between 60% and 70% total explained proportion by all four factors, hence were included in the outliers.

The final part of the study was an attempt to cluster the countries into 4 groups by setting a seed (1234), testing seven different clustering methods (ward, D, single, complete, average, Mcquitty, median and centroid) and using the method of maximum cophenetic coefficient to determine the ideal clustering method determined as average. Moreover, we observed the variation of means thus the movement of mean variables in the individual clusters to draw conclusions on possible performance of countries identified in the clusters. Tentative deductions were made such as the fact that countries in cluster 2 (Austria, Belgium, Germany ... Sweden) have higher variable means compared to other clusters while cluster 3 (Bulgaria, Hungary, Poland... Latvia) has more negative and lower variable means. Furthermore, cluster 1 (Cyprus, France Spain... Slovenia) and cluster 3 have positive means for environmental transitions while cluster 2 and cluster 4 (Czechia, Greece Lithuania) have negative means. The results of the clustering are not definitive and conclusive in themselves but need to be supplemented by other social, cultural, geographical and policy parameters to make informed and responsive decisions.

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BIM Maturity Factors in Small and Medium-Sized Design Institutes in Sichuan Province, China

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Abstract

In construction projects, the maturity of BIM application capabilities not only includes project planning, design, construction and other processes, but also includes the content of information sharing and communication and coordination of relevant units of the project, so BIM applications involve a wide range, and multiple factors will affect the maturity of BIM application capabilities. Therefore, it is necessary to follow the principles of systematicism, scientific rationality, industry characteristics, representativeness and other indicators to evaluate the maturity of BIM application capabilities. Taking Sichuan Design Institute as the research object, this paper proposes five dimensions of strategic field, application field, technology field, talent field and performance field, and constructs a BIM technology maturity evaluation system To promote the application and promotion of BIM technology in China's construction industry.

Keywords: Exploratory factor analysis, Bim technology, Maturity evaluation

1. INTRODUCTION

In recent years, with the application of BIM in some places, it has brought about changes in the industry. Some enterprises through self-built BIM standards to form a whole process from design to construction to operation and maintenance management system, the design institute is required to implement BIM forward design to achieve model consistency and digital module integration, the delivery standards of the design tend to construction depth, the model reflects the calculation, quality inspection, progress and other information. At present, the design institute BIM development is relatively slow, in various industries BIM development analysis, the current design institute in the promotion of BIM design is facing the main difficulties: First, the design institute generally lacks a deep understanding of BIM, and still stays in the CAD stage. Second, design to create value is not very good reflected. Third, establishing BIM thinking is the key point of future competition. If the design institute does not carry out BIM design or do not solve the above-mentioned dilemma, will face the pre-design stage profits are taken away by the builders, the late design profits are consulted enterprises, construction enterprises, and the remaining middle part of the profits will not be enough to support the normal operation of the design institute or dismal operation, therefore, the design institute needs to constantly strengthen the BIM design, and need all professional BIM design, in order to solve the current dilemma.

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The number of architectural design enterprises in Sichuan Province in China remained at about 500 before 2015, and grew rapidly to 1,447 after 2016, and the number of employees increased from about 65,000 to 188,000, accounting for 4.1% of the total number of employees in the country. However, in terms of operating income, Sichuan Survey and Design Institute in 2019 operating income of 213.4 billion yuan, accounting for only 3.3% of the national operating income (Source: China Statistical Yearbook 2021), the business operation is relatively poor, in order to improve the business ability of the enterprise, adapt to the trend of BIM development, while comprehensively, objectively and continuously reflect the application status of BIM technology in China's architectural design enterprises. It is important to study the maturity of BIM application, identify the ability factors of maturity, build the corresponding BIM maturity model, and promote the application, development and promotion of BIM in the architectural design industry.

2. RESEARCH OBJECTIVE

This paper aims to investigate the maturity of BIM application in architectural design enterprises in Sichuan Province, China.

3. LITERATURE REVIEW

The concept of the term Building Information Modeling was first proposed by Professor Charles M. Eastman (1975). Because BIM can be applied to different subjects in real engineering to produce different utility, the BIM concept is not static, but is defined as continuous. By contrast, the U.S. NBIMS has a clearer understanding of BIM.

“First of all, BIM is a digital model of construction projects, in which the complete physical characteristics and functional characteristics of construction projects are included. Secondly, BIM is a public shared knowledge resource warehouse, based on the information sharing and exchange related to the construction project, so as to provide accurate reference for the necessary decisions in the whole life cycle of the project; Finally, based on the same BIM platform, each participant can easily share information about the exchange project at different stages to achieve collaborative and efficient work”.

Maturity refers to the transition of things from the initial state to the advanced state, which evolves in the process as a measure of an enterprise's or organization's ability to evaluate an aspect. Western developed countries apply maturity to project management and evaluate the project management level of the organization by the project management maturity standard.

The maturity model provides a complete framework in which the process of specifying how to acquire or enhance certain desired capabilities is identified. The Project Management Maturity Model provides a more complete framework for how an organization can improve project management capabilities from low to high levels, with maturity proportional to project management capabilities. On the one hand, it is often used by enterprises to evaluate the level of project management capacity, on the other hand, through the tool to analyze the weaknesses in project management, clear direction of improvement to take measures.

Although the application of maturity model originated in foreign countries, with the introduction and in-depth study of domestic scholars, it has also been fully applied in China's economic and management fields. Taking the research of Chinese scholars on information maturity as an example, Cai Zilong (2013) used maturity model and fuzzy comprehensive evaluation method to evaluate the information maturity of power grid companies in western China[1]. Xu Xukan (2011) constructed the ecological environment maturity model of enterprise information system, which provides reference and basis for the construction of information system environment at all levels[2]. In the construction industry, Gai Feng (2014) and Liu Junying (2012) studied the risk management of construction enterprises and constructed a comprehensive risk management maturity model for construction enterprises[3,4]. Wu Jingjing (2014) uses the maturity model in the evaluation of multi-project management level of construction units[5]. Zhang Dexin (2017) used artificial fish algorithm to optimize BP neural network, introduce the concept of maturity model, and establish an information maturity evaluation model based on AF-BP construction enterprises[6].

Fu Haifeng (2013) and so on from the reasons affecting the use of BIM, indicators follow the principles of the establishment of BIM application maturity index system, and then using AHP, Delphi and other methods to evaluate the project BIM CMM[7, 8, 9]. Cui Xiao (2012) and so on from the policy, technology and other aspects of the summary evaluation indicators, and then build BIM application maturity evaluation model, the model can not only identify the shortcomings of BIM application, but also can deepen BIM application recommendations[10, 11]. Chen Yonghong (2019) and others, through combing through the literature, established the BIM capacity maturity measurement system, and then used structural equations to establish a model, in order to promote the deep-seated application of BIM in China[12].

