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From the Editor

Dear readers,

The interest in publishing in the Journal of Information and Organizational Sciences increases every year. So, I thank all authors that find our Journal appropriate to submit their papers.

Regardless of the ever-growing number of submitted papers, we are keeping a high level of the review process. Therefore, I would like to thank our reviewers for the care and expertise they employ in their reviews.

This issue contains 14 scientific papers, eight original scientific papers, four survey papers, and two preliminary communication.

I hope that this issue will not disappoint our readers, for, in my opinion, it contains high-quality and interesting papers from the fields of information science and management.

Alen Lovrenčić
Editor

A Novel Classification Model for Employees Turnover Using Neural Network to Enhance Job Satisfaction in Organizations

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Abstract

The most important challenge facing modern organizations is to keep their employees as valuable assets. Employee turnover is one of these challenges. This paper aims to develop a novel model that can help decision-makers to classify the problem of Employee Turnover. The proposed model is based on machine learning algorithms. The model was trained and tested by using a dataset that consists of 1470 records and 25 features. To develop the research model, many experiments had been conducted to find the best one. Based on implementation results, the Neural Network algorithm is selected as the best one with an Accuracy of 84% and AUC (ROC) of 74%. By validation mechanism, the model is acceptable and reliable to help origination decision-makers to manage their employees in a good manner and setting proactive plans to keep them. Besides the model, three important features should be dealt with carefully as Over Time, Job Level, Monthly Income.

Keywords: Employee Turnover, Job Satisfaction, Machine Learning, Classification.

1. Introduction

Employee turnover is one of the most important challenges facing modern organizations. Employee attrition in terms of deterioration influences the efficiency of the organization [1]. The market world is currently experiencing extreme competition leading to the failure of organizations and businesses that cannot invest optimally in human capital, as the position of these services is based on the new administrative sciences [2]. Employee turnover is defined by the willingness of the employee to quit his current job, whether by his will or the desire of the establishment. Also, it could be defined as the choice to be compensated by a person who belongs to an organization to quit his current work [3]. There are many causes for employee turnover, the most important of which are: lack of a consistent promotional career direction, lack of a sense of justice in measuring work results and lack of a sense of job security [4]. Job satisfaction is a psychological feeling of contentment, satisfaction, and happiness. It satisfies the needs, desires, and expectations with the work itself and the work environment, with confidence, loyalty, and belonging to

work and with the relevant internal and external environmental factors and influences [5]. In another definition, it indicates that job satisfaction is a trend that is the outcome of many beloved and unloved experiences Associated with work and reveal himself with the appreciation of the individual for work and management. Job satisfaction reduces employee turnover [6].

To reduce the ratio of employee turnover, data mining can play an important role by providing a model that works as a decision support system [7]. Data Mining is the process of discovering patterns from large data sets based on methods that intersect both machine learning, statistics, and database systems [8]. In the data mining process, we have the same concept. For data mining, you must first collect data from various sources, prepare it, and store it in one place, as nothing from data mining is related to the process of searching for the data itself [9]. The model in data mining is a computerized representation of real-world observation. Forms are algorithm applications to search, identify, and display any patterns or messages in your data. There are two types of models in data mining: taxonomic, descriptive, or predictive [10].

In this paper, a new model has been proposed. The model will be used as a decision support system that helps the organization managers to take the right decisions for keeping their employees as a valuable asset. The model was built based on classification algorithms. Classification algorithms are a form of data analysis that extracts models that accurately describe important data categories and classifications. For example, a classification form can be built to evaluate loan applications in a bank's loan granting system, dividing the group of applications into two categories, safe and unsafe [11]. By using the model, we can classify employees into two classes: attrition class or not.

The rest of the paper is organized as follows: The next section presents some interesting researches related to the research area as related work. In Section 3, a full description of the proposed model is provided in terms of Framework, Dataset, implementation, and the results. Section 4 concludes the paper and suggesting some points to improve model accuracy as future

2. Related work

There is no doubt that technological discoveries, especially in the field of artificial intelligence, have greatly assisted decision-makers in the decision-making process [12]. They provided them with the ability to analyze their decisions and compare them with similar decisions and show the results that may result from this or that decision. Also, these systems provide advice to administrators through an analysis of Information stored on private databases in decision-making support systems [13]. A decision support system provides organizations with valuable information to achieve their strategic objectives [14].

Several previous studies have shown that turnover is the consequence of work dissatisfaction a combination of factors which include pay, recognition, and career development opportunities.... etc. In one of the previous studies, data were collected from primary and secondary sources, they used the questionnaire to analyze factors

affecting employee turnover and found there were three main factors that influence the decision to resign: internal factors, personal and external [19].

Due to stressful work environment retention of employees in IT sector is low. These stressful situations stimulate employees to keep changing their jobs. Job satisfaction is directly associated with the continuance of the employment specifically in IT sector Jan et al., (2016). It is cumbersome process to replace tech workers as it has negative effects on customer services and information security. In compare to other professions IT professionals receives more job solicitation per week.

A previous study conducted several in-depth interviews and surveys with leaders and managers who lose their employees in the department and proved that there is no unique factor that leads to turnover but is a set of factors that influenced the employee and led to the decision to resign. The salary is an important factor that causes turnover; other factors found are recognition, identification of responsibilities, and career opportunities. This set of factors indicates that the employee has found other job offers or dissatisfaction resulting in his resignation, which means that employees are going through a series of stages before deciding to change the jobs [20, 29 , 31].

Data Mining Model is one of the important models that help the decision-makers by discovering knowledge behind data. Knowledge has different forms such as predictive or descriptive models. This paper focuses on predictive models. Many types of research have been conducted in this area. This section presents some of them.

IBM Team M. Watson Singh et al. conducted brilliant research on the turnover cycle. The research proposed a system that defines the causes of the turnover and predicts future employee turnover. They also attempted to quantify the cost of attrition and recommend the name of the employee for the retention process, comparing the discrepancy between the Expected cost of attrition before retention period (EACB) and the Expected cost of attrition after retention period (EACA) [15].

L. Carlos et al. put forward a proposal for a Chronic problem with college forecasts for Brazilian Universities Heartlessness. H2O software was used as a data extraction tool and deep learning and attempted to predict the dropout cases Identify and initiate student attrition profiles [16]. K. Dejaeger et.al suggested a centric production on income by Maximum benefit estimation using a maximal fraction of the Best forecasted consumer loss rates in retention [17].

For another research, Choudhary et.al outline the implementation of the methodology of logistics regression based on the demographic data for independent personnel as well as current staff Create a probability algorithm to estimate the turnover of the workforce. This will come later Equation used to compare the probability of turnover with the present one Employees set. The high-risk cluster was established after the assessment to figure out the reasons for this, and the action plan was named to reduce the risk [18].

Also, research studies predicted a voluntary turnover rate by applying cluster analysis which considered an unsupervised learning method. It was found the results indicate that the high turnover trend circle was primarily caused by a lack of inner fidelity identification, leadership, and management [14]. The Predictive Model can be created by various methods of data mining.

Data mining defined as “the process of sorting through large data sets to identify patterns and establish relationships to solve problems through data analysis. Data mining tools allow enterprises to predict future trends” [15] Data mining Techniques can be useful for Human Resource Managers in identifying factors influencing employees to predict turnover.

There are many data mining algorithms for classification such as Decision Tree, SVM, Random Forest, Neural Network, and Naïve Bayes. In this paper, a brief description is provided for Neural Network and Naïve Bayes Algorithms.

Neural networks are a series of algorithms that are closely modeled after the human brain and programmed to identify patterns. They view sensory data by means of a form of raw input system interpretation, marking, or clustering [21] [30]. The trends they know are empirical, stored in vectors that need to be converted into all real-world data, be it images, voice, text, or time series. Neural networks allow one to build and identify clusters. On top of the data you store and handle, you might think of them as a layer of clustering and grouping. They help group unlabeled data according to differences between example inputs and identify data when they have to work on a labeled dataset. (Neural networks may also derive characteristics that are fed into other clustering algorithms and Classification; and you can think of deep neural networks as components of broader machine-learning systems including instruction, classification, and regression reinforcement algorithms [22]. Figure 1 presents Neural Network Algorithm.

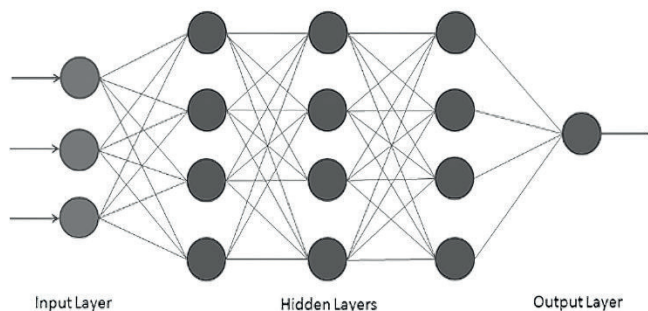


Figure 1. Neural Network Algorithm

Naive Bayes algorithm is a technique of classification based on the theorem of Bayes with an assumption of freedom of predictors [24]. A Naive Bayes classifier believes, in basic words, that the inclusion of a specific function in a class is irrelevant to some other function. Naive Bayes model is simple to construct and particularly useful for incredibly large data sets. Naive Bayes is considered to outperform even extremely advanced methods of classification, in addition to simplicity. Bayes Theorem provides a way for $P(c)$, $P(x)$, and $P(x|c)$ to measure posterior likelihood. Look at the equation underneath Fig. 2:

$$P(c|x) = \frac{P(x|c)P(c)}{P(x)}$$

Likelihood Class Prior Probability
 ↗ ↖
 ↘ ↗
 Posterior Probability Predictor Prior Probability

$$P(c|X) = P(x_1|c) \times P(x_2|c) \times \dots \times P(x_n|c) \times P(c)$$

Figure 2. Naïve Bayes Algorithm

3. Method and Techniques

The purpose of this research is to save organization costs by use information available in human resource management to predict employee turnover and also, to improve retention of valuable employees. In this way, the internal resources of the organization will be maintained as much as possible. The experimental method was used to develop an accurate machine learning model. Based on this, machine learning classification algorithms were used for multiple experiments to find the more suitable algorithm for the proposed model. This research answers two questions: First, how can an organization detect the expected turnover of employees. Second, what are the features that should be focused on by the organization for the detected group? Fig 3 shows the research model components terms the methodology that was used to develop the proposed model.

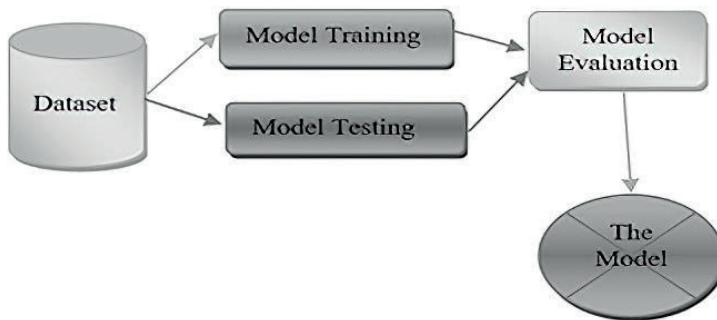


Figure 3. Model Components

The dataset contains HR employee records. The model is trained and evaluated by means of the dataset and classification algorithms. Based on the test results, the best algorithm is selected to be used to identify knowledge about the new staff. The model should help decision-makers make the best decision to keep their employees.

3.1 HR Employee Dataset

The dataset includes a fictional data set created by IBM data scientists. The dataset has 1470 observations that refer to employees with 25 attributes. This data set is obtained from IBM Data Science Community [25].

The attrition attribute has been selected to be used for the classification model. It is very important to understand the dataset before conducting the analysis. One of the options is feature selection. The selection of features can be defined as a process that selects a minimum subset of M features from the initial set of N features so that the feature space is minimized optimally according to a certain evaluation criterion. The amount of function N decreases as the dimensional of a domain extends. It is typically intractable to find the right subset of functions [23]. The table. 1 gives an overview of the dataset variables.

Variables	Category	Frequency(Percentages)
Environment Satisfaction	Low	284(19.3%)
	Medium	287(19.5%)
	High	453(30.8%)
	Very High	446(30.3%)
Job Involvement	Low	83(5.6%)
	Medium	375(25.5%)
	High	868(59%)
	Very High	144(9.8%)
Job Satisfaction	Low	289(19.7%)
	Medium	280(19%)
	High	442(30.1%)
	Very High	459(31.2%)
Performance Rating	Excellent	1244(84.6%)
	Outstanding	226(15.4%)
Relationship Satisfaction	Low	276(18.8%)
	Medium	303(20.6%)
	High	459(31.2%)
	Very High	432(29.4%)
Work Life Balance	Bad	80(5.4%)
	Good	344(23.4%)
	Better	893(60.7%)
	Best	153(10.4%)
Education	Below College	170(11.6%)
	College	282(19.2%)
	Bachelor	572(38.9%)
	Master	398(27.1%)
	Doctor	48(3.3%)

Table1. Descriptive statistics for variables

For ranking the important attributes, two methods were used: Information Gain and Chi-Square. Information gain is a synonym for Kullback – Leibler divergence in information theory and machine learning; the sum of knowledge obtained regarding a random variable or signal from another random variable being measured [26]. However, the term is often used synonymously with reciprocal knowledge in the sense of decision trees, which is the conditional predicted value of the Kullback – Leibler variance of the univariate distribution of the probability of one variable from the conditional distribution of this variable to the other. The information gain is obtained by the following equation:

$$IG(T, a) = H(T) - H(T|a),$$

where $H(T|a)$ is the contradictional entropy of T given the value of attribute a .

For machine learning, the Chi-Square test is important, and how this test makes a difference. The selection of features is a significant problem in machine learning, where we will have many features in line and have to select the best features to create the model [27]. Through checking the relationship between the features, the chi-square test lets you solve the question of feature selection. The chi-Square is obtained by the following formula:

$$\chi_c^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

where:

c = Defrees of freedom

O = Observed value(s)

E = Expected value(s)

The two methods are agreed on four attributes Over Time, Job Level, Monthly Income and Years at Company. These attributes have a strong effect on building the model. Table 2 shows the ranking attribute by using two methods: Information Gain and Chi-Squair.

Features	Rank(Information Gain)	Rank(Chi-Squair)
Over Time	0.04	63.845
Job Level	0.036	44.669
Monthly Income	0.03	41.795
Years at Company	0.028	37.09

Table 2. Ranking Features

Based on the results in table 2, these four features are reflecting very important indicators for keeping employees satisfied with their jobs and they play a significant role to reduce employee turnovers.

3.2 Proposed Model development

To develop the research model, many experiments have been conducted using five classification algorithms in order to reach the best one. These algorithms are as follows: Decision Tree, SVM, Random Forest, Neural Network, and Naïve Bayes. The Cross-Validation 10 method was used for testing the models.

To evaluate the model, a confusion matrix was used. The confusion matrix, also known as the error matrix, is the problem of mathematical classification in the field of machine learning [28]. The uncertainty matrix is a table frequently used to describe a classification model's output (or "workbook") on a collection of test data recognized for the real values. It allows the algorithm's output to be visualized. different parameters were used as mentioned in fig. 5:

		Prediction Class		
		Positive	Negative	
Actual Class	Positive	True Positive (TP)	False Negative (FN) Type II Error	Sensitivity $\frac{TP}{(TP + FN)}$
	Negative	False Positive (FP) Type I Error	True Negative (TN)	Specificity $\frac{TN}{(TN + FP)}$
		Prediction $\frac{TP}{(TP + FP)}$	Negative Predictive Value $\frac{TN}{(TN + FN)}$	Accuracy $\frac{TP + TN}{(TP + TN + FP + FN)}$

Figure 5. Confusion matrix attributes

Many experiments have been conducted to build the model in three phases: phase one the model was trained by using classification algorithms (Decision Tree, SVM, Random Forest, Neural Network, and Naïve Bayes). In phase two, the model has been tested by using Cross-Validation 10. Finally, the model has been evaluated based on the confusion matrix to select the best algorithm. Table 3. Shows the implementation results.

Model	AUC	CA	F1	Precision	Recall
Tree	0.577	0.791	0.78	0.771	0.791
SVM	0.475	0.727	0.718	0.711	0.727
Random Forest	0.704	0.836	0.819	0.812	0.836
Neural Network	0.755	0.85	0.819	0.823	0.85
Naive Bayes	0.7416	0.8116	0.8114	0.8112	0.8116

Table 3. Confusion Matrix Results

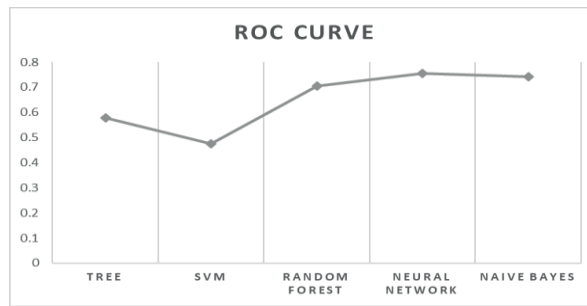


Figure 6. Model ROC curve

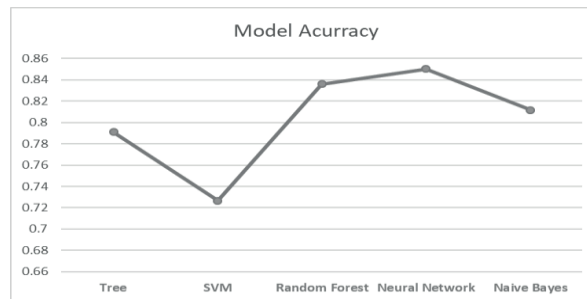


Figure 7. Model Accuracy

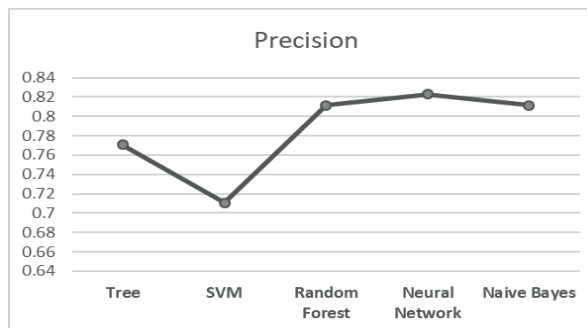


Figure 8. Model Precision

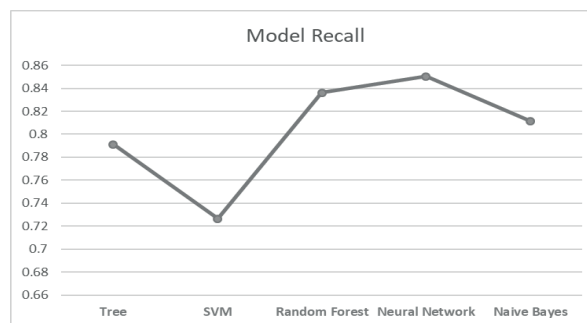


Figure 9. Model Recall

3.3 Results Discussion

As mentioned in table 2 The accuracy of five algorithms: Tree, Random Forest, Neural Network, VSM and Naïve Bayes were above 80%. The accuracy is obtained by the equation mentioned in fig. 5. But, the accuracy is not a best factor to select the best algorithm and that because the tendency of the classification attribute “Attrition” is very high as shown in figure 10.

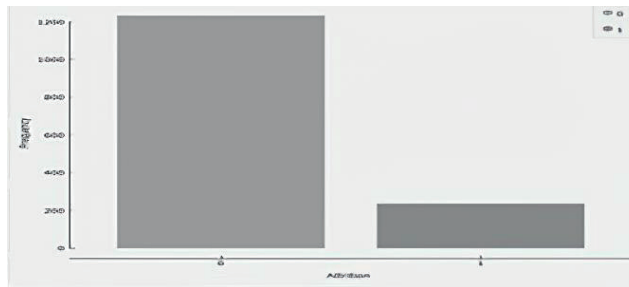


Figure 10. Classification Attribute: Attrition

In this case, the model depends on the Area Under Curve (AUC) Parameter and also called Receiver Operating Characteristics (ROC). AUC means "Space under the ROC Curve," i.e. AUC measures the whole two-dimensional space under the whole ROC curve (think integral calculus) from (0,0) to (1,1). Fig. 11 presents AUC for the five proposed algorithms [29].

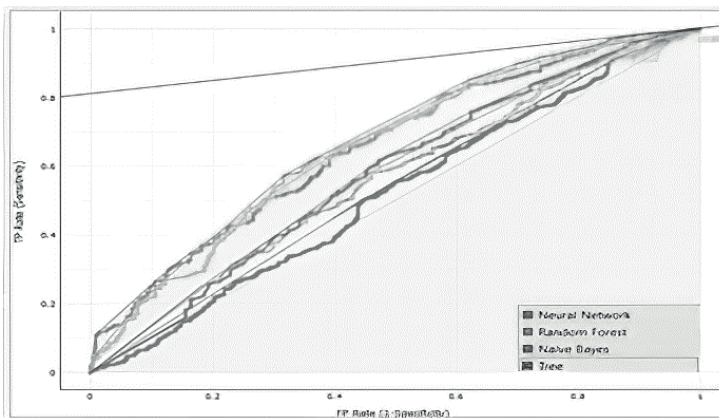


Figure 11. presents AUC for the five proposed algorithms

To select the best algorithms among the five ones, it is based on the AUC rate. The acceptable rate is between 0.5 to 1. The better ones, the nearer to 1. Based on this fact, the neural network algorithm is the best one to be used by the model to classify the employees. In this way, the top management of the organizations can prepare plans to keep their employees as valuable assets. Figure 12. presents AUC for the Neural Network.

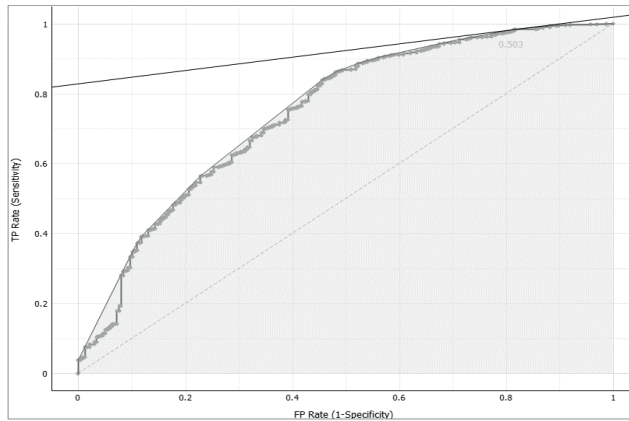


Figure 12. AUC for the Neural Network

4. Conclusion and future work

In this paper, a novel data mining model has been developed. By using feature selection methods: Information Gain and Chi-Square, the most important four features have been extracted from the dataset. These features are over time, job level, salary, and years in the organization. As one of the important results of this research, these features should be planned carefully to keep organizations their employees as valuable assets. The proposed model is based on machine learning algorithms. Classification algorithms were used to implement the model such as Decision Tree, SVM, Random Forest, Neuronal Network, and Naïve Bayes. The model was trained and tested by using a dataset that consists of 1470 records and 25 features. To develop the research model, many experiments had been conducted to find the best one. Based on implementation results, the Neural Network algorithm is selected as the best one with an Accuracy of 84% and AUC (ROC) of 74%. By validation mechanism, the model is acceptable and reliable to help decision-makers to manage their employees in a good manner. The could be used to classify current employees if they will be turned over or not. This point answers the first research question. Figure 13 presents the model with results. This model could be used by HR departments to predict employees into two groups: expected turnover employees or not. For the first group, they may set plans to improve the features: Over Time, Job Level, Monthly Income. This point answers the second research question.

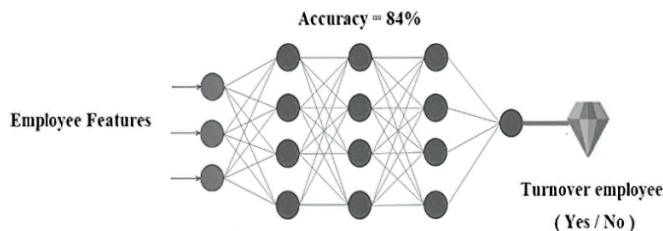


Figure 13. The Proposed model

As future work of this research, the dataset needs to cover the social information about the employees and not only information about the organization. In this way, the efficiency of the model will be improved.

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Existing Differences Between SMEs That Apply BSC and Those That Do Not

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Abstract

This paper aims to confirm the importance of BSC (Balanced Scorecard) in SMEs' organizational performance. To perform the empirical study of this investigation, a field study, namely a qualitative approach, Multi Case Study was selected and developed in two small and medium organizations (SMEs) in the wine sector. One of the organizations, had the Balanced Scorecard (BSC) implemented while the other did not, which made it possible to ascertain the existing differences among SMEs that apply and those that do not apply BSC.

The results showed that BSC has impact on business success. SMEs benefit from the implementation of BSC, consequently SMEs were encouraged to adopt it based on the benefits in terms of performance and measurement of strategic objectives.

This study reflects that BSC has been a discussion and research topic over the last few years as it leverages business. Managers seek appropriate BSC tools to implement indicators and monitor these in accordance with the global organizational strategy. Besides BSC provides managers with relevant information to take decisions, define action plans and achieve the whole organizational control.

Keywords: Management Control; Balanced Scorecard; Performance; SMEs.

1. Introduction

In recent decades Portuguese business structure has undergone sharp adjustments, reflecting changes in competition (China and other Eastern European countries). It is known that some sectors stand out more than others, namely the wine industry, tourism, catering and even agriculture. Among Portuguese organizations, SMEs have the greatest economic relevance. In the wine industry three-quarters of the organizations are SMEs and generate around 70% of the sector's turnover.

Given the relevance of SMEs, business success has increased supported by internal sets of Management Control Tools which guide business administrations and managers.

Bearing in mind the strategic relevance of Management Control Tools such as the need to interlink different organizational perspectives, Kaplan and Norton developed an important Management Control Tool, namely the BSC, in the 1990s. The well-known BSC as referred by [1][2] comprises four Perspective indicators: the Financial Perspective consisting of indicators that show the results of past actions; the Customer Perspective composed of indicators related to customer satisfaction; the Internal Perspective comprising processes referring to the potential to improve, and the fourth Perspective named Learning and Growth includes training and infrastructures to leverage organizational development.

BSC empowers strategic analysis, leads to value creation, as is the case with mapping and monitoring strategy in order to guide managers to interconnect operational performance with the strategic objectives, being considered as one of the most prevalent performance and strategic management tools [3][2].

As the strategic map is the basis for the BSC development, it characterizes the whole organizational strategy and describes the critical success factors of the organization. Furthermore, it illustrates the relationship between each of the four perspectives and their cause and effect relationships, showing an objective way of value creation to the entire organizational structure.

2. Literature Review

2.1. Management Control

Management Control Tools have gradually become recognized, especially since the 1980s. At that time, public institutions began to pay more and more attention to performance appraisal and to continuous improvement projects. As the primary objective of public institutions is the analysis and identification of processes, products (goods or services), also for public institutions, performance measurement tools guide to identify deviations and follow action plans [4][5].

In the early 1990s managers confirmed that the analysis and monitoring of financial indicators hindered an overall overview, with a short-term focus only on financial indicators that compromised long-term options [6]. Following this path, [7] proposed to change General Electric's eight perspectives to four perspectives composing the Balanced Scorecard (BSC), one of the most widely used management tools for monitoring and balancing organizational performance indicators [7].

The BSC proposed by [7] argues that management cannot only concentrate on financial indicators, because the financial aspect, by itself, does not generate value. According to these authors, at the time of BSC's development, only 5% of operational employees knew the organization's strategy and only 25% of managers received incentives to achieve previously defined objectives. Additionally, 60% of organizations did not link budgets to strategy, while about 85% of managers devoted

less than an hour a month to organizational strategy. Thus, after having developed Case Studies over a year, in twelve companies, as reported by [8], the BSC was presented in 1992 as a multidimensional Management Control Tool, which over time has become a more complete management tool, as shown in Table 1:

System	Functionalities
Measurement System	- Specific indicators and objectives (1992)
Communication system	- Information of the organisation's strategic objectives (1992-1993)
Global and individual evaluation system	- Implementation of strategies - Strategic implementation tool, transforming measures into specific actions and consequent value creation - Measures and actions also of intangible values (1993; 1996-1997)
Strategic management system	- Decision-making aid - Evaluates and monitors the management system, linking intellectual capital to strategy, communicating across organisational borders (1996-1997; 2004)
Self-assessment system of the management system	- Concentration of intellectual capital in favour of the established strategy (2004-2008)
Strategic relations management system	- Strengthening strategic relations with the outside - Bringing back extraorganizational relationships, giving primacy to strategic alliances (2010).

Table 1. Evolution of BSC, Source: adapted from [9] cited by [10]

Based on the previously mentioned four organizational Perspectives, namely: Financial perspective, Customer perspective, Internal Perspective and Learning & Growth Perspective, managers have a balanced view. The perspectives are interconnected through cause-effect relationships, which lead to the defined strategic objectives [7].

Managers are able to have an individual overview on the one hand and an aggregated overview of the actual performance, on the other. Furthermore, a comparison between the actual and the budgeted organizational strategy is enabled [11], as shown in Figure 1.

Knowing that traditional performance indicators are based only on accounting systems, [12] highlight the added value of Dashboards. Sustained on the Dashboards, like BSC strategic objectives might be communicated and monitored. In order to have this overview, managers need to be aware of the importance of the Balanced Scorecard Steps, as described in Table 2.

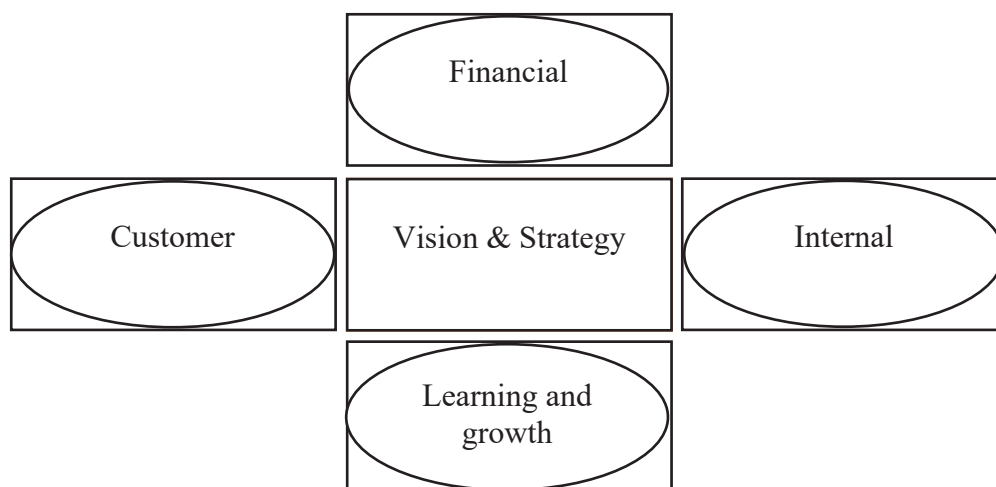


Figure 1. Perspectives of the *Balanced Scorecard*, Source: adapted from [4]

1. st Step	Strategy Development
2. nd Step	Definition and implementation of strategy support measures.
3. rd Step	Integration of measures into the management system.
4. th Step	Periodic verification of measures and results.

Table 2. Steps of the *Balanced Scorecard*, Source: Adapted from [13]

[14] argues that the implementation of the BSC is divided into the following steps:

- Define the sector of activity and evidence the role and development of the organization;
- Define the organization's perspectives;
- Define the organization's vision, taking into account each perspective;
- Identify critical success factors for the organization;
- Develop strategies to create an organizational balance across the organization;
- Set the goals to be achieved by the organization;
- Create and develop an action plan to execute the organization's strategy;

Managers should define the strategic indicators and their targets, in accordance with the organization's strategy, as seen in Table 3 in which the Process of Performing Strategy is highlighted.

Strategy development process	Objectives	Platform	Representative Activities
Mission, Vision and Values (What business are we in? Why?)	Reaffirm the organisational guiding lines	Set out how to execute the view	Mission analysis; Confirmation of vision; Central values;
Strategic objectives	Clearly set the financial target, as well as strategic	Establish the economic model that will be used	Mission measures Decomposition of value;

Strategy development process	Objectives	Platform	Representative Activities
(Where are we going?)	objectives that will lead to the overall strategy.	throughout the strategic management process.	Strategic themes; Goals for the next 3-10 years; Financial model.
Strategic analysis (What are our core objectives?)	Identify, through a structured analysis, the events, forces and experiences that impact and modify the strategy.	Define the link between influential forces and the value creation process.	Environmental analysis (Pestel / 5 Forces); Internal analysis (SWOT / Value Chain); Strategy for reviewing objectives; Identification of key subjects.
Formulation of the Strategy	Define where and how the organisation will compete.	Ensure that changes to the strategy are linked to changes in the planning and implementation of the process. Set the limits of admissible amendments.	Where to compete (niches); Differentiation (value propositions); How to compete (strategic map); Financial model/Stratex; Strategic change agenda.

Table 3. Process of Performing Strategy, Source: Adapted from [15]

Considering the strategy development process, it is verified that the point at which a given organization is, is measured by comparison to the goal. In this process it is effectively considered that the key to organizational success are employees [11]. It is known that the involvement and commitment of all the collaborators lead to a more efficient performance, so to have a clear overview about the Job Descriptions, the individual performance indicators also need to be clearly identified [16].

Despite its recognition, BSC was not the only tool proposed, given the need to broaden the field of action, involving medium and long-term financial and non-financial indicators, other management tools emerged, such as Tableau de Bord [17]. Although the Tableau de Bord and BSC tools use both financial and non-financial indicators, BSC distinguishes itself by incorporating cause-and-effect relationships between indicators grouped into four perspectives. BSC proves to be more dynamic, given its use of trend indicators, allowing future projections to be made, which may provide relevant information to reorient the strategy [18].

However, as noted and supported by the literature, BSC stands out as its applicability goes beyond the boundaries of private, for-profit companies, as it may also assist public institutions as public managers focus on performance indicators (KPI) and their causal relationships [19]. It is precisely on the basis of these gains that

the tool is also distinguished from the KPI Scorecard measurement system, as BSC, unlike the KPI Scorecard, interrelates strategic objectives in the four dimensions. Due to this limitation of the KPI Scorecard, strategic measurement of processes is achievable, in case that processes are interconnected with a global process [20].

Over the years there has been a need for the design of sustainability control mechanisms such as environmental sustainability [21]. Guidance on organizational sustainability is the key factor in justifying the integration of Sustainability Control Systems [22].

Over the past few years there has been much research and discussion on which definition of Management Control in the literature best fits the business reality [23].

Due to the high pressure to innovate, organizations and mainly managers seek Management Control tools [24], [25]. Consequently, Management Control gathers information to guide managers in decision making, planning activities and operational control [26]. A Control Tool goes beyond a monitoring process as it directs managers to decisions and guides their actions to reach their ultimate goal [27].

BSC influences managers' behavior as it highlights problems, avoiding the non-achievement of defined goals [28]. Furthermore, BSC promotes managers' capabilities to orientate the national and international market [29]. Overall, it provides all financial and non-financial information essential for making strategic decisions [30].

Management Control Tools should manage and coordinate communication between the different operational areas, so that stakeholders are able to coordinate, manage and dialogue about their needs [26]. [31] argue that much of the organization's financial success is related to its intangible resources.

2.2. Balanced Scorecard – its four Perspectives and the Strategic Map

From time to time, managers need to review and reconfirm their mission, namely to ask why this organization exists, what its values are, i.e., the attitudes and behaviors of the organization [32]. Organizations define their organizational mission to afterwards set internal and external goals [33]. Furthermore, the defined goals need to be aligned with the organizational mission. This alignment is performed by compliance of strategic objectives, resource allocation, organizational competencies, definition of responsibilities and competencies such as the development of strategic objectives [34].

[32] created an intermediate step between the definition and implementation of the strategy, which consequently will enable the analysis of the deviation between current and forecasted status for the next three to five years.

The mission has a more specific character, it defines how and in what way they should act to achieve the strategic objectives. Regarding vision, the internal and external environment elucidates where the organization intends to be in the future [35].

To make the communication of vision and strategy effective, it is important that the mission is defined by top management, while the strategy must be planned by all employees [36], [37]. Anchored in the BSC, several internal advantages are stressed,

such as strategically directioned communications and clearly conveyed information to employees using a common language. The added value consists mainly in a clear communication that allows all employees to understand and, consequently, work towards the same goal. In this sense, it is relevant to maintain intrinsic motivation, as employees often ask the following questions [36]: (i) Does my organization have a defined strategy for success? (ii) how does performance play an important role for the organization? It is essential that employees feel that they can contribute to the strategy. Organizations can link strategy maps to BSC to link all production units in a corporate way to vision and strategy [36].

[7] defined the concept of the BSC as an important instrument of performance evaluation, complementing the financial indicators that show the results of past actions with indicators of the operational side related to: customer satisfaction, internal processes and the learning and growth potential. Organizations need to improve the activities that lead to good financial performance in the future [7].

The BSC is considered a strategic management system involving the existing relationships between perspectives, aiming at the development of management processes based on the change of vision, strategy and the relationship between objectives and strategic indicators [38].

[39] argue that the BSC with its four perspectives is an adequate model to characterize the strategies devised for value creation. [40] reinforce this theory by encouraging four perspectives in the BSC that allow for a strategic analysis. In this sense, the financial perspective is geared towards a strategy of growth, profitability and risk. The customer perspective is driving the strategy of creating value and differentiation, based on the perspective of the customer. The internal process perspective focuses on the strategic priorities of business processes which create customer and business satisfaction.