Domestic scholars in the construction enterprise information maturity research is more extensive, scholars stand in the national construction enterprises, information advanced enterprises, information technology intermediate enterprises, individual enterprises and other angles of enterprise information maturity and level of evaluation and research. And the Ministry of Housing and Construction in 2012 has promulgated the "construction enterprise information evaluation standards." (Zhu Lianbo & Bai Ling, 2012) [13]. The standard evaluates the level of enterprise informationization from five aspects, such as business aspect, technical aspect, guarantee aspect, application aspect and effectiveness. However, considering that the evaluation criteria are for the construction enterprises at all levels of the country to evaluate, the accommodation is wider, and the evaluation process is more in the form of scoring evaluation, so that the accuracy of the evaluation results is low. However, the promulgation of this evaluation standard provides a benchmark and new ideas for the research on the information level of construction enterprises. On this basis, Chinese scholars are constantly in-depth study, and strive to evaluate the results more reasonable, evaluation methods are simpler.

Summary, domestic and foreign scholars have less research on the evaluation of information maturity of construction enterprises, but more extensive research on information maturity of medical enterprises and manufacturing enterprises. Although all kinds of enterprises in the main content of information construction is not the same, but in the information construction of the goal and the realization of functional value tend to be one. Therefore, this paper's research on the evaluation of information maturity of construction enterprises not only refers to the construction enterprises, but also refers to the research status of other types of enterprises, comprehensive research and analysis of evaluation indicators and evaluation methods, the construction of a more perfect system of evaluation indicators and the establishment of a strong applicability of evaluation methods.

4. RESEARCH METHODOLOGY

This study aims to analyze the key elements of the maturity of BIM application of architectural design enterprises and construct a multi-factor comprehensive evaluation index system for BIM application maturity. The methodological research developed by this survey can be described below.

4.1. How to select the research area and data providers

Target groups: Major architectural design institutes in Sichuan Province, China. According to China's National Statistical Yearbook, the number of architectural design institutes in Sichuan Province, China remained at about 500 by 2015, growing rapidly to 1,447 after 2016 and 1,151 in 2019, excluding design institutes from other provinces.

Sample size: In this study, quota sampling was used to design questionnaires for the Sichuan Institute of Architecture and Design. At the same time, in order to improve the reliability and stability of the questionnaire, the researchers conducted a sample survey of 20 small design institutes, a total of 30 people conducted a pilot questionnaire test. Then a total of 543 valid questionnaires were issued, mainly for professionals in the construction industry, with direct or indirect knowledge of BIM technology. Including in the construction project of the design institute senior management, middle management personnel, project leader, professional engineers and so on. Survey methods include mail, e-mail, field survey and online questionnaire four ways to conduct the survey, mainly the questionnaire star online questionnaire survey.

4.2. How to reliability analysis

George and Mallerx (2010) illustrated the value of Coefficient Cronbach's Alpha as the following: ≥ 0.9 =Excellent, ≥ 0.8 =Good, ≥ 0.7 =Acceptable, ≥ 0.6 = Questionable, ≥ 0.5 =Poor, and ≤ 0.5 =Unacceptable. Therefore, in order to make the research questionnaire to be reliable, its value of Coefficient Cronbach's Alpha must be at least 0.7. According to pilot test (N=30), the Cronbach's Alpha coefficient of the overall data is >0.7 . Therefore, the questionnaire is reliable and can be used for the analysis. (Hair et al., 2010).

4.3. How to collect data

The 543 data collected from the formal questionnaires were all sampled through the above quota. Then, the researchers confirmed that all the returned questionnaires were filled in correctly. In this study, data were obtained after online questionnaires were distributed. In order to ensure that the interviewees can understand all the questionnaire items, the English questionnaire was translated into Chinese. To complete this study, secondary data

were obtained from relevant literature or research papers, such as textbooks, essays, independent research, and academic papers.

4.4. Data Analysis

After collecting and collating the data, it is recorded, examined, and coded for social research. Through qualitative analysis methods, the first-level evaluation indicators of five dimensions of strategic field, application field, technical field, talent field and performance field are determined respectively, among which the strategic areas include: strategic planning, management support, and standardized system; Application fields include: application content, application process, application results; Technical areas include: BIM software, BIM hardware, technology integration; Talent areas include: talent reserve, capacity building; Performance areas include: economic benefits, social benefits; Through analysis, the importance of enterprise personnel's understanding of these evaluation indicators is determined, and the key factors of BIM application maturity are determined.

5. RESEARCH RESULTS

Respondent statistics: Most of the respondents were male (62.62%), and the design units were mainly Second Grade design institutes. Most of the exposure to BIM has been around for 4-5 years, and most of the interviewees are Enterprise professional engineer. The statistical characteristics are shown in Table 1.

Table 1 Demographic information for the respondents(n=543)

Variables	Categories	Percentage
Gender	Male	62.62%
	Female	35.54%
The design qualification of the unit	First Grade	8.47%
	Second Grade	64.27%
	Third Grade	27.26%
Position held	Senior corporate managers	6.08%
	Middle managers of enterprises	18.05%
	project manager	18.97%
	Enterprise professional engineer	45.86%
	Other	11.05%
Time of exposure to BIM	1 year and less	25.41%
	2-3 years	21.73%
	4-5 years	37.38%
	6-8 years	11.97%
	More than 8 years	3.50%
Enterprise-level investment in BIM applications	Within 100,000Yuan	32.23%
	100,000~500,000Yuan	26.15%
	500,000~1000,000Yuan	23.94%
	More than 1 million Yuan	8.29%
	I don't know, I can't judge	9.39%
The BIM application carried out by the respondent unit	BIM-based bid scheme simulation	42.17%
	BIM-based detailing	39.59%
	BIM-based collision checking	53.59%
	BIM-based drawing review and disclosure	39.78%
	BIM-based cost control	31.31%
	BIM-based quality management	24.31%
	BIM-based quantity calculation	44.94%

	Other	8.29%
The BIM application carried out by the respondent unit	Lack of BIM talent	49.72%
	Lack of experience and methodology for BIM implementation	56.17%
	BIM standards are not robust enough	46.22%
	Project personnel are not active enough to implement BIM applications	46.78%
	Unit leaders do not pay enough attention to BIM	36.65%
	The input is costly	29.83%
	BIM software is immature	18.78%
	Without concrete results, it is difficult to continue to advance	23.57%
	BIM applications are not highly relevant to the current project	19.89%
	There is no library of high-quality, informative BIM models	4.05%

Through the comprehensive analysis of multiple factors, the five most important aspects of BIM application are constructed. The results show that the average application of BIM in domestic enterprises is still in the development stage, and the domestic BIM application market potential is very large. In the fields of strategy, application, technology, talent and performance, the application degree of BIM is low, so in the face of rapidly changing market and technological innovation, the development model of traditional enterprises can no longer meet the needs of the market, resulting in its information lagging and low production and construction efficiency.