Finally, the main priorities of the perspective of learning and growth are the organization's development and the creation of new cultures, such as innovation and growth.

BSC guarantees managers a management tool focused on the creation of the strategic map of their organizations, which forces them to act to the detriment of the competitive factors that can direct them to success, interconnecting operational performance to the strategic objectives [41].

Proof of this is that strategic maps represent the key characteristics of an organization's strategy, since they provide the fundamental points for the construction of the BSC, making it possible to understand the organization's strategy, how it intends to achieve it and how it intends to create relationships between the various objectives and each perspective [42].

Thus, the strategic map describes the entire strategy of the organization, describing all the critical success factors of the organization and the relationship between each of the four perspectives and the cause and effect relationships, objectively evidencing the creation of value for the entire organizational structure [43].

In the event that deviations from the target are identified, action plans need to be developed, as explained in Figure 2:

STRATEGY MAP		BALANCED SCORECARD		ACTION PLAN	
		MEASURE	TARGET	INITIATIVE	BUDGET
FINANCIAL PERSPECTIVE	Increase revenues and margins	• Revenue mix	New = + 10%		
		• Revenue growth	+ 25%		
CUSTOMER PERSPECTIVE	Increase share of customers' financial transactions	• Share of segment	25%	• Segmentation initiative	\$ _____
		• Share of wallet	50%	• Satisfaction survey	\$ _____
PROCESS PERSPECTIVE	Cross-sell the product line	• Customer satisfaction	90%		
		• Cross-sell ratio	2.5	• Financial-planning initiative	\$ _____
		• Hours with high-potential customers	1 hr/Q	• Integrated product offering	\$ _____
LEARNING AND GROWTH PERSPECTIVE	Create organizational readiness	• Human capital readiness	100%	• Relationship management	\$ _____
				• Certified financial planner	\$ _____
		• Strategic application readiness	100%	• Integrated customer file	\$ _____
				• Portfolio-planning application	\$ _____
		• Goals linked to BSC	100%	• MBO update	\$ _____
				• Incentive compensation	\$ _____
TOTAL BUDGET					\$ _____

Figure 2. Comparison Between Strategic Targets and Obtained Results, Source: [44, p. 105]

BSC is designed based on four primary phases in order to reach the defined Strategy:

- i. plan/planing - where financial results stand out. It consists in defining the organizational strategy and the four perspectives;
- ii. do - definition of strategic objectives;
- iii. check/confirmation - results are presented to top management in periodic monitoring meetings
- iv. act / corrective actions, meetings are held to define action plans, and new directions

In SMEs led by the entrepreneur and co-founder of the organization, usually the future successors will continue to work in the way the founder started.

[45] and [46] further argue that BSC should allow organizations to take advantage of all the qualities and creativity of all its employees in order to control the organization's business strategies.

[47] define organizational performance as an important indicator for assessing the operational efficiency of an organization. [48] argue that the performance of employees in an organization is viewed through two strands, behavior and results.

2.3. Balanced Scorecard in SMEs

The performance of an SME business is influenced by ownership, management method applied, family involvement in management, legal aspects, and economic policies of markets and countries of operation [49]. In the wine industry, critical

success factors such as wine quality, brand, labeling and packaging are key factors influencing the volume of sales of Portuguese wine to the national and international markets. In addition to these key factors, there are also the particularities of the region, climate, soil, history, geography and culture, which are also essential for understanding the success of export sales [50]. [50] also stated that the relation between winegrowers and exporters is relevant. These mergers stand out, for example, through lower prices, product quality, the attractiveness of the packaging and the label. The relationship between the organization's performance, its competitiveness is aligned to the growth success of its business [37], [51], therefore to effectively align BSC, it is crucial to link it to strategy [52].

For [53][54] family organizations, are managed by their owner, who takes all organizational decisions.

In Portugal, there is still no key definition of the concept of family organization [55]. A family organization results from the strategy, vision and ability that the founder has in directing all his actions in order to grow the entire organization in a sustainable way, applying and investing all the necessary capital in human resources so as to achieve the necessary business objectives [56], [57].

The founders and owners of family organizations differ from other managers regarding the importance of the organization's solvency and business prestige [58].

The founder of the organization acts essentially as the organization's energizer and motivator, because he shares his values and convictions of the organization as a whole with all the elements of the organization, representing an important factor for the continuity of the organization. The continuity of the family allows the conservation of the values introduced by the founder, which are accepted by the collaborators. By effectively managing the resources available in the organization, together with strategic planning, management skills, owner decision-making and business orientation, an administration can achieve good results and growth [59].

There are authors who argue that family businesses should apply management control systems, namely the BSC [60], [61], as it is the management tool that best suits the family business relationship, family management – family business, functioning as an aid not only in the communication and training of organization members [61]. In this sense, below in Table 4 we can find the Balanced Scorecard of the SME with BSC:

Perspectives	Objectives	Indicators	Target	Action Plan
<u>Financial</u>	1. Increase profitability	Sales	$\geq 5\%$	1. Promote the product at national fairs and competitions;
Own capitals	$\geq 5\%$			2. Creation of a web store on the Internet;
2.Reduce Costs	Costs per unit		$\leq 10\%$	
3.Decrease average receipt time	Average receipt time	≤ 30 days		3. Resort to the importation of Spanish containers (bottles and carboys) since they have a lower cost;

4. Increase Gross Added Value		Gross Added Value		$\geq 200.000\text{€}$
<u>Customer</u>	5. Increase Number of Customers	No. of total customers per year	$\geq 10\%$	1. Enhance contacts with agents for product placement abroad (UK, DE and new EU countries); 2. Direct placement of the company's products in Spain; 3. Creation of new brands;
No. of export customers per year		$\geq 10\%$		
<u>Internal Processes</u>	6. Improve product quality	% grapes received from controlled farmers	$\geq 90\%$	1. Investing in new equipment for the oenology laboratory;
7. Research for new products		% investment in R&D in 2017		$\geq 1\%$ Turnover
Learning & Growth	Employee Training	No. of training hours per year	≥ 24	1. Protocol to train employees in the operationalization of organisational tasks

Table 4. Balanced Scorecard of the SME with BSC

The BSC supported the implementation of the strategy as well as the decision-making. Managers had to resort to strict procedures in order to ensure implementation:

- All employees of the organization had to be fully involved in the project;
- The head of the BSC implementation project was defined;
- Awareness was raised among all stakeholders of the importance of the BSC implementation project, and of the fact that it is a continuous endeavor and not a purely static tool;
- The organization had to identify potential elements which constituted a barrier to the creation and implementation of the BSC;
- The organization had to communicate effectively the mission, values and vision to all its employees, with the objective of ascertaining whether or not they identified with the strategy.

3. Methodology

This research focuses on Case Studies based on a qualitative and exploratory methodology, as it aims to understand differences in organizations with and without BSC.

We chose to conduct interviews because, according to [62], they represent a fundamental instrument for data collection for qualitative research. To this end, an interview guide (see Appendix A) with a structure and set of questions based on [63] was developed. Therefore, the research involves analyzing data collected through the interview method, visits to the organizations' facilities to monitor their business

activity, data collection from internal documents and quantification of the application of internal management control procedures.

Two small and medium-sized enterprises (SMEs) were selected from the wine sector in the northern region of Portugal. The sample served to study the relationship between management control and business success and to measure and evaluate the results obtained in the study time span, i.e., in the period 2014 and 2017. The sample was expected to enable a data analysis for the study of the relationship, which was to be conducted in phases. Firstly, interviews with business management were conducted, using a semi-structured interview guide based on the work of [63]. Direct observation of the activity of the organizations was carried out and documentary analysis of the data collected in the organizations was also done.

Phase 1 – The main aim of the interviews with the administrative staff of the companies was to collect data and information on them, concerning the characterization of the organization and its recent economic and financial developments, as well as the characterization of management control instruments implemented, among other information considered to be fundamental in the development of the study.

Phase 2 - In the direct observation of the activity our goal was to observe the activities of companies, the preparation of business plans and finally to be present at a monthly meeting where middle managers present and analyze the results of their area of responsibility.

Phase 3 - Finally, in the documentary analysis of the data collected in the companies, we analyzed the financial situation of the organization, the sectors and the evolution of what we intend to address in the case study:

- Business plan and its annual budget;
- Analysis of the results of the respective area of activity;
- Analysis of strategic planning and operationalization of the management control system;
- Analysis of the existing information system and the rules defined for management control;
- Analysis of existing resources within its activity, considering the operationalized management control system;

These three phases mentioned above allow us to link a number of views on the management control systems used by companies, to reduce subjectivity in the study of the information obtained.

The SME with BSC privileges gender equality (5 male and 5 female employees), employees with a lot of experience in the area and with training linked to management. It is clear here that the organization is interested in having qualified employees in its staff, as can be seen below in Table 5:

Average Age	39,3 years
Gender	5 Male 5 Female
Management Level	2 Top Management 1 Intermediate Management

	7 Operational Management
Experience in Management	<5 years 2 5-10 years 3 >15 years 5
Academic Background in Management	Secondary School Level – 7 Bachelor – 1 Master – 1 Other – Marketing 1

Table 5. Sociodemographic Characterization of Interviewees (SME with BSC)

On the other hand, the SME without BSC, despite privileging gender equality does not have in its intermediate, operational or top-level staff, many employees with academic training linked to management. It only has a certified accountant, who works in an external accounting office. However, many of the employees have more than 15 years of experience in the business sector, as can be seen in Table 6 below with summarized information.

Average Age	48 years
Gender	3 Female 3 Male
Management Level	2 Top Management 0 Intermediate Management 3 Operational Management
Experience in Management	<5 years 1 5-10 years 1 >15 years 3
Academic Background in Management	Secondary School Level – 4 Bachelor – 2 Master – 0 Other – 0

Table 6. Sociodemographic Characterization of Interviewees (SME without BSC)

4. Analysis of the Results

The criteria that characterize a successful organization are common between organizations with and without BSC implemented, namely customer acquisition, customer loyalty and satisfaction, turnover, product quality and internationalization of products and brand, while it is notable that the perspective with the most relevance, immediately after the financial perspective, is the customer perspective

The success of the last five years, in comparison to the predicted success for the same time span is more aligned to its strategy in the case of the SME with BSC. In the organization with BSC the main key factors for success are related to customer satisfaction, loyalty, volume of orders, the turnover and the increase in revenue. Other factors that contributed to the organization's success in the last five years and especially in the last year were the brand expansion through internationalization and the increase of exportations. BSC enabled a better understanding of the success

achieved by the organizational performance, such as better communication among departments and employees.

Regarding question nr. 3 of the Interview Guide (Attachment 1 “In your opinion, has this organization, over the last 5 years, been as successful as expected? Why?”). They justified their responses by stating that the organization improved its organizational performance and benefited from the introduction of BSC. All respondents responded positively, stating that the organization had had business success in the last five years. On the other hand, regarding question nr. 3 of the Interview Guide (Attachment 1 “In your opinion, has this organization, over the last 5 years, been as successful as expected?? Why?”) The SME without BSC did not achieve business success in the previous five years, with the main reasons being: strong competition, high wine prices, order failures, volume decreases, lack of diversified products, missing partners and competitors in the sector. Furthermore, the SME without BSC has not been successful in recent years and there was a reduction of 30% in turnover. Negative feedback from customers, which leads the organization to lose customers, a decrease in revenue and a negative business performance were identified. Concerning the perception of the performance evolution, the organization with BSC confirm that they are able to focus on strategic changes. It improved its organizational performance and benefited from the introduction of the BSC. The interviewees also highlighted the fact that with the introduction of the BSC, the organization improved its organizational performance, communication between departments and employees. The BSC enabled the SME to redefine itself as an organization outlining its priorities, operational activities, business strategies, and processes and working methods, but above all, it guided management decisions.

Organizations without the BSC have the perception that BSC has a positive influence on organizational performance and strategic changes. Furthermore, they consider that the BSC might be relevant to guide the organizational structure and sustainability, to compete in the activity sector, by innovating, developing products and achieving economic recovery and success. In SMEs without BSC, managers would welcome its introduction, in accordance with [64], [65], to provide them with useful information for decision-making, planning and evaluation of the organization’s activities, to combat the scenarios of uncertainty and business complexity that may arise and to be fundamental for the creation of business strategies.

In the SME without BSC it is well known that profitability in both the financial and customer perspectives is the most important for this organization. BSC was initially a simply model of performance measurement, but it became a model of strategic management, strategic communication and change management. [66] state that financial indicators translate organization strategy through growth, profit and value creation, customer indicators focus on customer value creation, and internal indicators of learning and growth are characterized by measuring their success in the medium and long term through the flexibility and adaptability and adequacy of intangible assets. The literature recognizes the importance of intellectual capital and organizational learning in the overall performance of an organization [67]. BSC plays a fundamental role in organizations because it enables competitive advantages and the achievement of business success in the face of uncertainty and economic difficulties

[65]. Furthermore, SMEs without BSC showed a lack of business control grounded on management limitations and on the undefined organizational structure. In general, small and young organizations perform better than older and larger ones, as small organizations are more concerned with business performance [68].

On the other hand, the SME with BSC benefited from the adoption of the BSC in its business management, because it obtained better results, increased performance, whereas organizations without BSC, showed several limitations which constituted a barrier to positive financial and operational results.[69], [70] argue that BSC should adapt and support the organization's business strategy in order to achieve superior performance. [71] highlighted the importance of turnover, as the performance increase is linked to organization's results.

When comparing the importance given to each Perspective by SMEs with BSC and SME without BSC, we verify that organizations with BSC have a more accurate and equal distribution, as seen in Table 7 below:

Perspective	Average Relevance
FINANCIAL	27%
CUSTOMER	24%
INTERNAL	11%
LEARNING & GROWTH	10%

Table 7. Average Relevance of each Perspective (SME with BSC)

In contrast, organizations without BSC focus much more, in an unbalanced way, on the Financial Perspective:

Perspective	Average Relevance
FINANCIAL	41%
CUSTOMER	21%
INTERNAL	19%
LEARNING & GROWTH	19%

Table 8. Average Relevance of each Perspective (SME without BSC)

The top managers of the SME without BSC attributed a weight of 60% and 70% to the Financial Perspective, which doubtless confirms their main focus on this 1 Perspective. Without a management tool it is difficult to align the relevance of the perspectives, so managers without BSC highlight the Financial Perspective.

Regarding the academic background, some differences were identified, as organizations with BSC have staff from the Management field, whereas those from organizations without BSC have an engineering background. Considering these differences, it is notable, as [72] argue that SMEs should improve management knowledge because the renewal of knowledge and the development of professional aspects are essential for SMEs. [2][73] confirm that there is a need to define professional competence, but above all, to identify the people with the best knowledge

and skills that allow and contribute to the organization's success thereby improving their business and performance.

[39] emphasize the importance of alignment of the objectives in the four perspectives, representing the key factor for value creation through a consistent internal strategy elaborated by the whole organization. Organizations with BSC can distribute and balance the importance of all the perspectives in an adequate way, whereas organizations without BSC miss this balancing feature. Furthermore, inefficient or lack of communication by managers may be a barrier to implement strategies [74], [75]. According to [76] many managers seek to align the objectives of the BSC's perspectives to identify new businesses, increase their competitive advantages, in order to achieve better organizational performance. Finally, [77] consider that a strategically aligned model is one that contemplates a strategy that can integrate and relate the external environment (market) to the internal environment (organizational structure). Organizational strategies are aligned to gather individual strategic indicators or definitions in a comprehensive way [78], [79].

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Appendix A - Interview Guide

GUARANTEE OF CONFIDENTIALITY

This study aims to evaluate the importance of Management Control Tools and their impact on organizational performance.

The Balanced Scorecard (BSC) is a recognized management tool that translates the vision and strategy of organizations through a set of performance indicators, based on critical factors. The data obtained will be aggregated to allow their processing and conclusions. This way, we not only assure the total confidentiality of the data, but we also guarantee the study in aggregate form. In this context, we ask you for the utmost rigor and objectivity in order to ensure that the analysis is performed with the desired validity and reliability

1. What is important in this company? Score each of the statements from 0 to 100.

This company attaches importance to human resources. High cohesion and morale are important in this company.	
This company attaches importance to the growth and provision of new services. How fast you are facing new challenges is important.	
This company attaches importance to permanence and stability. Efficiency, incremental changes are important in this company.	
This company attaches importance to competition and results. Achieving goals is important in this company	
Total	100

2. What are the criteria you can point out to characterize this company as a successful company in the sector?

3. In your opinion has this company, over the last 5 years, been as successful as expected? Why?

4. In your opinion, did this company last year achieve the expected success? Why?

5. Indicate how much relative weight each Perspective has for this company.
Consider a total percentage of 100%

Financial Area

This company is concerned with asset and earnings management capabilities (Profitability)	
This company seeks new products and services by reaching new customers and markets or increasing current ones (Growth).	
This company aims to create shareholder value (Value Creation)	
Total	100

Customer Perspective

This company tries to secure a customer base that contributes to the value of the company (Profitability)	
This company aims to achieve high levels of customer satisfaction (Satisfaction).	
This company has the ability to captivate new customers or increase the number of current customers (Retention)	
This company has the ability to keep current customers (Loyalty)	
Total	100

Internal Perspective

It is recognized that this company exists to ensure processes and not accumulate functions (Process Management)	
This company identifies non-value generating activities (Rationalization)	
This company ensures high acceptance rates of its products (Quality)	
This company can optimize the utilization of the resources on which the results depend (Efficiency and Effectiveness).	
Total	100

Learning and Growth Perspective

In this company, employees are able to present new ideas (Innovation)	
This company guarantees high levels of motivation and commitment (Satisfaction)	
This company ensures knowledge levels of employees that enhance their performance (Qualification)	
Total	100

6. Indicate how much relative weight each Perspective has for this company. Consider a total percentage of 100%.

Financial Perspective	
Customer Perspective	
Internal Perspective	
Learning & Growth Perspective	

7. Question for organizations with BSC implemented:

- What is your opinion about the organizational (non-financial - internal) performance of the last 5 years?
- Does BSC allow the company to focus on strategic changes defined by managers?
- Do you perceive that BSC contributes to the previously defined organizational performance?

8. Question for organizations that have not yet implemented BSC

- Do you think BSC could allow the company to focus on strategic changes previously defined by managers? Why/ why not?
- Do you think that BSC will be a tool capable of enhancing the organizational performance of your company? Why/ why not?

Sociodemographic Characterization of the Interviewee

Age:

Gender:

What level of management are you in?

Top management

Intermediate Management

Operational management

How many years of professional experience do you have in this area?

≤5 years

5-10 years

>15 years

Do you have a degree in Management

No

Bachelor

Master

Other

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Implementation of Feedback as an Important Element of Modern Corporate Websites

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Abstract

The Internet has become an independent global electronic environment for economic activity, which for many companies has come to the forefront, not only complementing but also replacing the business methods used for decades. Almost any company, linking its activities to the Internet, develops and maintains its representation in the form of a corporate portal or website. Sites become more functional, more beautiful and informative over time, but many managers forget or do not pay due attention to such an important element of the site as feedback from external and internal contractors. This article presents the effectiveness of using feedback on specific examples in a simple and straightforward way, and gives an overview of the different forms of organisation of such communication, with an indication of possible tools for their implementation.

Keywords: feedback, corporate website, communication with customers, organizational culture, sales support.

1. Introduction

It is impossible to imagine modern society without the Internet. Moreover, while the Internet was originally a means for promoting goods and offline services, it is now an independent global electronic environment for economic activity, which largely determines activities and strategic ways of business development. The use of Internet technologies leads to increased productivity, increased sales and improved relationships with consumers. One of the most widespread and widely used means of conducting such activities is corporate websites and portals that contain relevant, accessible and reliable information and are a link between the organisation and its counterparties [1], [2]. Modern websites provide direct access to the market, direct communication with target consumers, and not only opportunities to conduct marketing research, but also effective tools to influence consumers, development trends and demand in their market segment, improve their image, etc.

From a marketing point of view, the objective of the sales website is to transfer a potential customer to a real customer, then, with the help of specialised offers, to make him a regular customer and, as a result, make him a partner [3]. It is important to note that using the corporate website, the company can provide customers with additional services in addition to sales: provide various analytics and detailed information on products and services, independent feedback, and provide pre- and after-sales service.

A modern understanding of corporate websites requires the following elements [4]:

- unified corporate design;
- registration and authorisation module;
- description of activities, company mission, contacts;
- news feed;
- a system of internal and external messages;
- organisation of joint work;
- forums (or other similar means of communication);
- guest books, feedback and voting forms;
- the company's knowledge base.

According to the authors of this research, such elements as news feed, message system, chats and chat rooms, forums, guest books, contacts, voting, feedback forms, tools for forming a permanent audience of visitors (subscribers) to the site, e-mail distribution, activity in the site's accounts on social networks, mobile applications can be combined with one term "feedback". It is not always given sufficient attention when designing, developing and maintaining a website.

The purpose of this article is to provide a comprehensive study of the purpose and ways of implementing feedback from a management point of view, and to highlight the importance of this tool for business.

2. Research Methods

This research is based on the analysis of business requirements, current trends in the development and application of web-technologies, on the analysis of publications and scientific discussions on this topic. Observation and comparison methods were used based on data obtained during interviews with business representatives and professional IT communities. In particular, the findings are based on discussion of this problem with specialists from several companies:

- The Centre of Information Technologies is a state autonomous institution working in the field of development, implementation and maintenance of software for state and municipal structures;
- Aqua Delivery Company, working in the field of development and provision of specialized service for automation and development of water delivery business in eight countries, and Dodo, providing food delivery service;
- an organization working in the financial sector in the Komi Republic.

The authors' experience gained through years of practice in participating in IT projects, for example, has been taken into account:

- for city services (e.g. “Komi Republic in numbers”, “Active Syktyvkar”);
- for museums (the National Museum of the Komi Republic and the Museum of Archaeology and Ethnography at the University of Syktyvkar);
- journal sites “Bulletin of Syktyvkar University. Series 1: Mathematics. Mechanics. Informatics” and “Human. Culture. Education”;
- for educational and medical institutions;
- development of terms of reference for web-resources of the Syktyvkar University.

The authors also participated at various times in the support of several web resources, in particular, the official website of the Syktyvkar University and its components. In such projects, there has always been a question of organizing feedback and its maximum convenience for both parties.

The experience of eight graduates of our university of different years was also interesting from the described point of view. They worked in IT-services of various companies and organizations providing IT and financial services, public administration institutions and companies of technological sector, starting from 2012.

This led to the identification of problems in the organization of feedback from a management point of view, both from external contractors and the organization of effective intra-corporate feedback, as well as problems in the technological implementation of feedback.

3. Results

3.1. Feedback From a Management Point of View

3.1.1. Feedback From External Contractors

We will show the importance and necessity of using feedback on websites in various situations. We will begin the description with market research, which makes it possible to adjust the assortment policy and improve the service in accordance with the wishes of [5] clients. For example, market research for educational institutions makes it possible to track and update the requirements of employers and the global market in educational activities and adjust them in time. A study by [6] showed the advantages of a feedback system for graduates compared to manual questionnaires or other methods of improving the curriculum, while [7] shows possible options for organising feedback from university applicants. High-quality feedback support is a modern web design trend [8].

Increased number of channels for communication with customers – all types of advertising, website, mobile application, social networks, chat rooms, messengers, etc. – requires the diversity and improvement of content, focusing on target information consumers and potential customers.

Online reviews are an important information base for customers to create an opinion on possible purchases. At present, before buying a product, people study the feedback about it on various resources. So why not make it possible to discuss it on your site? Encouraging people to buy is discussed in various articles, in particular an article [9] examining the use of video announcements to create online reviews.

Feedback from the tourism industry, which is one of the most important economic activities, and from some regions is crucial. Here feedback is used to collect and refine information both for tour selection and to support tourists in their journey. A study by [10] shows that tourists give priority to the three main types of feedback – chat rooms, e-mail and telephone. Customer feedback on these tours is also important for potential buyers of tours.

Customer support through the corporate website can be realised through knowledge bases made using wiki [11], [12] technology. Working together on knowledge bases can also be seen as a feedback element, as it allows you to express your vision of different business processes.

Feedback can be seen as an element of support for the organisation's image, as it enables the assessment of the goods and services offered, the actions of the company's employees and the information provided. With the advent of social media, company mistakes are easily brought into the public domain by customers and responding to them becomes not just good practice, but a vital necessity to avoid problems and stimulate a positive attitude towards business or brand. More companies begin to pay attention to their image on the web and monitor what they and their competitors are saying on the network.

There are business projects that simply cannot work without feedback. For example, work [13] describes an application that is integrated with the database on the restaurant's website and provides notifications for orders so that the customer knows the status of the order.

Some business ideas are that the customer can control the entire production or service process. An example is the pizza making process [14].

It is extremely important now to implement the possibility of interacting with customers on social networks. This is due to the fact that social networks have become not only a platform for communication for the next generation, but also a tool for finding content, such as brand information, and making purchases. 37% of Western users are subscribed to various brands on social networks. Shopping with the help of social networks (Social Commerce) is modifying the usual approach to sales today. In many Asian countries, users already prefer social media shopping, while Western countries prefer traditional online retailers, although the Social Commerce segment is growing [15].

In conclusion of this section, it should be emphasized that monitoring industries, collecting and exchanging views and experiences, improving products, services, scientific calculations and other achievements can also be more useful and cost-effective in building effective feedback, as mentioned in the works devoted to GeoFarmer and EOSDIS systems [16], [17].

3.1.2. Intracorporate feedback

The term “feedback” can be interpreted more broadly - it means not only getting a response from a business customer, but also from an internal corporate customer. It can also be used to solve intra-corporate problems. The management of the company can, through survey forms or other tools for identifying problems, find out the mood of employees, their opinions and suggestions on important production issues, organisational plan problems, and issues of building business processes, thus relieving possible tension in the team and building more efficient production and other business processes.

Based on the results of the feedback, it is possible to revise the company’s policy, introduce or change motivational measures, implement the creative ideas of employees, receive information about the career aspirations of employees, their desire to grow and develop and their readiness to improve their skills.

However, feedback from employees will work if they are confident that the information will not be used against them, will reach the recipient, will be heard and used in the company’s work.

The use of the social network and the intranet can also be seen as an element of feedback. This issue is discussed in an article [18], which describes a software product that allows you to monitor the flow of data related to employees on a continuous basis and, based on this flow, make a judgment about the sentiments within the team.

3.2. Review of Ways to Implement Feedback

We will now move on to a discussion of how to implement feedback. We will preliminarily note the following. Quite often, the head of the company does not quite understand the role of the corporate website, and at the same time, removing his or her responsibility, he or she passes on issues of making strategic, image and other important decisions to middle-level managers. However, the growing influence of the Internet on the success of business has led to the realization that the lack of a corporate approach to the management of the site generates many different problems that cannot be solved at the middle level of management. In addition, the corporate website has begun to play a significant role in achieving the strategic goals of the company. Worldwide models suggest highlighting several areas in the corporate website management system and making decisions in each area separately [19]. The proposed model for building a corporate website management system will help to write guidance documents, define decision-making procedures and draw up regulations for website management [2]. In view of the above, top managers should pay attention to the implementation of feedback, as well as the entire site.

The easiest and most obvious way to create feedback is to place an email address in the “Contacts” section where everyone can express their opinion or ask questions. The main advantage of this method is that it is easy to use for small companies, simple and cheap. Shortcomings include the unwillingness of people to write letters, lack of publicity, difficulty in selecting and indicating the intended recipient.

Feedback forms on the website effectively protect the corporate letterbox from spam and provide a convenient channel for communication with customers. They are not only an effective protection against spam, but also a powerful marketing tool to make the site as convenient as possible for the visitor and eliminate all possible obstacles to contacting the manager, such as unwillingness or inability to call, open a letterbox, register, etc. The feedback form can be implemented as a separately written module, or as a ready-made plug-in in the case of the Content Management System (CMS – Content Management System), or it can be simply used by third-party resources such as Google forms.

It is impossible to imagine a modern corporate website without the “News” section. The purpose of this section is not only to convey information about ongoing business processes and improve the image of the company, but also to solve the issues of site promotion in search engines. However, in our opinion, this opportunity is not fully used, as on most sites this section is closed from commenting. The explanation is simple – if there is a possibility of commenting, there should be a moderator who monitors the order, and therefore his work should be paid, which leads to additional costs. At the same time, comments are a great opportunity to get a user's reaction to the company's activities and to study potential customers in more detail, their preferences, vision of the next steps of their favourite brand, etc. This requires allowing comments only to registered users. It should be noted that all modern CMSs contain comment packages, and there is no need for large additional costs for their installation. Also, to protect against spam and unwanted comments, you can use the Akismet capsule or plugins used in CMS WordPress, or JComments and Cleantalk, Komento, Spam protect in CMS Joomla, or the Cackle commenting, feedback and survey system, which supports 8 popular CMSs and provides APIs for developers (<https://cackle.pro/>).

Another way of obtaining feedback is through a rating system for evaluation or “likes”. Modern Internet users want to evaluate publications, goods and services, preferably using simple and familiar tools. Studies presented in [20] show that a significant proportion of social media users take into account the evaluation of previous publications when publishing another post. The use of simple assessment methods can serve as an incentive for developers and sellers of goods and services, as well as for content authors of corporate websites to take into account the preferences of visitors and buyers. As noted by researchers in [21], the lack of evaluation does not necessarily indicate a negative response from users, as users may have encountered difficulties due to interface shortcomings and were unable to vote. The structure and design of the website therefore needs to be well thought out from the start.

When developing the website, it is important to choose the visitor statistics system wisely, as statistics is also an example of feedback, as it allows us to evaluate some parameters of the website users, such as their age, place of residence, education, income, etc. Popular ready-made solutions for maintaining statistics are LiveInternet metrics (<https://www.liveinternet.ru/>), Yandex.Metrics (<https://metrika.yandex.ru/>), Google Analytics (<https://marketingplatform.google.com/about/>), Alexa Rank (<https://www.alexa.com/>). By the way, ways of recording the behaviour of

website visitors are currently being developed. These metrics are also quite effective tools for assessing the convenience of the website for visitors.

A fairly popular way to arrange feedback recently has been online chat or online consultant. However, in this case it is necessary to take care of the services of an individual operator or expert consultant. As a special case, it is possible to implement a callback order. A more advanced option is the creation of a website messaging system, the so-called corporate messenger.

For a long time, such feedback methods as forums have been used. Modern popular IT tools for forum creation include IPB, vBulletin and phpBB forum engines. It may be noted that many CMS have their own embedded forum engines, e.g. bbPress in CMS WordPress. However, at present such forums are not very popular with the next generation, which favours similar tools on social networks. In turn, linking modern corporate websites to social networks is a prerequisite for the convenience of sites. Integration with social networks is one of the criteria for ranking sites in search engines. The presence of conversations and groups in social networks is also a way of organizing feedback.

Along with the trend towards integrating corporate websites with social networks, the creation of mobile applications is becoming popular, allowing users to receive feedback and control user interest in various products and the demand for services. There are two main ways to create such tools; the first is to use a built-in browser engine using JavaScript and HTML. The second way is to create native applications for Android [22] and iOS [23]. There is a need to additionally address compatibility issues for various devices [24]. However, given the fact that in recent times mobile traffic has almost equaled, and in some regions it has become more than the traffic of desktop solutions, and in addition, the time spent on the Internet by users using mobile devices is constantly growing, the development of web applications may represent a good strategic solution for business [25].

“Flutter” (<https://flutter.dev/>), which allows you to create applications in the language “Dart” (<https://dart.dev/>), can be offered as one of the fairly new but promising platforms for developing mobile applications. At the same time, to create a managed and supported application, it is necessary to adhere to the “Clean Architecture” architecture with the division of the application into independent layers, which allows creating flexible and supported solutions [26]. There is an adaptation of this approach to the Flutter platform, as described in the series of articles on <https://resocoder.com/>. In this case, the “Business Logic Components” approach, which is relevant for the “Flutter” platform, can be applied [27] to manage page state. Well-established tools such as React Native, Xamarin and Adobe PhoneGap can also be recommended.

In addition, we can note the mechanisms for creating a permanent audience of visitors (subscribers) to the website, which include the organisation of e-mail and SMS links and subscriptions to RSS feeds, and note that this method of feedback organisation as guest books is currently practically unused.

4. Conclusion

The Internet world is rapidly evolving and, as a result, the way corporate websites are created is also changing. The list of ways to organise feedback is not exhaustive, some feedback options are no longer available and new ways may emerge, for example, through voice and video messaging, or through the creation and use of neural networks.

The following conclusions should be noted.

1. CEOs of companies and organisations should not be afraid of using feedback on the corporate website, as it helps collect unique information about the opinions of target visitors, their problems, frequent questions and difficulties. Using this information, it is possible to qualitatively improve the quality of goods and services, improve the content of the corporate website in accordance with the needs of the target audience and, as a result, improve the image of the company.

2. When creating and, in future, when operating the website, attention must be paid to the issues of competent organisation and functioning of various types of feedback. It should be noted that not only feedback from external contractors is important, but also from company employees.

3. It is necessary to use several feedback channels as they improve the usability of the website, provide visitors with different ways of feedback and increase the overall user activity.

4. The use of social networks as a feedback tool has become very popular.

5. It may be recommended that company management should mandatorily set up and discuss issues related to the organisation of feedback and listen to the advice of web studio specialists when developing and re-engineering corporate websites. Investing in these mechanisms, which are a source of invaluable information, is a good investment in the future of business.

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From Discord to Concord and Back Again (Managing the Formation, Transformation, and Fission of Organizational Culture)

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Abstract

By means of theoretical analysis based on the results of previous research, and the relevant historical and factual material, the author outlines a new theory of formation, transformation, and fission of organizational culture. The mechanism that consolidates organizational culture (selection of “right” persons; adjustment to the common cause; and people’s accommodation with each other), the toolkit for renewing it (involvement of the key bearers of the culture to be introduced; elimination of those inconsistent with it; and translation of the proclaimed values to the “pliant mass” ready to get engaged in changes) as well as the nature of cultural ruptures in organizations and the ways out are brought into relief. The paper promotes a better understanding of the dynamics of organizational culture and gives an access to more efficient instruments to manage it.

Keywords: organizational culture, mechanism of consolidation, pattern of transformation, cultural split, management of culture

1. Introduction

Elliott Jacques who was the first to thoroughly explore culture as applied to organizations stated that “the culture of the factory is its customary and traditional way of thinking and of doing things, which is shared to a greater or lesser degree by all its members, and which new members must learn, and at least partially accept” [1, p. 251]. He emphasized the role of values as a prerequisite and moving force in establishing efficient interpersonal and professional relations. It was obvious to him that without shared values, workers could scarcely act together as a single whole.

At about the same time, to the same conclusions, albeit from another standpoint, came Talcott Parsons. According to him, any organization should get integrated so as to appear as a collective unit [2, p. 20]. And the force joining them is common values they keep to. “Where roles are differentiated,” Parsons observes, “the sharing of values becomes an essential condition of integration of the system.” For an organization to act effectively and achieve the results it seeks, “there must be, to some degree and on some level, a unitary system of institutionalized values, in this aspect a common culture.” Only due to that, a group of people “constitute a single

collectivity” [3, pp. 167, 169]. The culture they adopt communicates meaningfulness to the goals being pursued, and stability, to the patterns of their doing.

More than six decades elapsed since. A heap of works – both conceptual and empirical – devoted to organizational culture saw the light. Diverse approaches to it emerged aplenty. However, all they still rotate on the axis of values.

Simona Giorgi and her colleagues “revealed five prominent models of culture used by organization scholars: as values, stories, frames, toolkits, and categories”. However, as they stress, these models “stand on unequal footing.” Values and toolkits constitute the core round which the rest of them run [4, pp. 4, 20]. Indeed, “stories”, “frames”, and “categories” are secondary. But so are “toolkits” as well. They retain a cultural meaning, that is, turn into a part of culture, exactly to the extent they are stamped with values.

The exponents of “toolkits” treat culture as a reservoir of opportunities people possess or available resources and instruments, and pass it through the lens of not so much things or their importance for people as practical actions. The metaphor “toolkit” is called upon to shift “attention away from values as the driving force of behavior to bits and pieces of culture that can be differently assembled, opening up the possibility of a variety of outcomes, even given the same values.” But it is impossible to put an end to a phenomenon by evading it. The examples the authors adduce demonstrate, contrary to their intent, that one concept is merely replaced with another. So, they insist that, despite health is an undoubted value for most people, their real actions are drawn on wonted repertoires and frequently cause harm to health (4, pp. 13 - 14). But does this mean that instruments of behavior are quite independent of values?

Sure, sometimes health is put at risk, but not because it is occulted by habitual doing. As a value it still guides the behavior. However, no value can be an isolated and, all the more, a single entity. Each is surrounded by other values which modify its role and restrain its influence. Moreover, values always constitute a hierarchy with an essential subordination of its elements. Some of them seeming to be most important turn out less significant when confronted with stronger ones. Thus, health may be pushed to the sidelines if it deprives people of pleasure or prejudice their status when pleasure or status is of higher priority to them than health.

Of course, nobody devises all the actions he undertakes, from scratch. In most cases, ready-to-use patterns are employed. But which of them is chosen and in what combination, depends just on the values one follows. Any instrument must be not only efficient but also acceptable. And consequently, it cannot be value-free.