Judging from the survey, the design institute generally believes that the application of BIM is more important in the strategic areas, application areas and technical fields in the future(31.12%,30.39%, 33.89%) ,Applications should be strategically planned (More important and very important accounted for 48.25%.) Administrative support is also important (29.1%) ;The upper echelons of the unit recognize that the application of BIM is more important (36.1%) and very important (14.36%), Need to do more research and development and education training, However, at present, the income of the design institute is difficult to support large research investment; At present, the application of BIM by the surveyed units is mainly based on the collision check, quantity calculation and bidding scheme simulation of BIM, accounting for 53.59% and 44.94% of the total, respectively 42.17%; The obstacles encountered in the implementation of BIM are mainly the lack of experience and methodology in BIM implementation, the lack of BIM talent, the lack of sound BIM standards, and the project personnel on BIM app implementation is not aggressive enough, The proportion is respectively 56.17%、49.72%、46.78%、46.22%, The reason why the project personnel are not active enough in the implementation of BIM and the relatively small scale and low fee accepted by the small and medium-sized design institutes have a large relationship; From the perspective of technical fields, the application of BIM is mainly based on software, and the requirements for hardware are easier to meet; From the perspective of talent field, the talent reserve and capacity building of BIM application are generally important, which is mainly because the software used by the design institute has gradually expanded the functions of BIM and has a certain application foundation; From the perspective of performance field, the design institute believes that the application of BIM needs to consider more economic benefits (More important 36.83%), If it cannot produce high economic benefits, the enthusiasm of project personnel is difficult to reflect.

6. DISCUSSION AND CONCLUSION

In the process of implementing policy reform in government departments, the system should be updated. The application of new technologies, guidance and support within the project is key, Items Should be set up in the designated housing and construction department research team, to exchange learning, on the wide application of BIM technology in-depth research, to each construction enterprise to play a guiding role and can be applied, in the application of building information model in the process of publishing relevant details.

At the same time, based on the introduction of project guidelines, all new projects should use BIM technology in bidding and evaluation of project design and use BIM technology to standardize the fees charged for design.

At present, the application of BIM in China's construction projects related laws and regulations, norms, standards, guidelines, etc. have not been formulated, in the application of BIM encountered a lot of resistance. Therefore, it is necessary for the construction project to formulate relevant rules from inside or outside the construction enterprise in order to regulate the application of BIM and ensure its own rights and interests.

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Post-Pandemic Educational Pathways: Creating the Next Great Academic Dream for Learner Empowerment

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Abstract

While the world stopped in many ways during the Covid-19 Pandemic period, the world of education was spirited and motivated by great educators, academic leaders, and devoted staff members. However, it does raise the bigger questions - where does this extra effort and devotion stem from? Is it due to their belief in the mission of education or does the spirit of education and its rich historical background cause all these key stakeholders to hold steadfast and continue the dream, momentum, and write the next chapters? The purpose of this paper is to example how the status quo was dramatically impacted, yet not completely discouraged. Did the effects of the Pandemic trigger a new momentum in the lives of visions of educators and other stakeholders? What directly happened to the field of education in terms of the quality of education delivered, understood, and applied? This paper will address how the impact of this terrible event in global history perhaps unlocked a new chapter in the educational vision for numerous educators, stakeholders, and learners, as well as helping them to evaluate the next generation of learning through chaos moving forward to a new horizon or platform for improved and sustained learning.

Keywords: Online learning, learner empowerment, stakeholders, best practices

1. CONTEXTUAL BACKGROUND

Prior to the Pandemic period, the key issue in many educational circles was focused on the stronger, yet more reliable learning environment – the traditional Face-to-Face (F2F) learning environment (physical classroom) versus online learning (virtual classroom). Despite the numerous debates, academic presentations, variety of academic and business publications on this same academic debate, many educators and administrators were 100% for one learning environment over another. However, once the Covid-19 Pandemic (Pandemic) was finally “realized” by all types of individuals, groups, and organizations – immobilization plans were imminent. In fact, this is when the former educational debate between the two types of learning environments had to be “shelved for later debate”. Thus, online learning became the one of the most common elements that help save the educational movement all over the world. Even though many people still had reservations about the role and function of the Internet and accomplishing new educational technology, this also had to change, which was reflect in blogs, websites, peer-reviewed journal articles and chapters in the ensuing years. Consequently, some wondered why such a change should be considered. Many people were left out of many educational opportunities that could only be initiated, conducted, and reviewed completely online. The world was “forced” to accept what technology could offer or suffer in silence. The key focus of this paper will be to look at this period during the Pandemic and leading up to the period afterwards, known as the “New Normal” or rather the post-Pandemic era. The following sections will help to

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outline what was happening during these years of the Pandemic and life after this chaotic period in both American and Global education.

One way of learning how educational organizations and the associated stakeholders worked either in sync or chaotic odds, Senge's work on his Five Disciplines of Learning Organizations still holds a good lens for all stakeholders to view if an organization is learning or still is struggling to learn more about itself and its process. These noted five disciplines are: (1) Building a Shared vision; (2) Systems Thinking; (3) Mental Models; (4) Team Learning; and (5) Personal Mastery.[1][2]. Further, Zeeman (2017) noted that "Senge's learning organisation describes how to manage the success and development of an organization and how employees give the extra mile that goes beyond the expectations of the company." [3] However, it should be noted that not all organizations are interested in helping all stakeholders to go beyond the expectations of one's organization, but naturally believes that everyone will be devoted entirely to the mission go of the organization, but later discussion will address such a line of thinking as this one. Therefore, to understand these points of view, we need to delve into the line of thinking held during the Pandemic period, as well as looking at the devotion and motivation of the stakeholders in the educational mission.

2. WHERE DOES THIS EXTRA EFFORT AND DEVOTION STEM FROM?

Prior to this difficult period in the Global Education Movement (GEM), educational systems were comprised of traditional learning, known as Face-to-Face (F2F) learning, online learning, or hybrid/blended learning. However, when the Covid-19 virus began to spread, and schools were forced into closure – only three options were given to those in the educational movement: (1) to teach or not to teach; (2) changing of one's career; and (3) become part of the Great Resignation. Thus, it should be noted that while many people were not fond of transitioning over from the face-to face teaching, or traditional teaching, to online teaching during the time of the COVID-19 pandemic, they finally realized that this was a necessary change. However, it should be noted that some people did not accept the change and were very slow in accepting it. Thus, some of these unyielding educators decided to leave the profession by either switching professors or becoming part of the Great Resignation movement, which did begin prior to the Pandemic period. Consequently, there were those educators and administrators that did embrace the need for change and realized that their students depended on their example and what would happen next. Despite the chaos, there were several educators, professors, and trainers who were inspired, motivated, and encouraged to keep the faith and continue with the noble profession of education. While the pay did not change during the time of the transition for some, it should be noted that some organizations did offer additional teaching duties and stipends to encourage and motivate their educational staff. For those educators who did stay in the educational profession and helped with the transition over to a new form of learning, they be commended for their dedication and heroic actions. While each of these professionals had various roles and functions during this period, there were individuals who struggled with the concept of online learning, some learned how to accept it, and some learned how there were benefits to online learning. For example, some people that were in this new role and function learned that they could rearrange some of their normal schedule, could rearrange their current work tasks at various parts of the day, as well as learn different ways of using various newer and enhanced educational technologies. Also, during this time, this was a good "work in progress" period for many people to help build better relationships and network with other teachers in similar positions who were facing the same dilemma – this was a global reality that educators started to unite as one through virtual conference calls, Zoom/Skype calls and conferences, or publications.