A degree of unity in value orientations is the main and indispensable condition of integration and joining of efforts. Organizational meanings and priorities should be in tune with people’s personal attitudes and preferences. Sure, not all and not to the same extent put up with the values of their organization, but that the values must be accepted at least by its active backbone is beyond doubt. Meanwhile, this engenders a difficulty which most researchers not only disregard but even do not notice.

How are shared values possible if organizations comprise people with very diverse attitudes, social and life experiences, and personal likings? Before fusing

into a collective, workers have, for the most part, no notion of each other and of what are their fellows' values. An association of those with more or less similar cultural backgrounds may look to be quite realistic, since they are primordially guided by kindred priorities. But the probability of that tens, hundreds, and thousands of "suitable" persons turn up at the same time in the same place by accident, is lost in the noise, while divergences and, all the more, inconsistencies in values seem to make any joint activity of their bearers almost infeasible. And yet, organizations with so unlike members are in abundance, and they contrive to maintain the unity of their cultures. That is why the mechanism of transition from the discord of variegated societal values to a harmony in an integral organizational culture as well as its transmutation and splitting appears to be the pivot without which no satisfactory theory of organization can be built.

What do organizations owe their cultural uniformity to? How do they get it? What does lead to metamorphoses in organizational culture? Why, despite essential changes in values, does it ensure their commonality? When is a culture threatened with disintegration? And is its breakup into antagonistic pieces preventable? By answering these questions, the author reveals the key mechanisms in the dynamics of organizational culture and suggests efficient measures for managing it.

2. The Making of Cultural Unity

People do not grow up in an organization or join it after adopting its culture. One may import a cultural "baggage" essentially differing from that of its other members. This urges on some researchers to deny organizations, particularly multi-national, to have common values, or at least to acknowledge only their minor part in ordering the organizational life. "What holds a successful multinational together," Hofstede asserts, "are shared practices, not, as the 'corporate culture' hype of the early 1980s wanted it, shared values" [5, p. 1360]. The problem gets moved aside. However, that is not an actual solution to, but, rather, an escape from it.

2.1. The culture of Founder(s) the Ground for Homogeneity

Though sometimes are found relatively small affinity groups, in most cases there are really no societal values common to all workers. Nevertheless, it is beyond doubt that the majority are guided by similar or related business priorities. Should it be otherwise organizational culture would lose its practical meaning. And the cultural cement fastening together the parts of an organization and creating in it a favorable milieu for efficient joint activity would disappear as well.

The fusion of individual business cultures in an organization implies some initial core round which they cohere into a single whole and are put in order. Every entrepreneur, according to Edgar Schein, has clear and strong convictions as to what and how to do which ensue from his previous experience and personal preferences. By combining them with his views on the world and the mission the organization established by him is to perform, he sets, as the founder, the main tendency of its future culture [6, p.225]. In the course of development, the culture acquires more

comprehensive contents and gradually absorbs the compatible business values of other notable members. So the cultural dominant of the organization gets crystallized. It is always appreciable and manifests itself distinctly even if individual workers or their groups do not emphasize its role or keep to priorities somewhat different from each other.

A good illustration of this is the early history of the accounting firm “Arthur Andersen.” At the very beginning of its activity, in 1915, it turned out in a rather awkward situation. Its client, a railway company, in order to improve the financial statements deferred relatively large charges to be taken into account as current expenses and, thereby, essentially distorted the data. Andersen required the statements to reflect the facts and drew up a report in which the costs had been presented according to their true nature, while the head of “railroaders” demanded from him to “correct” the report. To this, Andersen answered that there was not enough money in Chicago to make him do it. Despite the hard time and the fact that the firm was just getting on its feet, and every client was worth its weight in gold, he preferred to lose the client than betray his own values [7, pp. 19 – 20]. The principle embedded by him in the business philosophy of the firm got implanted there and continued to work many decades on.

That the culture of an organization imbibes and assimilates the business orientations of its head receives also empirical backing. Thus, it has been found that “organizational culture values are, at least to some extent, a reflection of the CEO’s personality.” Say, those reluctant to get involved in new undertakings are commonly surrounded by employees who view “their organizations’ culture as characterized by higher levels of hierarchical values.” And they together “foster cultures that encourage stability and control of operations” [8, pp. 133 – 134]. No wonder: as the core, so the fruit.

But how the basic business values are transmitted to workers and inculcated in them?

It is the primary selection that underlies the relative homogeneity of organizational culture. The placing of personnel appears to be a rather rigorous procedure which not everyone can pass. So, in order to hire 3000 workers for an assembly plant in Kentucky, “Toyota” had screened out and rejected nearly 100 thousand applicants [9, p. XVI]. Candidates for a vacancy go through a sieve of quite exacting requirements that are not at all of formal nature, but step far beyond the limits of job descriptions.

No less, and at times more, significant is the individual’s conformity with the demands on him as a personality, his ability to fit in with the cultural milieu of the organization [10]. The model of “ideal” worker implies him to be not merely a qualified specialist ready to do the job up to the mark (meet the high standards of performance), but first and foremost, to subordinate himself to the common cause, the satisfaction of his own ambitions being put on the back burner. But this means just a knack of getting built into the culture which underprops the common cause. Consequently, winning the vacancy presupposes outstripping the contenders most of all in cultural and personality accordance with the organization’s central values.

Hence, already at the stage of admission, is done the most for the worker to be not unconcerned about them.

However, errors happen on the part of both those who make selection and candidates for jobs. Some of employers neglect their duties or incorrectly assess the aptitudes of applicants, and the latter turn out to be alien to the values of the organizations they join. Likewise, an applicant himself may make a faulty choice through underestimating the disparity between the organization's and his own cultural preferences, defying it, or going along with alien rules because of the despair (acute need) he is gripped by. In these cases, most often either the organization gets rid of the unsuitable worker or the worker himself, on understanding that has got a wrong number, rather quickly quits his job.

The empirical study of the correlation between employee's perceptions of and preferences for organizational culture and his commitment to the organization and intention to stay with it has shown that "people adapt best when there is a good person – environment (P – E) fit." And contrariwise, the deviation of the cultural realities of the organization from the expectations most likely brings to the slackening in their commitment to it and readiness to remain a part of the collective [11, pp. 458 – 459]. However, it is known that novices who do not leave the organization during first several months usually stay there for long. Thus, a member not willing to accept cultural values of his organization gets "culled" by a kind of natural selection. That restrains, from the very outset, the sources of remonstrance and opposition due to which an organization might run a danger of rupture.

2.2. Adjustment to the Tasks, and Reciprocation

It would be naïve to believe that those remaining in an organization primordially and totally share its values. Many of newcomers evince virtually no opposition not because are overjoyed at them. Rather, despite some skepticism maintained by workers about the organizational culture, it arouses in them no strong disapproval; or they attach small importance to the "inacceptable" values and, therefore, the dissensions do not hinder them in joint activity.

The common cause expresses not only the interests of the organization but, to some extent, also those of the workers, providing them with opportunities of earnings, self-fulfillment, professional communication, etc. This increases their personal involvement and reinforces commitment to the organization and self-devotion in the course of work [12, pp. 147 – 148]. In the issue, the readiness for certain sacrifices, losses, and compromises for retention and increase of what has been acquired thank to the collective rises. Respectively, they put up with the "demands" (values, principles, and norms) which at first seem to them not quite opportune and reasonable. Moreover, when nothing of the kind does occur, all sorts of explanations mitigating the contradictions between their personal attitudes and the "doubtful" elements of the organizational culture are devised. As a result, people – even within the same unit or work group – sometimes very differently treat the meaning of cultural entities.

For instance, the policy of constant improvements is supposed to support the creative approach to the tasks being performed, and some autonomy in decision-making. But not all of those working in an organization where it has been successfully introduced believe that its main advantage is the freedom of action it provides with. Some find this policy to give them an opportunity for self-development, while others associate it with the stability of the collective they belong to. That is to say, people attach to the same elements of culture not identical meaning, since pass them through the lens of their own expectations and preferences. The only thing which creates an affinity between these interpretations is that they allow employees to regard a cultural entity as something meeting their needs.

Any organizational novelty should fit in with the notions and expectations of workers. Otherwise it would scarcely function as devised. The Toyota way, including the policy of continuous improvement, “is most often viewed as a set of tools to remove ‘waste’ from processes” [13, p. 3682]. And just for that very reason, the attempts to implant this production system in another cultural ground ordinarily end with failure. It is not a mere formula, a magic spell which by itself is able to transform the life of an organization, but, rather, a “clod” of culture; not only knowledge of an instrument and skill in handling it but also – what is much more important – an ability to understand which of instruments, when, and how should be employed. It needs “to ensure that the tools implemented fit the organization and support its people while achieving the objectives they were designed for” [13, p.3696]. Toyota way is a culture supported by a toolkit, not a set of instruments as an appendage to that culture. For an instrument to function, people must communicate to it their own sense so as to turn it into a part of their inside cultural world.

When the demands made on a worker evidently help him in fulfilling his task they, though not accepted totally, are taken in with understanding and, in any case, are not dismissed out of hand. As workers get “built” into the common cause and “appropriate” it, that is to say, make it their “own,” they more and more accustom themselves to the organizational culture as promoting the common cause and, thereby, answering their own interests. At that, people’s attitudes and preferences get geared to the organizational culture and corrected so as to eliminate obvious, outrageous divergences and discrepancies. Thus a single “strategic” orientation arises which, for all the diversity of societal cultures the workers have imbibed, sets the integral “vector” of the organizational culture, unifying and “aligning,” to some extent, their strivings and valuations.

Joint activity in the course of achieving the common goals not merely gives workers an opportunity to rally round it but also allows them to pool their efforts [14, p. 282]. In the issue, they come closer and get adapted to each other, while their notions of what is done, and mindsets, however diverse at the outset, begin to overlap and sometimes even coincide. This imparts a certain measure of

homogeneity to the business cultures of individual employees thank to what they behave not only as a single whole, but frequently undertake steps to the same template and together oppose abrupt changes. Not in vain, many executives complain that employees often come out with very similar ideas, for instance, during brainstorming. This occurs even in organizations encouraging creativity and innovations, such as “Toyota” [15].

In the course of communication and joint working, some rectification, reconciliation, and mutual adjustment of personal attitudes and preferences are made. The crucial role of meetings “in employee socialization, relationship building and shaping of the culture” comes to be more evident. Inter alia, “they reinforce formal and informal reporting structures, and provide clues about organizational values” [16, p. 18]. Within the bounds of possibility, workers find “tactical” compromises. They close their eyes to what is secondary and has no decisive significance. But when seeing that their personal values do not fit in with the “reasonable” culture supporting the interests of both the organization and its individual members, workers have to reconsider their orientations.

Thus, the members of an organization do not stick to completely identical values, but adjust them to their own understandings and interests. Formally the same value, on passing through the crucible of a person’s construal, slightly or even essentially changes its meaning. However, the distinctions come to the foreground not so often. Under normal conditions, they draw little attention and only in critical (crisis or conflict) situations when every trifle is examined nearly through a microscope leap to the eye. Then, after keen discussions or even vehement debates, the slants of workers come closer to each other, while contradictions get mitigated. Thereby, diverse individual meanings “are woven into a shared frame of reference” [17, p. 221]. What in the beginning seems to be incompatible and irreconcilable acquires in the end a common denominator and turns into a unity in variety, a common field of (frequently quite sensibly) differing business cultures and, eventually, becomes a source of plasticity for the organization, and a mechanism of its adapting to changing circumstances.

2.3. Common Values: Learning or Accommodation?

As distinct from societal, organizational culture is not learnt, but accepted (taken over). An employee not so much shares the values of his organization as accommodates himself to them and, at the same time, adjusts them to himself, eliminating the possible alienation between organizational values and his own priorities. In cases these values are not in complete tune with his notions and expectations, he normally reconciles himself to the values one way or another and sometimes even tries to “modify” (reinterpret) them so as they become closer and more understandable to him. That is why organizational culture is not in the least something strongly defined and solidified. It constantly changes, absorbing features from notable new members, and intergrinding them with the impulses from old members which, for a reason, were before disregarded. Organizational culture is a

dynamic entity for which the communication between people is the chief condition of self-maintenance and development.

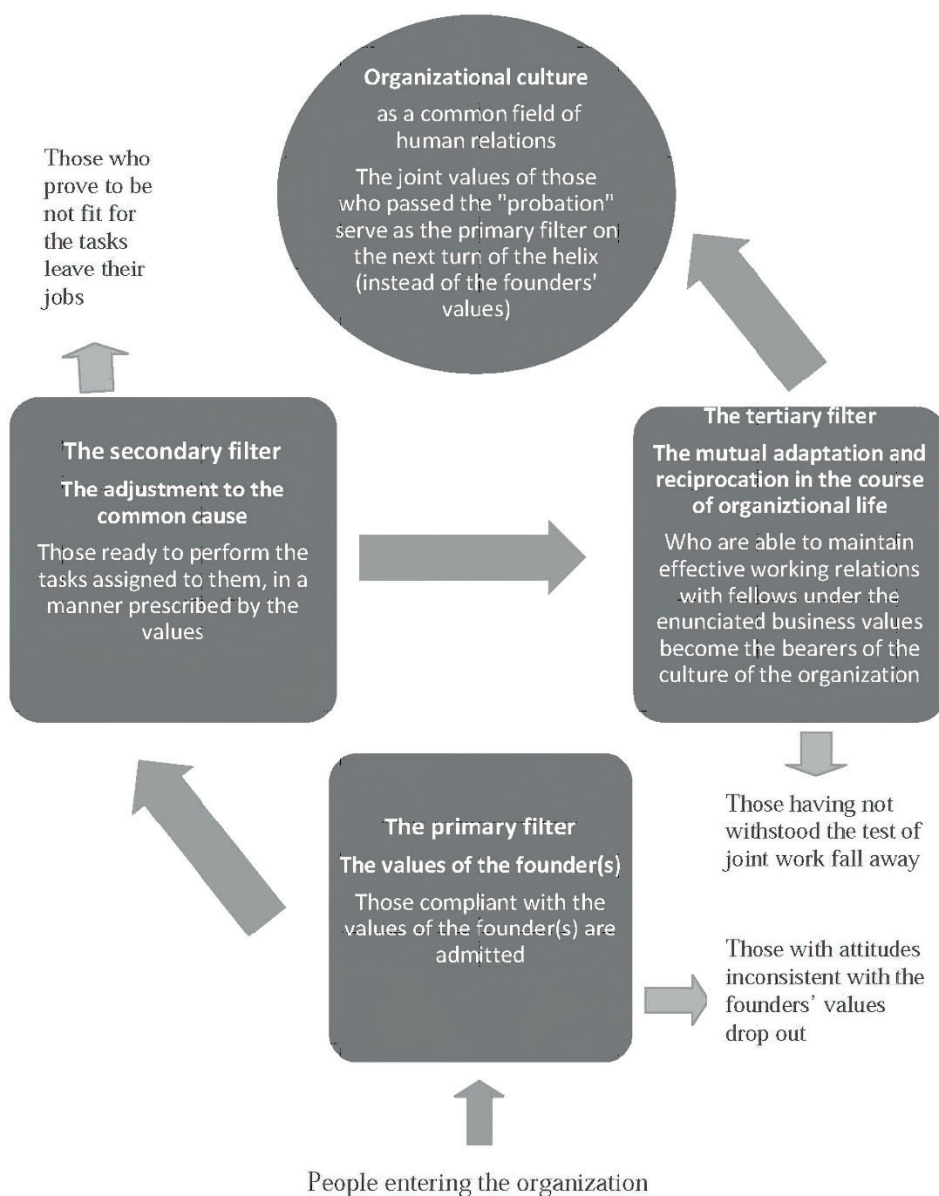


Figure 1. The helix of organizational culture
(How a business culture gets consolidated)

Hence, without stability and long-run orientation to some established values, no strong and self-contained organizational culture is possible. But such an orientation can arise only on the condition of relatively stable employment when workers are

deeply penetrated by the cultural dominants and pass them as a baton to newcomers. Just therefore the enterprises assigning to organizational culture the central part in shaping the relations between workers and the patterns and mechanisms of their joint activity, particularly Japanese ones, elevate the continuity of manpower to the rank of fundamental principle of business philosophy.

True, the scope of life-time employment gets smaller even in Japan. So, the amount of fixed-term workers redoubled from 1992 to 2001. By the same year, the portion of part-time employees reached nearly 23 percent. In aggregate, the non-regular labor-force constituted already one-third of those employed. Companies began to hire more outsiders, particularly in electronics and other high-tech sectors. Nevertheless, the share of regular workers was still very high – 69 percent [18, p. 9 – 10]. Under the hard conditions of crises in the beginning of this century when sales dropped off and all tried to find profoundly hidden reserves to survive, Japanese firms sought not to dismiss their permanent employees who were considered the bearers of tradition. Major corporations kept to their core values. So, “Toyota” had not refused to respect the principles “customer first”, “investing in people”, “using challenge to motivate improvement”, but, to the contrary, demanded from both executives and rank and file to strictly observe them [19]. No wonder that the cultures of Japanese companies, despite some loosening, remain still rather strong.

Sure, not all workers contribute to the culture of an organization. Not everyone possesses a marked business culture, and few are able to evince their values to the extent to make the others reckon with and adopt them. But regardless of that, employees get geared and attached to the culture of their organization. Though there remain differences in both treatments and assessments of it, people get integrated into one organizational culture whose basic function consists just in making them talk if not the same language, at least its different dialects (fig. 1).

3. Organizational Culture in Metamorphosis

Organizational culture is in permanent change – up to radical transformations with shifts in its tendency. But they occur not because, as Schein maintains, people are “subjected” to reteaching [6, pp. 233 – 234]. It is hard to believe that those with established views on organizational life and firm convictions as to how to conduct business are, for the most part, ready to confess to falling behind the times and rush to retrain themselves and learn a fundamentally new business culture. Not to mention that it remains unclear where the latter should be taken, and up with whom and what one must keep.

3.1. Cataclysms on the Outside a Cultural Challenge

When major shifts happen in the environment, starting with markets and finishing with law and political institutions, adaptation to which implies an essential modification or even transformation of organizational culture, not only organizations severally but their majority as an aggregate virtually concurrently revise their notions about the cultural “baggage” the “ideal” CEO must have. Neil Fligstein [20]

has noticed that the functional background of the heads of large American companies assumed from the early 20s to the late 70s of the past century three different aspects. While in the period between the two World Wars “natives” of production were dominating, next, up to the early 60s, the supremacy belonged to those from sale and marketing, and afterwards, to financiers. He associates these variations with the control over organization and believes that they have been resulted from changes in strategy and structure, the amendment of antitrust laws that have promoted an increase in product-related and unrelated mergers in the postwar era, and the mimicking of firms in similar environments. In this explanation, there are, no doubt, kernels of sense. However, it does not reveal the main link in the chain extended from changes in the outside to the replacement of the generalized image of CEO. In reality, external turnabouts require significant changes in organizational culture, while renewed culture entails another mode of management which, in its turn, gets embodied in the new model of head.