In the "Futures of Education", prepared by UNESCO, in November 2021, they wrote about a new "social contract for education. This raised the question for many as to why we needed to transform education, especially in light a major health crisis. They stated:

"We must ensure the right to lifelong learning by providing all learners - of all ages in all contexts - the knowledge and skills they need to realize their full potential and live with dignity. Education can no longer be limited to a single period of one's lifetime. Everyone, starting with the most marginalized and disadvantaged in our societies, must be entitled to learning opportunities throughout life both for employment and personal agency. A new social contract for education must unite us around collective endeavours and provide the knowledge and innovation needed to shape a better world anchored in social, economic, and environmental justice."[4]

Further, they explained more about the new social contraction for education in terms of how human rights was a central theme, along with dignity, cultural diversity, as well as reciprocity, solidarity, and maintaining an ethic of

care. Thus, they examined several areas and segments of culture, society, and education overall. The following list outlines the key areas that UNESCO considered important for transformation in the educational realm.

- Inclusive, equitable, safe and healthy schools;
- Learning and skills for life, work and sustainable development;
- Teachers, teaching and the teaching profession;
- Digital learning and transformation; and
- Financing of education. [5]

During the preparation of this UNESCO approach, another set of research, Sharm and Alvi (2021) overview works of others and discovered there were differences in the perceptions of students in terms of the learning methods applied during the Pre-Pandemic and Post-Pandemic time frames. Also, many students were acquainted with blended, or hybrid learning, than web-assisted learning. On the other hand, it should be noted that the introduction of newer technologies to a broader base of global learners did open the areas of hybrid and learning significantly. [6] While this key global organization, along with many other stakeholder organizations, knew that there was a definite change on the horizon, the Pandemic was a key triggering event that called educational institutions globally to rethink their outlook mission, vision, and focus on what needs to happen now and not wait until another global crisis makes education to stop and rush to change due to a Pandemic crisis.

3. DID THE EFFECTS OF THE PANDEMIC TRIGGER A NEW MOMENTUM?

Educators and other key stakeholders saw a need to keep the momentum going through the Pandemic as the world, not just the United States, was facing this harsh reality of COVID-19 that was still an unknown evil in the world affecting many from all socioeconomic levels. While some were trying to put their arms around the situation, many stakeholders, both internal and external, had to learn how to “rethink, relearn, and re-evaluation” how they did business – especially the business of teaching. While many scholars have argued that education is both an art and a science – sometimes educators and administrators tend to get too focused on one way of doing things and cannot look fully at the big picture. Basically, the world of Hegel’s had to focus on unlearning [7] to move onto newer technologies. Why did they need to unlearn? While some educators and administrators were still focused on learning in a physical classroom was the only way to learn – the shutdown of almost all organizations, schools, churches, and more. Therefore, these educational professionals could either unlearn their current education views or look for other work and become another member of the Great Resignation population. Consequently, during this period of the pandemic many people were trying to be pragmatic in their approach to the creation, design and development, and implementation of various teaching approaches, strategies, and methodologies for use with online learning. On the other end of the learning spectrum, there was a growing need for different types of visionaries during this time to forecast or create a newer approach during the Pandemic in terms of the learning environment and acceptance, along with motivation and inspire for both learners, educators, and other stakeholders.

It is important to remember that teachers, educational administrators, administrative staff, stakeholders, both internal and external, need to be open to all possibilities. In the next segment, we will look at what happened in the field of education, especially with educational delivery in a variety of areas.

4. WHAT DIRECTLY HAPPENED TO THE FIELD OF EDUCATION?

During this period of uncertainty, there were more questions than answers, especially around Covid-19 and its impact on communities and societies in general. In terms of the educational arena there were many questions, such as:

- Did educational delivery have to change during this time? If so, how?
- Who was involved in the design and development of this change event?
- Who was involved in the implementation of such a massive change?
- How was the situation being monitored and evaluated?

Therefore, one of the biggest questions at the center of all these questions was whether a quality education was still being offered to all types of students, whether they were in elementary, middle or high school or in higher education. Thus, we must wonder what types of measurements or metrics were used by individuals, groups, and organizations to evaluate if the quality of education was substantive or inadequate for some people and/or beneficial for other individuals or groups? Another area for consideration with the quality of education would be the use of various learning management systems or learning platforms that were being used. Equally important, one needs to

remember that there were people who may have been motivated, encouraged, discouraged, or perhaps frustrated with various changes that took place during this difficult time. Thus, evaluation along the way was critical to determine if educational methods were effective and if learning was happening or just a series of checkboxes for completion. Normal evaluative methodologies were marked immediately for change, such as in-person evaluators were now guests in online classrooms. Assessments were evaluated in perhaps many ways and by other individuals to obtain some form of checks-and-balances in this “new normal” way of learning and teaching. While evaluative instruments were being used online, some classes needed additional or different types of evaluate instruments to assess learning. It should be noted that online learning, just like any computer program itself, can be problematic – and human error can happen. Consequently, software design and online learning design in general is only one issue. In fact, some educators did not feel properly prepared before they had to learn the new technology and felt that online learning was forced upon them at a rapid speed, but they did realize the need to change teaching environments. Thus, there was more emphasis placed on teachers during this period, with a bigger lens focused on them to determine if they were able to perform or not perform according to the guidelines that were changed according to the different changes in their educational environments, ranging from teaching software, methodologies, and evaluative measures. Before we can go deeper and look at some statistics during the Pandemic that demonstrate changes in the educational arena.

4.1. Education Findings during 2020-2021

Li and Lalani (2021) stated, “At the height of school closures, in mid-April 2020, 94% of learners worldwide were affected by the pandemic, representing nearly 1.6 billion students in 200 countries.” [8] Perhaps the other 6% of learners were current online learners, but the Pandemic also helped many non-online educators consider a new way of teaching, learning, and another business opportunity. Also, Li and Lalani (2021) pointed out by the information shared by UNESCO, UNICEF and The World Bank (October, 2020) that they learned that 60% of the surveyed countries, most of the ministries of education designed and developed its own educational platform to display educational content for teachers and students on the primary and secondary learning levels.[9] Besides using commercial platforms such as Google Classroom and Microsoft Teams, some countries used open-source platforms to reinform their own educational platforms, such as Canvas, Moodle, etc. Further, they surveyed 149 ministries of education on the impact of Covid-19 on learning, students, and safety. According to UNESCO, UNICEF and The World Bank. (October 2020) [10], this is the listening from their Executive Summary on the topic of “Monitoring and Mitigating Learning Loss from School Closures” during the COVID-19 Pandemic.

1. Loss opportunities for learning
2. Learning assessments
3. Reopening support to remediate learning loss
4. Remote learning modes and effectiveness
5. Policies to boost access to online learning
6. Policies to support teachers
7. Policies to support parents and caregivers [11]

Further, they went on to address the safety issues of reopening schools during the close of the Pandemic. These are the areas that they addressed as follows:

8. School reopening plans
9. Health protocols during school reopening
10. Financing [12]

During this time, UNESCO, UNICEF and The World Bank (October 2020) discovered some of the leading educational groups that helped several countries to excel. For example, in Beijing, China, TAL educational Group, which is an edtech company headquartered in this location, which teaches over 3 million students. Another key educational provider is Onion Academy which is known for their animated videos which average 5-8 minutes in length (ideal for a younger learning audience). Surprisingly enough, Onion Academy has 1.8 million registered teachers and over 51 million registered students as noted by these organizations during the Pandemic period. Whereas the American counterparts are Coursera and Masterclass, which are focused on funding as these other educational provides, such the issue of global venture funding is a hot issue prior, during, and after the Covid-19

Pandemic. [13] According to the findings of Li and Lalani (Feb. 25, 2021), some of the key figures posted at the time of public was “ Coursera’s \$130 million round in July 2020 and MasterClass’ \$100 million in May, the largest deals in 2020 were China’s Yuanfudao, which raised \$1 billion in March 2020, followed by Chinese startup Zuoebang’s \$750 million in June. A global investment firm also purchased shares of TAL worth \$1.5 billion in 2020.” [14] After highlighting these key global educational entities, one can see how quickly the online learning impact did continue to grow during and after the Pandemic period. Following this discussion of the statistical growth of this new technology, we also to scale it back a little to look at other demographic information that has been and will continue to be important in the pursuit of educational offerings and considerations.

4.2. The Impact of the Pandemic on Learning

Besides the logistics involved, it should be noted that all learners do not learn the same and/or have the same socioeconomic means or health status – so additional care and considerations need to be evaluated. Kuhfeld, Soland, Tarasawa, Johnson, Ruzek, and Lewis (2020) used data from students in grades 3-8 who took the MAP Growth reading and math assessment in Fall 2020, which was based on 4.4 million students in this age range. What did they discover? They found that the students in this age range did about the same in reading as they did in the previous time in the Fall of 2019. On the other hand, the math data revealed something different. They discovered that the students were about 5 to 10 percentile points lower than students in the same age range from the previous years. [15] Where this new genre of literature continues to grow, it should be even more interesting to look at the upcoming assessments produced from the period after the Pandemic period. One of the most interesting facts that has become more apparent after the Pandemic is that some educational systems decided to continue with online learning and start to change their outlook on education overall. In fact, one must wonder if these organizations and educational systems have started to rethink and reevaluate their mission and vision for education. In the next segment, we will look at some of the changes and rethinking that has happened and made be in the process of continuously improving.

5. DID EDUCATIONAL INSTITUTIONS’ MISSION AND VISION STATEMENTS CHANGE?

The key underlying question is whether some schools who are 100% online versus those with hybrid, online, and traditional classes have a similar or different mission and/or vision statements before, during, and after the Pandemic? Equally important, another question is whether these educational institutions made any changes to their mission and vision statements or even consider rethinking their approach or during this time did they make any adjustments – whether permanent or temporarily. Key considerations before the Pandemic were the ability for families and school systems to provide adequate computer equipment and Internet access for the students. For example, students in rural areas and/or with lower socioeconomic households may have continued to be left behind had this Pandemic not happened and raised a level of social consciousness. Bauld (2021) noted “Bellwether Education Partners, an education nonprofit, estimates that between 1 million and 3 million U.S. students haven’t attended school since pandemic-related school closures began in March 2020, hitting high-risk groups including homeless students and children with disabilities particularly hard.” [16] Thus, this raises another key issue – what was the local government, educational authorities, and politicians doing if this large number of students were not attending or able to attend classes? Further, while there was stress placed upon the students, it was also felt by educators. The Education Week Research Center found almost 75% of educators noted that their morale levels were lower than levels experienced before the Pandemic. Why did they feel this way?

The teachers attributed this disconnect to dealing with their own lives, keeping students motivated and interested, as well as trying to learn new technology did impact their stress and morale levels. [17] Further, while the instructors were feeling a sense of lower morale, they were becoming even more emotionally exhausted and noticed they were not being as engaged in the educational process as before the Pandemic. [18] In a survey of 817 teachers, three-quarters of the survey respondents noted that same as noted above that they had experienced lower morale during the pandemic. [19][20] Further, Professor Christopher McCarthy, who teaches at the University of Texas at Austin studies the occupational health of teachers. He noted that teachers who are stressed may feel less satisfaction in their job duties and perhaps develop burnout symptoms. As a result, this affects not only their job performance, but also has an impact on their colleagues, educational system, and student learning. He noted that “Teachers [who are burnt out] feel a reduced sense of accomplishment in their job, they feel emotionally exhausted,” he said. “The way we cope with that is to pull back and become less engaged.” [21] Another educator, Professor Patricia Jennings at the University of Virginia who studies teach stress stated “To have a teacher feeling those same feelings—it just

reinforces it. When people are feeling discouraged, it can be contagious.” [22] Thus, this opens another area of concern following the Pandemic, there is an apparent need for educational administrators and authorities to focus more on teacher stress, morale, and other areas to consider the mental health of these educational professionals. Nonetheless, with considerations of the changes in learning environments, technology, educators, administrators, learning assessments, and students, there is a strong need for all stakeholders to be involved in a new genre of literature about the story of education during and after the Covid-19 Pandemic, which will be the topic following this section.

6. MEMORIALIZATION OF STUDIES, OBSERVATIONS, AND DOCUMENTATION

The final part of this paper will look at the need for memorialization of what has happened, what was documented, as well as what was published or continues to be perceived as an untold story about the events of this period. While many professions lost some of their brightest and best in their professions, educators were not exempt from this downfall. The educational profession lost many due to Covid-19 Pandemic effects and illnesses, and some educators died or left during this time. In addition, there were many Baby Boomers who were starting to retire during this time. Another key outcome during this time was the impact of remote work on the mindsets of traditional workers who learned to later love this new way of work. On the other side of work impacts, many educational systems and educators realize that some of the new best practices and methodologies learned and shared during this time were going to make a lasting effect on the field of education. According to the World Bank, there were still 57 countries with schools still closed as of March 2021. [23] During this period, The WorldClass Education Challenge was launched by Deloitte on the World Economic Forum’s UpLink platform. This platform would provide a way to search for innovators who are assigned to learning and access by bridging current gaps in these areas. In fact, 12 top innovations were identified by Deloitte which announced it would invest \$1 million U.S. Dollars with these finalists. This project is part of this organization’s WorldClass ambition or goal to provide “educational opportunities” by 2030 for up to 100 million individuals. [24] The Top UpLink Innovators selected by Deloitte in this Challenge were in the following countries:

- (1) Africa – Learnable, Pan-African Robotics Corporation, StanLab, UCT Online High School;
- (2) India – Call-A-Kahaan, Ekatra, Rocket Learning; and
- (3) Asia Pacific - #GenEducators, Komerce, Scaling Skills That Matter. [25]

It should be noted that there have been many start-ups in online learning environments and organizations during and after the Pandemic, with some for profit and others identified as non-profit. The test of time shall prove whether these new ventures will last or face, but while the Pandemic had many negative affects in some many areas and industries – it did have some good effects that changed only with human intervention, ingenuity, and creativity.