At the first stage when quite capacious markets needed to be saturated with reliable goods answering the minimal demands of consumers, those responsible for the organization of works and the securing of the required parameters of output came to the fore. After the Great Depression, the belief in “fathomless” market had been broken. One could convey the mood of the time by a jocular question: “Everybody produces something, but are you able to sell it?” Naturally, at the second stage, it was sales and marketing that turned up in the spotlight. Finally, the transformation of companies into diversified conglomerates including various businesses and lines of activity, made observers perceive them as “portfolios of assets” which required competent management to yield the desired effect. This turned the financial control into the dominant of managerial vision and, respectively, enhanced its part in handling of processes and relations in organizations. No wonder that financiers much more frequently were promoted to CEO positions.

Furthermore, in 80s, it had been noticed that the ideal model of head changed again. Financiers were supplanted by engineers and other persons with huge technical competence. According to the company “Management practice consulting partners” which had analyzed the life experience and business bias of newly appointed CEOs, the share of those with technical or at least marketing background from 1978 to 1982 had redoubled and amounted to 50 percent of their general number [21, p. 212]. After, this tendency persisted.

Technological gaps and the intensification of competition on markets required respective remaking of organizational culture. It needed not so much to respond to emerging situations as to foresee them and, consequently, to shift the emphasis to competitive advantages and new technologies and materials, considering company “a portfolio of competences” rather than that of businesses. If the anxiety of American enterprises was before “about the low cost and high quality of Japanese imports,” later they were “overwhelmed by the pace at which Japanese rivals are inventing new markets, creating new products, and enhancing them.” Innovations and engineered artifacts became the heart of organizational culture of large companies, at least in knowledge-intensive and high-tech sectors. The problem lay not in technical potentialities of American business which were not a bit worse than

those of their Japanese rivals, but just in cultural orientations. They “do not lack the technical resources to build competencies, but their top management often lacks the vision to build them and the administrative means for assembling resources spread across multiple businesses” [22, pp. 4, 10]. Hence, no small surprise that engineers as CEOs had caught on. Their task consisted just in inculcating unwonted values as a response to the challenges coming from the “outer space.” For, those which could not do it were losing in competition.

3.2. Outsiders as the Hearth of Renewal

Without making little of those at the head of an organization, they cannot serve as the main factor of its transformation. It is hard to hand something over when the giver himself does not possess it. As Jay Barney remarks, firms without a culture proven to be successful may aim to develop the wanting attributes, but they “are generally not as successful, because the culture of the organization neither supports nor values such behavior.” Conversely, those with high productivity obtained through their employees usually appreciate them, just as the obsession with “customer service and satisfaction” indubitably “reflects some of the core values” [23, p. 660]. That is to say, an organization should already have what is to be passed on. Therefore, any new cultural “seat” turns up in an organization together with new executives.

When “the CEO’s personal values and personality characteristics are not aligned with the new direction of the organization” and expected shifts run counter to his vision and mindset they “will likely go unsupported” because of his being “unable or unwilling to make decisions consistent with needed changes” [8, p. 135]. Only those having essentially different attitudes and business cultures can, on getting some freedom of action, begin to purposefully transform the cultural milieu of the organization or create another one to their own templates.

Under normal conditions, the promotion of insiders, that is, bearers of the same business cultures, to CEO positions is a ready commodity. The selection of candidates within the collective is highly formalized and the power of those coming out on top entrenched. That means not in the least that outsiders are wholly out of the running, but they win very rarely. It may be said that the choice of head among people of the “same kin” is taken-for-granted in most corporations [24]. Thereby are secured both the continuity in value orientations and mutual understanding of different levels of management and areas of performance.

But when an organization is going to bring about radical changes in its culture it needs an outsider executive. He is expected to “be cognitively open-minded, with low commitment to the status quo, able to envision and consider new courses of action, and socially and interpersonally unencumbered, with low attachments to internal executives, and hence able to make major staffing changes.” More than that, such an appointment in itself serves as a sign of coming turnabout and “an extraordinary measure to break with the past.” If there are no “inertia-breaking forces” such as “environmental shifts, strong boards, or poor performance,” that is, factors requiring major alteration of organizational culture, “not only will successors

tend to be insiders, they will also be the insiders who are most similar to the predecessors” [25, p. 190 – 191, 194]. For, the demand for safeguarding the existing culture means that the head may be replaced in physical sense, but not as a bearer of culture.

3.3. Partial Replacement of the Personnel the Core of Reformation

Any sizeable shift in the culture of organization significantly affects personnel. As Deal and Kennedy remark, “the business of change is cultural transformation,” and are blameworthy those who call for change, but ignore the “cultural issues of changing.” For, new values need to become “a reality in the minds of most people throughout the company, not just the senior executives” (26, pp. 164, 23). It is easier to dismiss “inappropriate” people than to make them imbibe “unadoptable” values.

Without new blood, no cultural transformation can be successful. The unlooked-for reconfiguration in the outer environment requires cultural responses in accordance with the altered situation. But, as Joanne Martin notes, they “are too often variants of the old” [27, p. 9]. The current organizational culture as though dies, but “inexorably” resurrects like Bible’s Lazarus if the personal composition of the organization remains the same. A part of its members are mostly unable, on one part, to get rid of what is deeply ingrained in them, although now needless, and on the other, to adopt the elements of another culture – useful, yet elusive - which radically differs from wanted.

Where this elementary consideration is disregarded organizations invariably fail to transform their culture. Thus, Kodak losing its leader position in the industry took a shot at preparing itself to the digital era and appointed George Fisher, an enthusiast of cultural reconstruction of the firm, as the CEO. He succeeded in reorienting several top managers, but encountered total rejection at the lower levels, including that of middle-managers with a “strong belief that Kodak meant film.” Their tried and tested professional culture turned out to be an insuperable impediment to his “efforts to turn Kodak into a high-tech growth company.” This “huge mass” missing the marrow of “the digital world” resisted and boycotted the new technologies, undermining the initiatives advancing digital photography, and, eventually, “jeopardized their own jobs” [28, p. 42]. No wonder: having profoundly imbibed an organizational culture and actually fused with it, they were unable to quickly switch over to another and adopt in droves the values in tune with the demands of the environment.

Not in vain, the attempts to coercively introduce into an organization a culture alien to it or to fundamentally change the existing one inevitably end in failure. When the executives of “3M” decided to implement the system of quality management Six Sigma, they scarcely thought of that there was a huge mismatch between its main principles – maximization of efficiency and minimization of waste - and the firm’s traditional culture which had been oriented since 40s of the past century to creative projects. Employees were used to the absence of rigidity in regulation, their activity aiming at innovativeness. That is why the new rules were taken not merely watchfully and without rapture but even with overt disapproval and

resistance; they became a nuisance almost for all. Though some elements of the system drove their roots into the company's practice, the program as a whole failed. It had only to change the CEO, and that launched the rollback. The firm mitigated its Six Sigma policy. What fit in with the traditional culture had been retained, while the elements at variance with it, discarded [29]. They could not be implanted in the organization, as the bearers of its culture took them as alien entities.

Still more instructive is the instance of "Siemens" caught in corruption practice. Although its executives disclaimed their involvement in crimes and lumped the blame onto several unscrupulous workers, it was obvious that the organizational culture had no embedded mechanism against bribery. To put the affairs in order, the firm had in 2007, for the first time in its 160 years history, appointed to the position of CEO an outsider (bearer of another business culture), Peter Loescher. He restructured the company and made those associated with scandal be cooperative with the investigation and keep away from old manners [30, p. 173]. But had the intolerance to corruption turned into one of the firm's key values and, more importantly, a personal preference of its workers?

Soon it had been recognized that the results were at a standstill. In 2013, the policy turned about again. Instead of Loescher, Joe Kaeser, flesh and bone of "Siemens," its CFO with 33 years carrier within the firm, had been designated as CEO. In an interview to the German newspaper "Spiegel" right after his appointment, he confessed that "regardless of what I say or the mistakes I make, things are still no better than they were." The aftermath of the corruption shock had been not overcome. And it needed to "once again concentrate on our core values" [31]. But can one culturally rebuild the company and implant in it the values brooking no bribe as an instrument of achieving the organizational goals, without getting rid of those entangled in shady dealings?

Sure, a part of workers are flexible enough to easily adapt to a new tendency. Another part whose attitudes do not coincide with those of the existing culture welcome the fresh waft, because reckon on it to allow them to be on a firmer ground. And they appreciably facilitate cultural transformation. Researchers having studied a number of British companies report that the culture of quality has been established successfully in the organizations whose "employees settled comfortably into the new culture" [32, p. 640]. Such "pliant" workers appear to be the very responsive mass the new culture relies on. Where this stratum is too thin there can be no thought of cultural renewal. However, they are understandably far from being the vast majority.

A rather significant part of the personnel does not fit in with the new demands at all. The turnabout in the organization tells on them most heavily. Some leave on their own, others are dismissed on the management's initiative, the third, alienated from the business culture being propagated, nevertheless, remain in the organization, but function in a mode of "inner emigration," trying not to meddle actively in what is happening. Anyway, without an essential renewal of the personnel (the replacement of at least a weighty part of the key incumbents), particularly at the middle level of management, with bringing into the picture the bearers of the culture to be introduced, no fundamental change in culture is feasible (fig. 2).

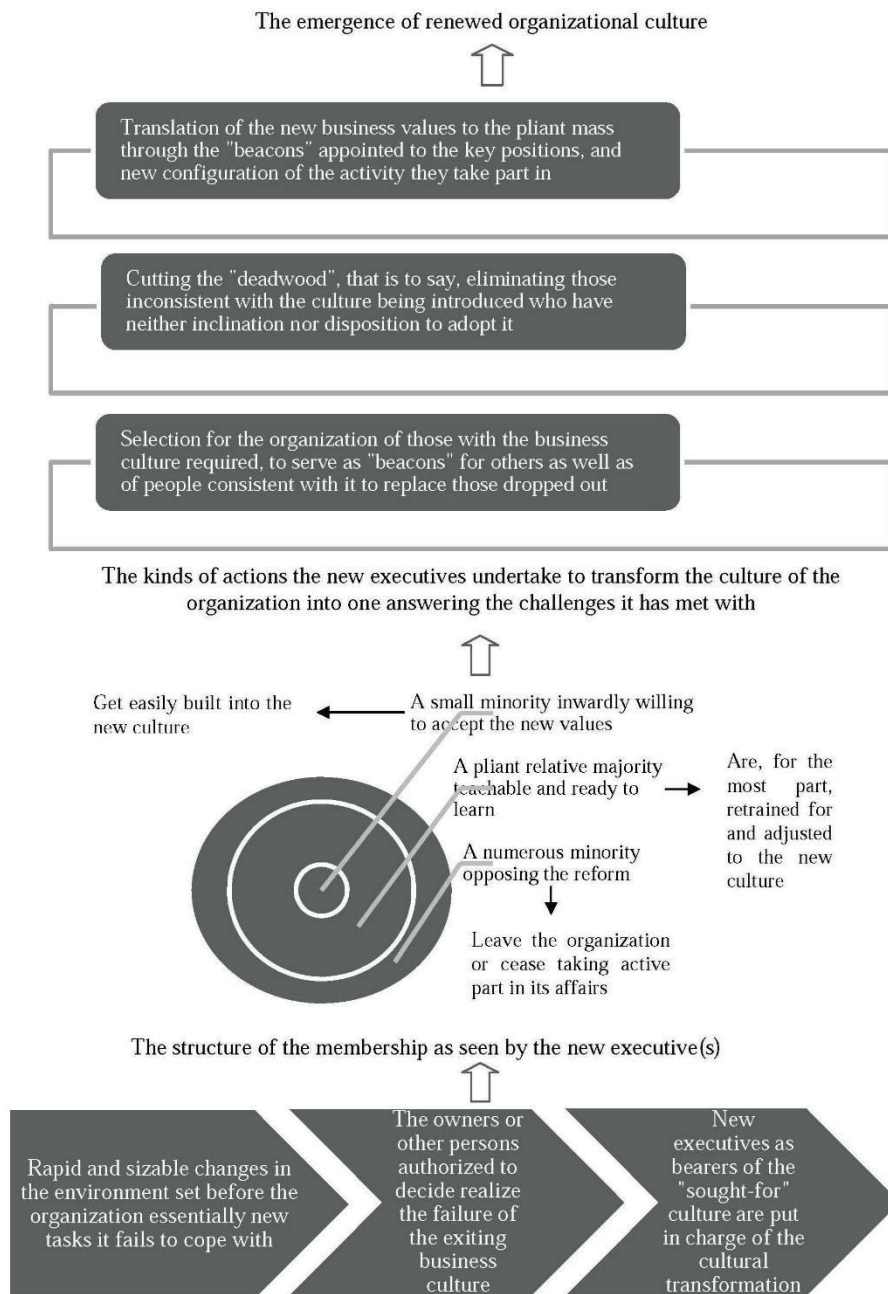


Figure 2. The pattern of cultural transformation

4. Cultural Split and the Ways Out

The collision of old culture with new not always occurs when the latter comes to supersede the former. Sometimes inside an organization, a germ of another culture inconsistent with existing arises. Little by little expanding, it grows into a separate entity opposing itself to the dominant culture.

4.1. New Culture beside Old

At first, the new culture is not highlighted, and people take it as a peripheral offshoot or a temporary anomaly. But as this formation gets stronger and consolidates its position in the organization it turns into an alternative culture rivaling the old one. Thus a cultural split shows up which becomes a headache for the organization and not merely engenders additional conflicts and frictions but even undermines its viability.

To make sure of this it is enough to retrace the story of “Arthur Andersen.” Leonard Spacek who headed it for 26 years decided once to support the experiments of Joseph Glickauf on electronic data processing, and after the first automated payroll system had been developed and set up (in 1953) at a General Electric plant, founded inside the firm an administrative system division which was meant for consulting on this sort of projects. Glickauf was a person from a whole other milieu, with quite different philosophy and business principles having little in common with Andersen’s legacy. And naturally, he selected employees and built up the working relations between them, proceeding from his own understanding and preferences.

The cultural discrepancies between the units were salient from the very outset. The “bookkeepers” took the “consultants” with a fair portion of skepticism. They named the new division “Spacek’s folly” and joked that its earnings were not enough to cover the expenses. However, the business philosophy and managerial abilities of Glickauf, the support lent to him by Spacek, and, more importantly, the progress of information technologies had done their work. Two decades later, the “consultants” began to secure much of incomes and got almost equal to the “accountants”.

While the role of the “consultants” remained secondary few concerned about contradictions. But when the consulting unit started claiming more discretionary power and a more weighty word in making decisions the dissensions degenerated into open frictions and conflicts. In 1989, “Arthur Andersen” had to send it to market as a distinct firm under the name “Andersen Consulting.” Though formal unity between the two companies was kept on the base of contractual relations under the umbrella “Andersen Worldwide,” the final severance seemed to be a matter of time. In 1997, the “consultants” brought an action against the “bookkeepers” for complete separation and in 2000 it had been officially recorded – up to the removal of Andersen’s name [33, pp. 231 – 233]. So the unit once set up to enlarge the company’s activity and communicate to it more stability not merely failed to carry out this mission but, in the last, drove it to the verge of survival.

Many put what has happened down to a mere conflict of interests. So, according to Andrew Crockett and his colleagues, the heart of the battle was “revenue generation and profitability” [34, p. 36]. But could these factors by themselves bring to the split?

Indeed, the statuses of the units essentially changed and the conflict for power and money acquired visible outlines. In 1989, out of 2134 partners only 586 pertained to consulting, while their unit yielded 43 percent of incomes. However, it was only a portion of the truth. Another the “bookkeepers” stood up for consisted in that the picture would be completely different if to take into consideration the contributions of all professionals working for the firm. Then, it would get clear that “bookkeepers” generated in average \$93300, while “consultants” only \$79500 [35, p. 86]. Besides, the “redistribution of revenues” occurred in nearly all firms of the kind, but it nowhere brought to so sharp consequences: the conflicting parties could relatively easily arrive at simpler and more effective solutions [34, p. 36]. Why “Arthur Andersen” found no “peaceful” way of settling the situation?

The problem of power and incomes was only the tip of the iceberg. Without belittling its acuteness and significance, another, stronger, though less conspicuous, factor lay in the heart of the conflict, which skin-popped its sides and strained the atmosphere in the firm. This has been confirmed by Duane Kullberg who headed the company in 1987 – 1989 and fulfilled the reform through which the consulting unit obtained the status of a separate company. In his words, higher reward was an important reason, “but we could have modified the compensation plan without reshaping the organization. The fact is that the change stemmed primarily from a need to position ourselves more strategically to serve a changing market” [35, p. 86]. The “consultants” had outgrown the “straitjacket” of Andersen’s values and the culture established in the firm. They were sure that it should change both the work style (be more responsive to clients’ demands and adapt to them more flexibly) and the business philosophy (add to its armory the principle “Profit first, at any cost”). That is why it was for them so essential to get out of the surveillance of “bookkeepers” and build up their relationships with clients independently.

4.2. One More Head a Threat to Tradition

The conflict in “Arthur Andersen” is often understood superficially and reductively. The responsiveness to the whims of market and the willingness to render services to clients seem to some mercenariness verging on the absence of moral standards. In 1995, even before the final “divorce,” Dick Measelle, the head of the firm’s audit and tax unit, heard from Matsutaro Morita, his colleague from Asahi Audit Corporation, such a diagnose of the cultural split: unlike the “accountants” guided by Samurai philosophy, the “consultants” were saturated, rather, with merchant spirit. Samurais notable for their absolute devotion and loyalty, personal dignity, call of duty, and valor could, if necessary, sacrifice their life in battle. Shame was of the key elements of their world and they did not seek profit at whatever the price - in tune with the words of Andersen who called for measuring “our contribution more by the quality of service rendered than by whether we are making a good living out

of it” [36, p. 1]. As to merchants they, naturally, care more for profit. For the sake of it, they are ready sometimes to forsake not only their professional honor but also moral principles. But has this anything in common with reality?

The “consultants” were no less principled than the “accountants” and did not yield to them in moral standards. However, the principles and business philosophies the sides kept to were not only not congruous, but even incompatible. Both units severally were capable of surviving and prospering, but they could not get along together.

Furthermore, just the attempt of “bookkeepers” to take over, at least partly, the business culture of their more successful consultant fellows brought them to the final collapse. Seeking to implant its elements in a ground alien to it, Andersen’s “heirs” had, in fact, spoiled their own culture instead of infusing new blood into it. The mishmash arose out of what could not be viable and effective. Merchant under the guise of Samurai was the worst thing one could devise.