7. CONCLUSION

The online learning environment can be seen as a tool of educational enrichment and salvation. Juxtaposed to this line of thinking, there were educators, educational administrators, and other stakeholders during this time and afterwards who viewed this forced change in learning as futile, negative or temporary. However, no one knew how long the Pandemic would last, nor did they realize the loss of human lives and the impact on the educational field. In any event, online learning was more advanced and readily available due to the efforts of online professionals and technologists who have been perfecting its many uses over the past two decades. However, here is the larger question that no one has been considering in many published accounts and in social media in line with its relevance and importance. Can we imagine what would have happened to the education of our young people and university studies had there been no online learning available at this time? While it was noted earlier that younger students did about the same in reading assessments, but lower in math assessments – can we still say the same if the technology was not available readily for them to learn and take assessments? This opens yet another line of inquiry – now that we know of some potential risks and challenges, are all cultures and societies better prepared and willing to prepare differently in case of another crisis?

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Individual Differences in Second and Foreign Language Learning

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Abstract

Learners have different ways to adapt and understand instructions especially in language learning. Each individual can be classified or composed of cognitive and affective / conative, where cognitive abilities such as intelligence, language learning talent, or memory capacity or speed differ from affective abilities such as fear, motivation, and emotion of one individual. Individual differences in second language learning can be seen from various scopes, such as intelligence, personality, and so on. In this scope the characteristics of second language learners include age, intelligence, personality, emotions, learner's attitude, motivation, and talent. Each learner has a different way of adapting and understanding instructions, especially in language learning. We know that each individual has their own uniqueness. The uniqueness that exists in each individual will distinguish the way of thinking, feeling, and acting. In the study we tried to find out individual differences in second and foreign language learning under the light of recent literature.

Keywords: Educational management, Language Learning, Individual differences, Lifelong learning

1. INTRODUCTION

A lot of research has been carried out on foreign language learning. Even though many researchers have proven the effectiveness of various learning models in these studies, there is no single model that is effectively applied in any condition and situation. This is caused by the many variables in language learning, one of which is individual differences.

Each learner is unique and has his own character. This is why the results of research in place A may not necessarily be applicable to place B. There have been many studies on these individual differences. The challenge experienced by most researchers is that they find it difficult to identify and classify factors of individual differences. Ellis (1985) argues that identifying and classifying these individual differences has become problematic because it is very difficult to directly observe qualities such as aptitude, motivation and desire.

In the learning process, a teacher must pay close attention to individual differences because this can affect the methods and techniques to be used. Ideally, teachers should be able to design learning activities in such a way as to accommodate all the differences in their students. Although this is not easy to do because it requires adequate sensitivity and experience. Therefore, knowledge about individual differences must be known by teachers. Each individual has different characteristics. Differences are generally caused by two factors, namely congenital factors and environmental factors. Inherited factors are biological factors that are passed down through genetic inheritance by parents. Environmental factors that cause individual differences include parents' socioeconomic status, culture, and birth order.

The differences include differences in gender, abilities, personality, and learning styles, all of which more or less influence learning processes.

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Individual differences among students are something that cannot be avoided, because there is almost nothing that humans have in common except for the differences themselves, the extent to which different individuals will manifest their different qualities or combinations of various elements of these differences. Everyone, whether he is a child or an adult, and whether he is in a group or alone, he is called an individual. The characteristics and traits of one person are different from another. These differences are called individual differences which can be dealt in physical and psychological aspects. In the educational environment, there are quite a lot of individual student differences, all of which are personality traits of students as individuals. The personality of the students includes physical, religious, intellectual, social, ethical, and aesthetic aspects.

2. INDIVIDUAL DIFFERENCES IN LANGUAGE LEARNING

Ellis (1985) distinguishes individual differences into two, namely personal factors and general factors. Personal factors include group dynamics, attitudes towards instructors and teaching materials, and individual study techniques. While general factors include age, intelligence and dexterity, cognitive-style, attitude and motivation, and personality. Personal factors are differentiating factors that come from within the learner. These factors have a great influence on determining success in the process of learning a foreign language. Personal factors can be grouped into three groups, namely group dynamics, attitudes, and learning techniques.

Group Dynamics

In terms of personal factors, group dynamics play an important role in the process of learning a foreign language. Some students will make comparisons between themselves and other students so that a sense of competition will emerge. In this case, Saville-Troike (2006) argues that the self-image of the learner (obtained from a competitive sense) can determine a decrease or increase in foreign language acquisition. If the self-image is not successful, there will be two possibilities. First, students feel like they have failed and their efforts to learn will decrease. The second possibility is that students will be more motivated to correct their mistakes and further improve their abilities. If the self-image is successful, students will have a positive experience so they will continue their business or even increase their business to make it even better. Thus, it can be concluded that group dynamics will make students assess their own abilities and compete to be the best in the class.

Student attitudes towards teachers and teaching materials

The attitude of students towards teachers and teaching materials can also affect the process of learning a foreign language and even the results of their achievements. A student will feel more comfortable learning if he is taught by someone he likes. At that time, the learning process becomes more effective and teaching materials can be conveyed properly. This will affect student learning outcomes. Likewise with teaching materials, when students don't like the material, they will install filters so that the learning process becomes less effective.

Learning Techniques

The last personal factor is the learning techniques used by students. The learning techniques they use are very diverse. Ellis (1985) classifies these learning techniques into two, namely learning language and acquiring language. Learning a language means that students use the techniques they usually use for learning such as memorizing, practicing (drilling), preparing something, and so on. While acquiring the language is the learner trying to plunge directly into situations where the target language is used. Examples include communicating directly with native speakers, watching movies or listening to music that use the target language and going to a country that uses the target language. All of this is done so that they can acquire the language they want, not by learning. The thing to note is that students need to recognize their own learning style in order to obtain optimal learning results. Schumann (2007) argue that personal factors are those that are difficult to observe by third parties. Therefore, personal factors can only be studied in two ways, namely using diary studies and using a combination of questionnaires and interviews with students directly.

3. COMMON FACTORS

As with personal factors, general factors are somewhat more universal. The followings are general factors that affect the language learning process:

1. Age

In relation to learning a foreign language, there is an interesting debate about at what age one should learn a foreign language in order to achieve optimal results. Many argue that children are the right period because there is a critical

period during childhood. The critical period is the time when the brain can digest language well. However, when it is related to learning a second/foreign language (L2), the assumption that L2 will be successfully learned in a critical period is still uncertain. Therefore, this hypothesis still needs to be studied further. In addition, there are also those who argue that adults will be better at learning languages. With regard to second/foreign language learning, several studies have concluded that children will be better at pronunciation and memory retention abilities (Hurd, 2006) while adults who have cognitive maturity will be better at dealing with the abstract nature of language (Taylor in Hurd, 2006).

2. Motivation

Motivation is an important factor in language learning. According to Crozier (2001) and MacIntyre, Baker, Clement and Conrod (2001) students who are highly motivated set high standards for themselves, work hard to achieve these, and stick to tasks even when they are difficult, whereas students who are less motivated will appear to give up in the face of difficult tasks. So, there is no doubt that motivation plays a very important role in the success of the language learning process.

There are two kinds of motivation; Integrative and Instrumental.

Integrative motivation is motivation that arises from the learner because of his interest in the language he is learning and his desire to be part of the community or culture of that language.

Instrumental motivation is the motivation that arises because the learner wants to benefit from the language being learned such as getting a job, passing a test and so on.

3. Intelligence

Intelligence influences the language learning process but is not dominant. Based on research conducted by Lightbown and Spada (2006), intelligence is related to reading, grammar, and vocabulary but intelligence is not related to the ability to produce oral. So intelligence has a very strong relationship with metalinguistic knowledge compared to the ability to communicate. In addition, different intelligences will produce different outputs. Howard Grangers (1993) formulated eight types of intelligence, hereinafter known as multiple intelligences (MI). MI includes language intelligence, logical/mathematical intelligence, visual-spatial intelligence, musical intelligence, motion intelligence, natural intelligence, social intelligence and self intelligence.

4. Dexterity

Dexterity is a special ability that someone has. There is a belief that dexterity will make someone learn something easily and quickly. It is argued that dexterity is related to success in learning a language. In addition, there are many tests that can be used to test dexterity, one of which is the Modern Language Aptitude Test (MLAT). This test is used to predict success in learning a foreign language. The dexterity test is used to measure four abilities, namely phonemic coding ability, grammatical sensitivity, inductive language learning ability, and memory and learning.

5. Cognitive-style

According to Ellis (1982), Cognitive-style is the way how people perceive, conceptualize, organize and remember information. It can also be said that cognitive-style is a person's way of thinking (Cook, 2008). Of course, these methods will affect the language learning process because if the ability to process information is different, the results obtained will also be different. There are two types of cognitive styles introduced by Witkin (1973), namely field dependence and field independence. In field dependence, students tend to be more easily influenced by the environment. Whereas in field independence, students have a tendency not to be easily influenced by the environment. In addition, there are four cognitive styles, namely Concrete Learning Style, Analytical Learning Style, Communicative Learning Style, and Authority-oriented Learning Style.

Concrete learning style: Students with a concrete learning style process information actively and directly. They prefer something concrete, such as a verbal or visual experience.

Analytical learning style: Students with an analytical learning style prefer to think logically and systematically in learning. They like to solve problems and build their own principles.

Communicative learning style: Students with a communicative learning style prefer learning using a social approach.

Authority-oriented learning style: Students with Authority-oriented learning style are more responsible. They prefer clear instructions and knowing exactly what they are going to learn next.

6. Personality

Personality is also very influential in the learning process. Because a person's personality will determine what attitude will be taken next and what response will be made in the learning process.

a. Introverts

Students with introverted personalities prefer to be alone and spend their time reading, writing or using the computer. In the learning process, introverted students prefer individual learning activities and learning that places more emphasis on language knowledge (Cook, 2008).

b. Extroverts

In contrast to introvert students, extrovert student personalities tend to be more open to the outside world. They like crowds because they like to interact and do social activities. In language learning, extrovert students prefer learning that uses the Communicative Language Teaching approach because they can interact with each other (Cook, 2008). Many people think that extrovert students will be more successful in learning languages than introvert students. This hypothesis still needs to be tested for truth. However, Rossier (1975, in Cook, 2008) found that there is a relationship between extroverted students and oral fluency. This might be caused by the character of extrovert students who like to interact so that their fluency in language will become more trained.

c. Anxiety

In the learning process, students often feel anxious, nervous and stressed. This feeling will greatly affect the language learning process. There are two opinions regarding the effect of anxiety on language learning. It is argued that students who feel anxious will not learn as fast as students who feel relaxed. Meanwhile, Lightbown & Spada (2006) think that feeling anxious before a test or presentation will provide more motivation and focus so that success will be achieved. From these two opinions it can be concluded that anxiety does not always have a negative impact on the language learning process.

4. CONCLUSION

Individual differences are a very important aspect of language learning. This is caused by the large number of students in one class which of course will differ from one another. However, these differences cannot be changed by the teacher. Therefore, it is the learning process that must adapt to these differences.

In order for the language learning process to be successful, the teacher must know the individual differences of each student in the class; not only knowing but also understanding. The teacher's understanding of these differences will make it easier for him to design learning activities. So the learning process will be more effective and the results will be more optimal. However, in reality, it is indeed difficult to accommodate all the differences that exist within the class. That's when a teacher's determination will be tested, because a good teacher is the one who tries to do his best for the success of his students.

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The Importance of Formal and Informal Education in Growing Students' Skills

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Abstract

Education is an important component of the development of society, often as a term education is not covered or even not treated in the right format and for this reason we have many problems that we face precisely because of education. The formal education that people receive in educational institutions usually has an impact on the growth of professional skills and abilities, but this is not enough, therefore a balance between formal and non-formal education is needed as an important component of the development of the principle of lifelong learning to give you the opportunity for students to continue to have flexibility and adapt their knowledge and skills to the needs of the environment, school, profession. The formal part of education and the non-formal part through the development of workshops and trainings are essential components for professional preparation with an impact on increasing the level of education. Research question: How much does formal education affect the development of students' abilities? Does non-formal education have an impact on the development of the principle of lifelong learning? The methodology consists in the collection of primary and secondary data through the use of literature and Internet resources, as well as in the analysis through a quantitative research through questionnaires and data analysis with the Spss software package.

Keywords: Formal education, non-formal education, professional skills, flexibility, lifelong learning

1. INTRODUCTION

The topic has been a significant area of interest to the researchers, theorists, and practitioners, and there have been numerous researches carried out to emphasize the importance & effectiveness of life skills education in the development of students' social, emotional and cognitive development & dealing with their psychosocial problems and issues. According to Albertyn et al. (2004) life skills training enhance critical thinking abilities, which further impacts were living life actively, being responsible in the job and in future planning too. Ramesh and Farshad C. (2004) in his study proved the effectiveness of like skills training in increasing mental and physical health, pro-social behavior and decreasing in behavioral, social problems & self-destructive behaviors. Smith & et al., (2004) noted significant improvement in interpersonal relationship and reduction in aggression and behavioral problems. Tuttle et al., (2006), during their investigation, add the life skills to students' curriculum. The results of this study suggested the extraordinary capability of teens to positive promotion and flexibility. Vranda and Rao (2011) proved that life skills training enhanced their psychosocial Competencies. Puspakumarag (2013) in his study showed that life skills training was effective in preventing a wide range of problems such as substance abuse, teenage pregnancies, violence Bullying & to promote self-confidence and selfesteem among the adolescents. Roodbari, Sahdipoor, and Ghale (2013) in their research showed that life skills training has a positive effect and improves social development, emotional and social adjustment, suggesting an increase in compatibility of children and public

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health. The present paper focuses on how enhancing social, emotional and thinking skills through life skills education, helps the 21st- century youngsters to achieve their goals strengthens the abilities to meet the needs and demands of the present society and be successful in life.