The wish to attract clients turned into readiness to indulge them. For instance, Enron was allowed even to choose auditors. When Carl Bass, returning to the “Samurai practice”, called in question some operations of the company he had been blamed for impeding the transactions and dismissed. To pander to clients “Arthur Andersen” resorted to “funky accounting, ignoring some losses and hiding others in partnerships that were off-balance-sheet” [37, pp. 6, 9]. Nevertheless, Enron burst under the burden of losses and debts and dragged with it to the bottom its auditor. But it was not Merchant that passed into nothingness on the client’s heels. He continued his business under the name “Accenture,” with no less success than before. Who really fell was just Samurai in the skin of Merchant.

What enabled “Arthur Andersen” to open a new market and create a source of additional incomes proved to be a delayed-action bomb. Within the organization, a completely different cultural “locus” arose which began to unfold into a self-contained culture. Around Glickauf, gathered those holding the same views who gradually selected other workers. Together, they formed their own cultural practice fundamentally distinct from old. In 80s, the process had been finished in the main and required institutional legalization.

Thus, cultural splits get possible when a new head with respective authorities and charisma as well as business values and philosophy fundamentally different from “traditional” appears in the organization. If he succeeds in rallying his adherents to form a vigorous “combat unit” and makes, together with them, a go of the business they are responsible for to the interests of the organization and thereby strengthens their position in it the new business culture engendered by them becomes self-sufficient and opposes itself to old. In the issue, the organizational culture gets bifid, and the war between its parts undermines the unity of the organization and weakens and eviscerates its activity. This seems to be a kind of schizophrenia when one half of the brain orders the organism to do what is totally inadmissible for the other, and vice versa.

4.3. Preventing the Ruptures in Culture

The new culture is successful if it is consonant with the demands of the environment, and the inner readiness of its bearers to take over its values not in word, but in deed. At that, as the old culture whose crown is contested by new begins to lose, it blames the latter not merely for undermining the tradition but also for unfair practices and sometimes even the breach of moral norms. Nevertheless, it gradually gets obvious that the new culture proves to be better adapted to the existing conditions and outweighs its rival. Then, the old one tries to imbibe the elements of new to recover its competitive strength. But that brings normally to not a revival, but the ruin. Since these elements are not organic to it and directly do not fit into its framework, they get inevitably distorted and, thereby, mutilated. As a result, they not merely fail to succeed but make the culture itself nonviable.

Though intolerable, the situation is quite natural, because the alternative culture is not imposed on the organization from outside, but arises within it as a response to some vital tasks it is to perform. For this reason, cultural clearages appear to be real menace to any organization. Hence, the issue of how to avoid them acquires special importance.

There are two ways of preventing such a split in organizational culture. The first and simplest is not to allow an outstanding figure with peculiar, fundamentally different from “traditional,” business culture and philosophy to take up a key and, at that, independent position in the organization and form round him a team of like-minded persons. However, such a solution is not always expedient from the practical point of view. For, it happens sometimes, as in Glickauf’s case, that, thank to such a figure, the organization manages to eliminate the “bottlenecks” in its activity and improve the results obtained. To lose real and obvious advantages out of fear of possible future (sometimes very remote and even imaginative) conflicts is not the most effective approach to running the business. Therefore, if such a team poses no immediate danger to the interests of the organization and, at that, allows it to essentially raise the level of output, it is regarded as reasonable to put up with the situation. But then, one needs to be ready to potential split.

Those who have, for a reason, enabled the alternative culture to get self-contained and oppose old may avail themselves of another means. Without waiting for acute and overt collisions between the adherents of the two confronting cultures to take place, the organization should be divided through detaching the bearers of the new culture into a separate organization capable of developing on its own and save them from the yoke of subordination to their “antagonists.” If such a “divorce” takes place at a sufficiently early stage when the relations of the sides has not yet entered the phase of incompatibility it gets possible not only to deliver the both cultures from their baneful impact on each other but also to make a ground for peaceful coexistence and even fruitful cooperation in future in the capacity of independent, but “allied” entities. Otherwise they will have devoured, in an irreconcilable fight, not only each other but also the organization itself.

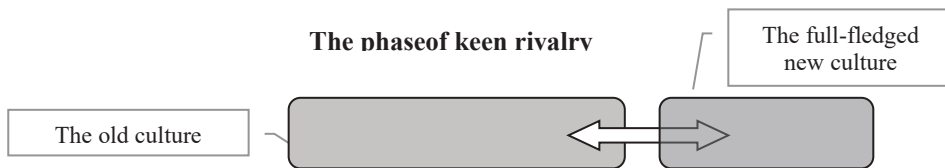
Some companies came to realize this as early as the last third of the past century. They widely practiced the “autonomization” of groups with business cultures

essentially differing from that of the organization, granting them the status of independent profit centers or spin-off partnerships with discretion, within a sufficiently broad range, over what to do and how to spend money. By 1990, “Johnson and Johnson” consisted of 166 autonomous companies. “Hewlett-Packard” had about 50 separate units. The same path was taken by “AT&T” and IBM. Large publishers created small divisions which acquired and printed books on their own. “Hitachi,” “Xerox,” and “3M” established new partnerships, reserving rather big stakes for themselves. Meanwhile, the reasons for that are reduced mostly to financial considerations and mercenary ends. It is brought to the fore that the heads’ “compensation is linked to the unit’s profits,” and “risks and returns are shared between headquarters and the managers of the separate businesses” [38, p. 139]. Sure, material interests play a very important role. But it is not them that turn the scale. Just the understanding of the cultural peculiarity of emerging groups and its incompatibility with the firm’s “traditional” values, and the anticipation of probable frictions and clashes are crucial to “autonomization.” Due to peaceful “divorces,” parent companies not merely escape destructive inner conflicts, but also retain control over prospective areas of business (fig. 3).

One more person with outstanding business culture distinct from “traditional”, vested with power to man a unit or project and build a team round it engenders sooner or later another “seat” (or “hearth”) of organizational culture opposing the dominant one.



While the group the new culture ripens in remains relatively small and its influence on the organization, this culture is taken for a whimsy peripheral entity worthy of raillery rather than suppression. But as it expands and consolidates it becomes a self-sufficient force and not merely opposing the “traditional” culture, but claiming the dominance.



Competitive properties	Cultures	
	The old culture	The new culture
Advantages	• Vested with formal power • Deeply rooted in organizational life and riding on tradition • Stronger and more comprehensive	• A real force competing with the old culture • Passionary and fervent • Ascending and evincing a positive dynamics as to both consolidation and expansion
Drawbacks	• Begins to yield to the new culture in the “turf war” • Sluggish and not so much	• Mostly informal, with few officially acknowledged leverages over the

- looking ahead as clinging to the past

 - Descending and waning, with comparatively small inner potential for renewal and adjustment to changing conditions
- organization

 - Not enough ingrained in the organization’s history and routine
 - Still weaker in ability to influence the organizational life

The phase of keen rivalry comes in when the new culture, though still yielding to old on the whole, is strengthened enough to claim the right to be on an equal footing with it, demanding that the factual state of affairs be officially fixed. Neither side is in the position to turn the balance: numerous, but waning actual merits of old culture are countervailed with potential, but weightier virtues of new. Continuous being in such straits is deleterious for organizational culture, for as a kind of functional schizophrenia that undermines its capacity.

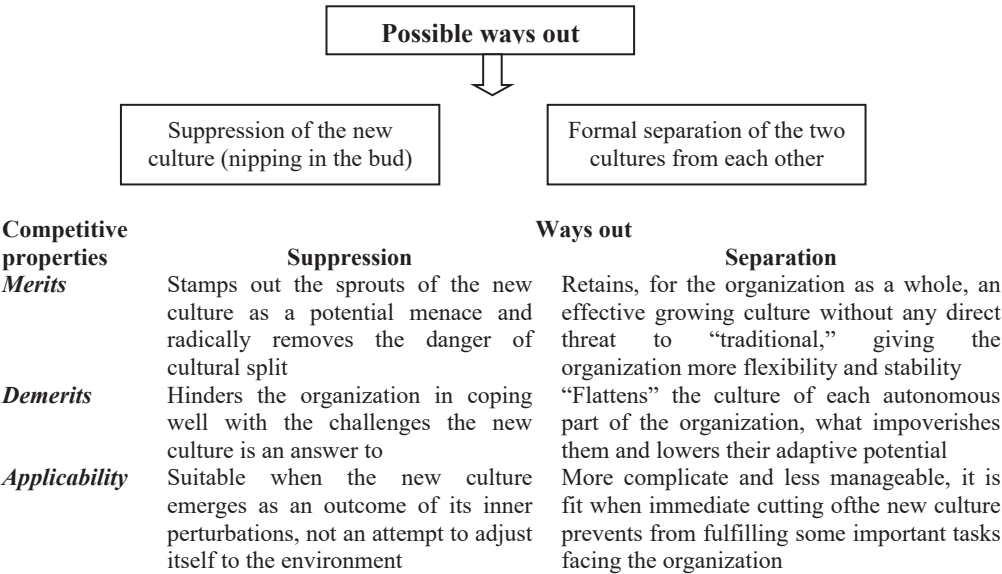


Figure 3. The origins of and remedies for cultural split

5. General Conclusions

The unity of organizational culture is secured, first and foremost, by the selection of “right” personnel. The common cause the workers are to be adjusted to gradually glosses over the discrepancies in their attitudes towards it. Moreover, it makes them not attach primary importance to most of varieties still remaining. That is why even the values not to their liking arouse in them frequently little opposition.

In the course of joint activity, workers “rub together,” get used to others’ mindsets, and “correct” their own to avoid collisions and conflicts. They come closer and get adapted to each other, while their notions of what and how to do, primordially too diverse, begin to overlap or even coincide. This imparts a certain measure of homogeneity to the business cultures of individuals. But no employee shares the values of his organization in the sense of assimilating, or adopting them

unreservedly. Rather, each accommodates himself to the values as well as adjusts them to himself, what essentially mitigates the completely not removable strain in relations both among workers and between their personal and organizational values.

The germ of the culture of any organization is the business culture of its founder(s) or first head(s). It sets the tone of development in the course of which acquires more comprehensive contents and, gradually absorbing the compatible impulses coming from other notable members, unfolds and turns into a full-fledged organizational culture. The bits of a new culture begin to take shape with the coming of executives having different visions and business cultures and wanting to transform the cultural milieu or create another to their own templates. Such leaders try to replace the existing values with their “own” or raise the sprouts of a different culture somewhat away from old, the chances of success being determined largely by the consonance of new values with the needs of the organization, and the inner readiness of its personnel to take them over.

No attempt to coercively transform an existing culture or introduce into an organization a culture alien to it can be crowned with success. Its people may be divided into three main groups: 1) a small minority inwardly willing to accept the alternative values because of taking old critically and wanting to change them; 2) the pliant relative majority not enthusiastic over the new culture, but teachable and ready to participate in alterations to the organization’s and their own benefits; and 3) a rather numerous minority opposing the reformers (in view of commitment to the old culture or reluctance to get engaged in changes). To overcome the “strength of materials” the head needs reliable pivots, that is to say, a number of like-minded persons on the key positions coming, as a rule, from the outside as bearers of the culture to be introduced and serving as “beacons” (models to follow). Though comparatively few, they carry much weight. Besides, a body of people enters the organization to replace those leaving it because of their incompatibility with its proclaimed business values. Most of newcomers remain in the organization and take part in working out the new culture. It gets gradually imparted to the pliant mass in accord with the “helix mechanism.” As to the opponents their majority leave the organization or, remaining there, imitate loyalty, only few of them joining in the new culture with time.

When another cultural “seat” inconsistent with existing emerges in the organization and, gradually expanding, grows into a separate entity opposing itself to the traditional culture, the divergence in values turns, at last, into a cultural split. An organization with bifid culture resembles a schizophrenic making inconsistent and conflicting decisions and, therefore, normally not achieving the results intended. Such an effect can be recovered in two ways. The first implies forbidding big figures to make around them self-contained business cultures, what is sometimes not merely non-efficient, but even harmful to the tasks being performed, while the second, the separation of the bearers of the new culture (before its confrontation with old has turned into a menace to the organization) into an autonomous division not accountable to their “old” opponents. That allows the organization to get, instead of self-destruction, an opportunity for self-diversification and strengthening its position in the external environment.

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Spectral Indexes Evaluation for Satellite Images Classification using CNN

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Abstract

Deep learning approaches are applied for a wide variety of problems, they are being used in the remote sensing field of study and showed high performance. Recent studies have demonstrated the efficiency of using spectral indexes in classification problems, because of accuracy and F1 score increasing in comparison with the usage of only RGB channels. The paper studies the problem of classification satellite images on the EuroSAT dataset using the proposed convolutional neural network. In the research set of the most used spectral indexes have been selected and calculated on the EuroSAT dataset. Then, a novel comparative analysis of spectral indexes was carried out. It has been established that the most significant set of indexes (NDVI, NDWI, GNDVI) increased classification accuracy from 64.72% to 84.19% and F1 score from 63.89% to 84.05%. The biggest improvement was obtained for River, Highway and PermanentCrop classes.

Keywords: Earth remote sensing, deep learning, spectral indexes, convolutional neural networks, EuroSAT

1. Introduction

Remote sensing is a technique that is used for monitoring the physical characteristics of objects and capturing information remotely using sensors. Remote sensing is based on measuring radiation at a distance.

In recent years, the availability of remote images regularly acquired by satellites has been increased due to high-resolution and multi-spectral imaging Landsat and ESA Sentinel missions. These missions opened opportunities for collecting images in datasets and using them for solving issues.

Deep Learning (DL) approaches including neural networks are applied for a wide variety of problems, popular in the remote sensing field of study and showed high performance. These models learn features from the input data automatically, unlike classical machine learning algorithms that usually require data preprocessing.

Deep learning was successfully used for land [1] and fire hazardous forest areas classification [2], [3], object detection [4], deforestation problems [5], observation of global changes, agriculture analysis [6], and healthcare issues [7]. Among all the DL models, convolutional neural networks are becoming increasingly ubiquitous because of their remarkable results in many domains, including remote sensing issues. This is because of the image's stationary property which states that contents retrieved from one part of an image can also be applied to another part of the image [8].

The novelty of the research is investigating the significant set of spectral indexes for multiclass classification of satellite images on the EuroSAT dataset and proposed convolutional neural network, that could increase classification accuracy and F1 score in comparison with classical true color (RGB) images.

2. Remote Sensing Images

Landsat8 and Sentinel2 are multispectral instruments that are publicly available and provide remote sensing images of Earth's land surfaces continuously. Landsat 8 that was launched in 2013 according to the Landsat Earth observation program (since 1972 [9]) in NASA and USGS collaboration, acquires global moderate-resolution measurements of the Earth's terrestrial and polar regions in the visible, near-infrared, short wave, and thermal infrared [10].

The Sentinel-2 mission provides for a combination of two satellites – Sentinel-2A and Sentinel-2B – equipped with identical Multispectral Instruments (MSI). Sentinel-2A was launched in June 2015. The MSI has a very wide field of view (290 km swath width, which is significantly larger than the 185 km of the OLI) [11]. Despite Landsat8 supplies images in 11 different bands with (30-15 m) spatial resolution and global coverage approximately every three days, the Sentinel-2 Multi-Spectral Instrument features 13 spectral bands spanning from the visible and near-infrared (VNIR) to the short-wave infrared (SWIR), featuring 4 spectral bands at 10 m, 6 bands at 20 m and 3 bands at 60 m spatial resolution and 10 days minimum revisit time at the equator. Aerosols, Cirrus and Water vapor bands could be used for the correction of atmospheric effects [12], [13]. Higher image resolution allows to figure out more precise calculations.

Getting periodically remote sensing images permitted forming them in datasets for next usage in neural networks. Some of the open-sourced remote sensing datasets are presented in Table 1.

	Dataset Name	Type	Number of images	Reference
1	UC Merced	RGB	2,100	[14]
2	RSSCN7	RGB	2,800	[15]
3	AID	RGB	10,000	[16]
4	RSI-CB	RGB	36,707	[17]

5	PatternNet	RGB	30,400	[18]
6	NWPU-RESISC45	RGB	31,500	[19]
7	EuroSAT	Multispectral	27,000	[20]

Table 1. Comparison remote sensing datasets.

UC Merced – classical remote sensing dataset that consists of 21 classes with 256x256 pixels image size. All images are presented in true color (RGB). The dataset is small (only 100 images per class). PatternNet and NWPU-RESISC45 datasets include a few numbers of images per class but with high-resolution. RSI-CB contains 45 categories and more than 36,000 images with up to 3m spatial resolution. The AID remote sensing image dataset is based on Google Earth images. It contains 10,000 images with 30 classes and up to 400 images per class.

Among considered remote sensing datasets EuroSAT is the most recent (published in 2019) and has all possible multispectral bands. It consists of 27,000 images across 34 European countries: Austria, Belarus, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Macedonia, Malta, Republic of Moldova, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, and United Kingdom. The dataset is separated into 10 different classes with 2,000 to 3,000 images per class (see Fig. 1). Images size is 64x64 pixels, spatial resolution is up to 10 meters per pixel [20]. The dataset is slightly imbalanced for Highway, Industrial, Pasture, PermanentCrop, and River classes.

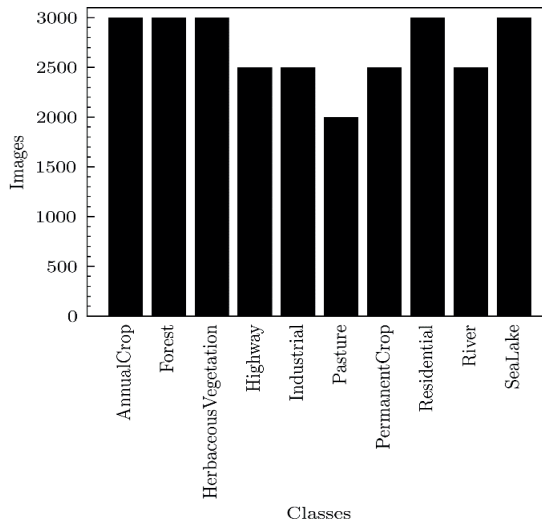


Figure 1. EuroSAT dataset distribution by classes.

3. Spectral indexes

Deep learning allows computational models, that are composed of multiple processing layers to learn representations of data with multiple levels of abstraction [21].

However, sometimes these algorithms are not able to find all significant representations from given RGB-like input images and their efficiency of the DL could be improved due to adding more information into the system. To analyze specific land surface changes, land use/land cover change, or urban expansion, a common approach involves the processing and transformation of the raw spectral information contained in remotely sensed images [22]. For this purpose, we can calculate spectral indexes (SI) from available spectral bands to generate additional features for the deep learning neural network.

The vegetation spectral indexes are features that represent directly or indirectly the biochemical and biophysics vegetation or crop characteristics. These indexes are obtained through information provided by spectral sensors [23]. Some scientists around the world have demonstrated the efficiency and potential of generating vegetation indexes for the estimation of useful variables for agricultural activities. Spectral indexes are used for improving the accuracy of classification. In [24] they were applied to the problem of land cover classification of tree species and forest change detection.