A relevant and proper implementation of life skill education is a need of an hour, for today’s society. Imparting life skills education to the students, can be helpful as it specifically addresses the needs of children, helps in motivating, providing practical, cognitive, emotional, social and self-management skills for life adjustments. Yadav P, Iqbal N(2009) showed positive results of imparting life skills education to students and bringing the change in adolescent’ s attitude, thought and behavior by providing supportive environment to them. According to Errecart et al., (1991) and Caplan et al., (1992) life skills education proves to be an effective approach in primary prevention education, as its more interactive, uses problem solving approach and is activities based. Hence, teacher and the taught both involves in learn and fun too.

In the light of above discussion, it could be concluded, that, Life skill education has its importance and significance in overall development of students. Our findings are in common to the findings of Botvin, et al., (1998), Nair. M.K.C, (2005) many more, suggesting life skill education program as a good supportive system for adolescents.

Imparting ‘Life Skills Education’ In Classroom Imparting Life Skills Education in classroom has been researched meticulously. In the light of the above literature review, now have been a proven fact that it has positive outcome when taught as a part of curriculum Yadav P, Iqbal N (2009). There are various past research indications, over life skills be implemented as a training program, as an intervention approach and a model contributing to healthy development of adolescents. Thus, the significance of life skills education and in the following section researchers have tried to attempt, how with the help of simple activities it can be implemented in classroom settings. Different activities that can be used to enhance Life Skills in Students are as follows: Classroom Discussions: An activity, providing opportunities for students to learn and practice turning to one another in solving problems. Enables students to deepen their understanding of the topic and personalize their connection to it. Develops skills, in listening, assertiveness, and empathy. Brainstorming: It allows students to generate ideas quickly and spontaneously.

Helps students use their imagination and think out of the box. Good discussion starter because the class can creatively generate ideas. It is essential to evaluate the pros and cons of each idea or rank ideas according to certain criteria. Role Plays: Along with being a fun activity and involves whole class, to be active and participative, it also provides an excellent strategy for practicing skills; experiencing how one might handle a potential situation in real life; increasing empathy for others and their point of view; and increasing insight into own feelings. Groups: Groups are helpful when the time is limited as it maximizes student input. Allows students interactions, allows to, know, one another better which in a way enhances team building and team work. Educational Games and Simulations: It promotes fun, active learning, and rich discussion as participants work hard to prove their points or earn points. They require the combined use of knowledge, attitudes, and skills and allow students to test out assumptions and abilities in a relatively safe environment. Analysis of Situation and Case Studies: It gives a chance, to analyze, explore, challenges, dilemmas and safely test solutions for; providing opportunities for working together in groups, sharing idea, new learnings and gives insight and promotes sometimes to see things differently. Case studies are like powerful catalysts for thought and discussion. Engaging in this thinking process; students improve their own, critical thinking, decision-making skills. It also gives chance to confront with risks or any challenges and find ways to cope with it. Contemporary Issues in Education Research – First Quarter 2017 Volume 10, Number 1 Copyright by author(s); CC-BY 4 The Clute Institute Story-Telling: Can help students think about local problems and develop critical thinking skills, creative skills to write stories, or interact to tell stories. ‘Story-Telling’ lends itself to draw analogies or make comparisons, help discover healthy solutions. It also enhances attention, concentration, listening skills and develops patience and endurance. Debates: Provides opportunity to address a particular issue in depth and creatively. Health issues lend themselves well: students can debate, for instance, whether smoking should be ban in public places in a community. It allows students to defend a position that may mean a lot to them. It offers a chance to practice higher thinking skills.

2. STATISTICAL DATA AND RESULTS

Table 1. Definition coefficient of independent and dependent variables

Model Summary

Model	R	R Square	Adjusted R Square
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1	.926 ^a	.863	.848
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a. Predictors: (Constant)? Formal education, the ability of professor, the methodology of the lecture , educational curriculum

In this table is presented the coefficient of determination, R = 0.86, while Rsquare 0.85, or the adjusted coefficient $0.84 \times 100 = 84\%$, which means the independent variables explain the dependent variable for 84%.

Table 1. significance expressed through anova the explanation F test

ANOVA^a

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	40.137	4	10.034	158.720	.000 ^b
	Residual	18.650	295	.063		
	Total	58.787	299			

Dependent Variable: a. development of students' abilities

b. Formal education, the ability of professor, the methodology of the lecture , educational curriculum

b. Predictors: (Constant),

Here is presented the model of Anova, where the level of significance is 0.000, which shows that the model has relevant links.

Table 2. Regression analysis expressing the impact of independent variables on dependent variable

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	.116	.066		2.755	.010
	Formal education	.183	.074	.238	3.487	.000
	the ability of professor	.590	.048	1.097	12.297	.000
	the methodology of the lecture	.862	.076	.483	11.410	.000
	educational curriculum	.179	.050	.373	3.607	.000

a. Dependent Variable: Development of students' abilities

In this table is presented the regression analysis, which shows how many independent variables have an impact on the dependent variable, which is explained through the OSL equation,

$$Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + U_i$$

In the table 1 are presented coefficients and their significance for the Development of students' abilities. Table shows that independent variables that consist Formal education, the ability of professor, the methodology of the lecture, educational curriculum which all together have impact on dependent variable Development of students' abilities. Based in research question - How much does formal education affect the development of students' abilities. **The formal education has impact to develop the students abilities.**

Table 3. correlation analysis expresses connectiveness between two variables.

Correlations

		non-formal education	lifelong learning
non-formal education	Pearson Correlation	1	.432**
	Sig. (2-tailed)		.000
	N	300	300
lifelong learning	Pearson Correlation	.432**	1
	Sig. (2-tailed)	.000	
	N	300	300

According to this, there is a strong, positive and important relationship between non-formal education and life longn learning at the level sig 0.000 which is less than 5% of the calculated coefficient. From this, we can say that there is a positive relationship between these two variables.

3. RECOMMENDATIONS AND CONCLUSIONS

The continuous orientation in the development of more practical and efficient models for teaching and learning directly affects the quality of education. Kosovo should draft genuine educational policies both at the central and local level to harmonize the theoretical and practical part. Orientation in the development of professional skills through an effective system of education and synchronization with informal education greatly affects development throughout life. Investments in education are made today to give results in the future, so education is the basis of the development of a country and therefore everyone must participate to develop this important social concept.

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