Vegetation indexes help to estimate changes in the environment caused by growth in the human population and decreasing natural resources [25]. Some studies have focused on the production of thematic maps using remote sensing data and they reported that remote sensing provides effective support to the management of agricultural fields by providing spatial and temporal information for vegetation monitoring over large areas [26]. This research effectively applied spectral indexes for monitoring agriculture fields and generated a classification map. Spectral indexes are successfully used for analyzing the urbanization problem and got high performance [27].

Among a wide range of spectral indexes proposed in the papers mentioned above, we selected 10 and calculated each of them for all images in the EuroSAT dataset (Table 2).

	Spectral Index	Abbreviation	Equation ¹	Reference
1	Normalized Difference Vegetation Index	NDVI	$\frac{\rho_{nir} - \rho_{red}}{\rho_{nir} + \rho_{red}}$	[28]
2	Normalized Difference Water Index	NDWI	$\frac{\rho_{nir} - \rho_{swir}}{\rho_{nir} + \rho_{swir}}$	[29]

¹ Where ρ_i – reflectance value of i -th band.

3	Plant Senescence Reflectance Index	PSRI	$\frac{\rho_{red} - \rho_{green}}{\rho_{nir}}$	[30]
4	Normalized Difference Green NDVI	GNDVI	$\frac{\rho_{nir} - \rho_{green}}{\rho_{nir} + \rho_{green}}$	[31]
5	Global Environmental Monitoring Index	GEMI	$\eta(1 - 0.25\eta) - \frac{\rho_{red} - 0.125}{1 - \rho_{red}},$ where $\eta = \frac{2(\rho_{nir}^2 - \rho_{red}^2) + 1.5\rho_{nir} + 0.5\rho_{red}}{\rho_{nir} + \rho_{red} + 0.5}$	[32]
6	Normalized Difference Pond Index	NDPI	$\frac{\rho_{swir} - \rho_{green}}{\rho_{swir} + \rho_{green}}$	[33]
7	Water Band Index	WBI	$\frac{\rho_{blue} - \rho_{red}}{\rho_{blue} + \rho_{red}}$	[34]
8	Enhanced Vegetation Index	EVI	$2.5 \cdot \frac{\rho_{nir} - \rho_{red}}{\rho_{nir} + 6\rho_{red} - 7.5\rho_{blue} + 1}$	[35]
9	Modified Simple Ratio	MSR	$\left(\frac{\rho_{nir}}{\rho_{red}} - 1 \right) : \sqrt{\frac{\rho_{nir}}{\rho_{red}} + 1}$	[36]
10	Simple Ratio	SR	$\frac{\rho_{nir}}{\rho_{red}}$	[37]

Table 2. Spectral indexes.

4. Convolutional neural networks (CNNs)

In recent time, deep learning has brought revolutionary achievements in many applications, including the classification of remote sensing images. The state-of-the-art results have been achieved by the Convolutional Neural Networks (CNNs) due to their structure being able to extract more hidden and deeper features than classic machine learning methods [38]. This concept lies at the basis of many deep learning algorithms: models (networks) composed of many layers that transform input data (e.g., images) to outputs (e.g., disease present/absent) while learning increasingly high-level features [39].

CNN architecture consists of layers, namely, convolutional layers, max-pooling, and fully connected layers. The main idea of a convolutional layer is extracting significant features from previous layers of the network and generating feature maps as an output. There is a kernel that is defined as a matrix and saves information of an object. Feature maps values bind with the kernel. Features encode useful information about a considered object from simple to most generic (for instance, image color,

orientation). The sub-sampling layer also called as pooling layer, is mainly implemented to reduce the size of the image data and the variance of features extracted from the convolutional layer with the retention of the geometry of the input data [8].

For the current research, we propose convolutional neural network architecture presented in Fig. 2. It consists of sequences of Convolutional and MaxPooling layers. At the final stage of the neural network, there are two Dense layers with a softmax activation function that represents classification probabilities for each class in the EuroSAT dataset. For preventing overfitting problem BatchNormalization (after every combination of convolutional and pooling layers) and Dropout (after fully connected layer with rate 0.2) layers were used.

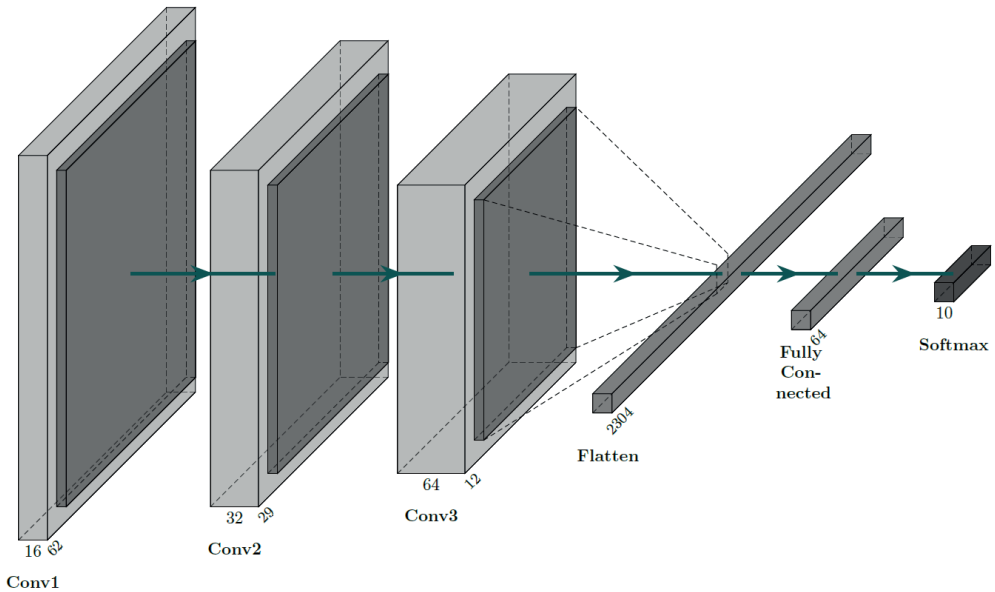


Figure 2. The architecture of the proposed convolutional neural network.

For experiments, we had chosen $\text{ReLU}(x) = \max(0, x)$ activation function among

neural network layers and softmax $s(\vec{x})_i = \frac{e^{x_i}}{\sum_{j=1}^{10} e^{x_j}}$, where $\vec{x} = (x_0 \dots x_{10})$ in the end.

RMSprop learning algorithm with $1e-6$ learning rate was selected. The learning algorithm is employed to decrease the categorical cross-entropy loss (which relates to a probability over the classes for each image and is suitable for multiclass classification issues) [40]. While training we used EarlyStopping [41] technique with the patience of 5 that monitored accuracy on the validation subset. That is why the number of epochs varies for every experiment.

To evaluate the considered models the classification accuracy metric and F1 score were selected. Accuracy is one of the most commonly used measures for classification

performance, and it is defined as a ratio between the correctly classified samples to the total number of samples:

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}, \quad (1)$$

where correctly classified positive sample is called (TP), classified as negative – false negative (FN). If the sample is negative and it is classified as negative it is considered as true negative (TN); if it is classified as positive, it is counted as false positive (FP). However, classification accuracy in multiclass tasks is sensitive to the imbalanced data [42]. It can give high results when the number of samples in one class more than in others, but it doesn't mean that a neural network could classify all classes correctly with the same value of success. F1-score represents the harmonic mean of precision and recall. The value of F-measure is ranged from zero to one, and high values indicate better classification performance. The metric is sensitive to changes in data distributions and could be used for imbalanced datasets evaluation:

$$F_1 = \frac{2TP}{2TP + FP + FN}. \quad (2)$$

5. Results and discussion

The programming environment, for the research was the Jupyter Lab with Python 3.7. The learning frameworks Tensorflow 2.0 and Keras 2.3, and the library for working with multi-dimensional arrays Numpy 1.18 were used. Training, validation, and testing of CNN were performed on ASUS laptop. The laptop has 16Gb of RAM, one Nvidia GeForce 940MX GPU and an Intel Core i7 extreme 7th generation CPU (up to 3.5 GHz).

We have separated the EuroSAT dataset to train, validation, and test subsets. The train dataset contains 70% of all images, validation and test datasets consist of 15% each. Examples of images by classes are shown in Fig. 3.

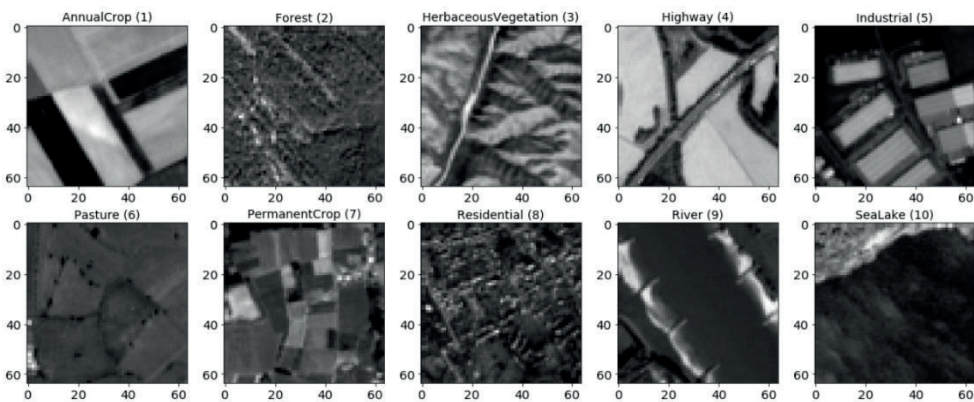


Figure 3. Image examples of the EuroSAT dataset.

We have carried out a set of experiments using the grid search to find the best suitable combination of spectral indexes that allowed to improve classification accuracy and F1 score on a given dataset.

The graphs in Fig. 4-5 show the accuracy classification dependence on epochs for RGB images and their combinations with indexes. The highest growth was for RGB NDVI, NDWI, and GNDVI combination on train and validation datasets.

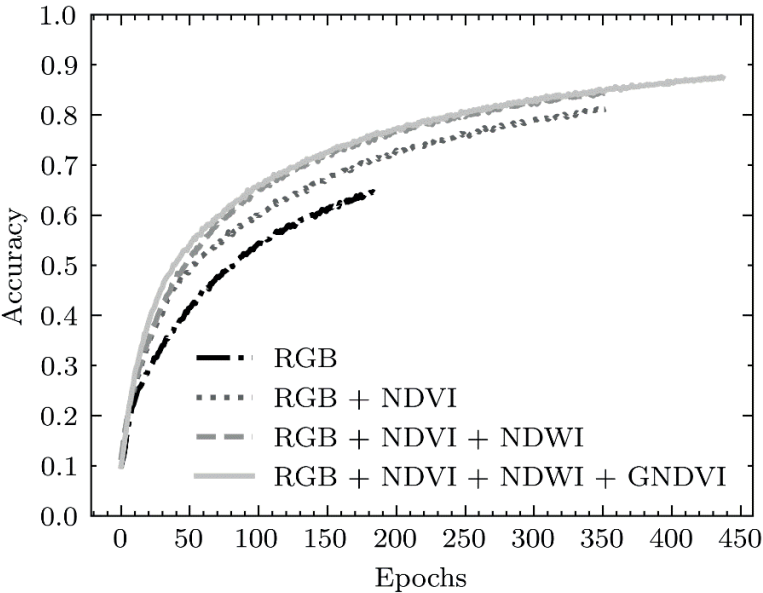


Figure 4. Classification accuracy on train data.

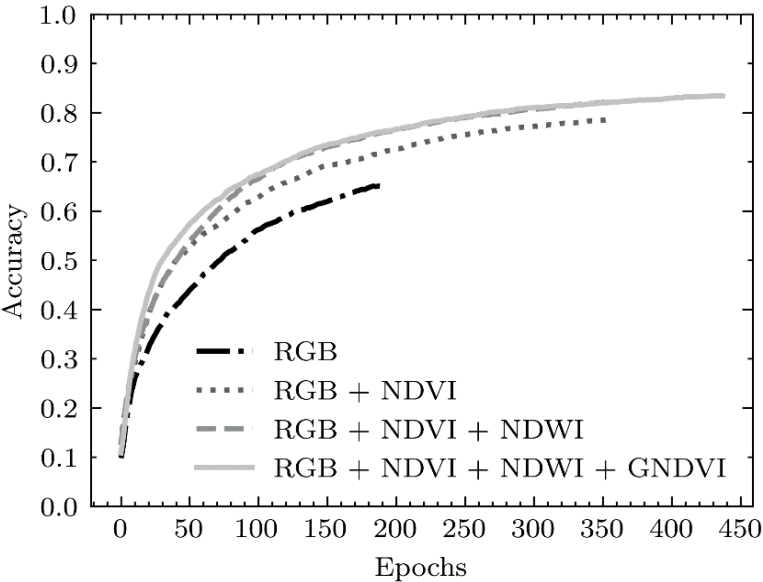


Figure 5. Classification accuracy on validation data.

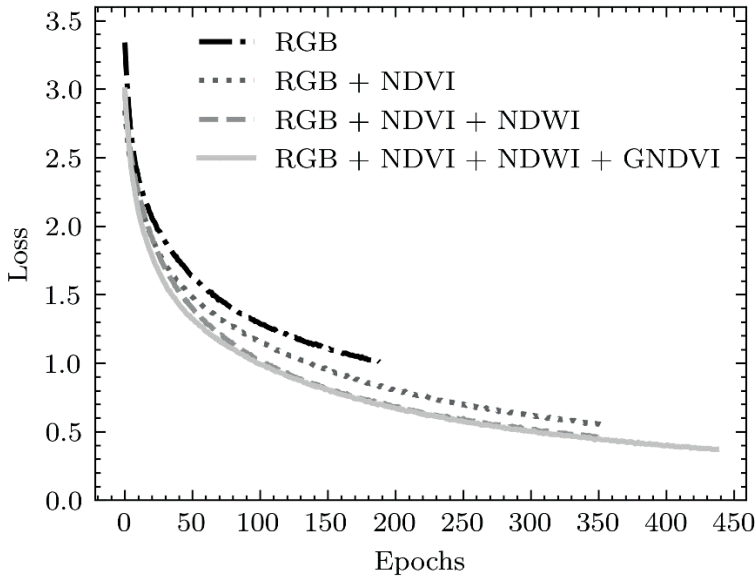


Figure 6. Classification loss on train data.

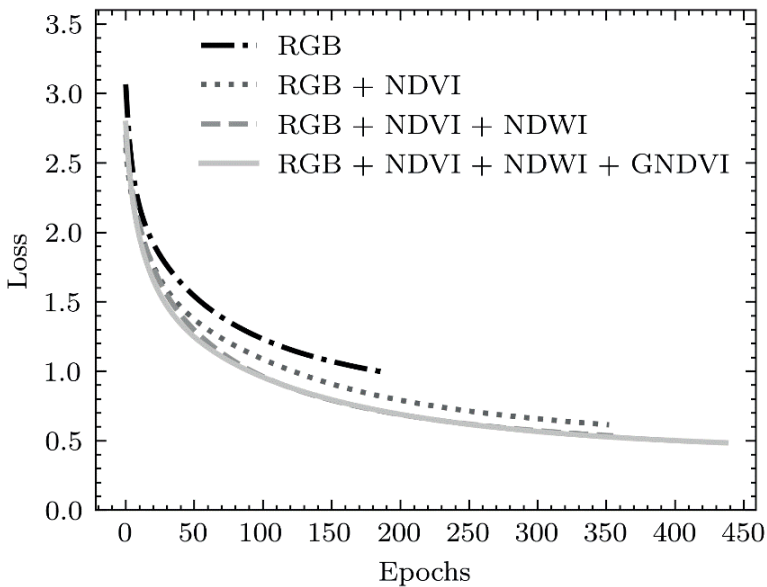


Figure 7. Classification loss on validation data.

The graphs in Fig. 6-7 present loss dependence on epochs. A consistent drop of loss on train and validation datasets was observed. Even on the first fifty epochs adding indexes helped to decrease loss function compared to images with RGB channels. The combination of NDVI, NDWI, and GNDVI indexes showed a more sharpened drop on early epochs.

Table 3 outlines the process of finding the best set of spectral indexes. As a baseline in the first experiment, only RGB images were selected. The classification accuracy and F1 scores were 64.72% and 63.89% respectively. In the next steps, we added indexes one by one and monitored selected metrics. In the last Step 4, the improvement was not achieved, so the grid search had been stopped. The maximum obtained accuracy is 84.19%, and the F1 score is 84.05%.

According to the grid search results, it had been established that for the EuroSAT dataset most relevant indexes combination is NDVI, NDWI and GNDVI together with RGB channels.

	Step	0		1		2		3		4	
	Combination	Acc ²	F1	Acc	F1	Acc	F1	Acc	F1	Acc	F1
1	RGB	64.72	63.89	–	–	–	–	–	–	–	–
2	NDVI	–	–	79.09	78.88	–	–	–	–	–	–
3	NDWI	–	–	74.59	74.21	81.48	81.30	–	–	–	–
4	GNDVI	–	–	77.00	76.69	81.07	80.92	84.19	84.05	–	–
5	PSRI	–	–	69.87	69.53	81.31	81.12	80.61	80.43	78.59	78.30
6	GEMI	–	–	72.13	71.68	77.61	77.36	80.56	80.28	78.19	77.87
7	NDPI	–	–	73.98	73.47	80.78	80.52	82.54	82.33	83.63	83.44
8	WBI	–	–	72.30	71.65	80.80	80.69	82.04	81.85	82.43	82.26
9	EVI	–	–	68.22	67.51	79.65	79.43	79.15	78.88	77.50	77.08
10	MSR	–	–	76.93	76.65	76.81	76.51	81.50	81.35	81.46	81.28
11	SR	–	–	78.54	78.28	79.74	79.54	78.76	78.50	82.06	81.87

Table 3. Experimental results on EuroSAT dataset, %.

Although on Step 3 we achieved F1 score of 84.05% it is useful to analyze metrics in the context of every class in the dataset (Table 4). Despite, on zero step F1 score is 63.89% for River, Highway, PermanentCrop and HerbaceousVegetation classes the metric even low than 50% which means that the neural network couldn't retrieve significant features from input information and correctly classify images belonging to the classes.

	Class	RGB	RGB + NDVI	RGB + NDVI + NDWI	RGB + NDVI + NDWI + GNDVI	Δ^3
1	River	43.46	77.47	85.63	88.78	45.32
2	Highway	43.26	62.99	66.59	73.17	29.91
3	PermanentCrop	37.97	60.67	62.85	67.52	29.55
4	Industrial	64.46	85.74	87.23	88.95	24.49
5	HerbaceousVegetation	49.42	67.91	66.96	71.34	21.92
6	AnnualCrop	66.42	75.93	80.22	84.72	18.30

² Acc – classification accuracy.

³ Δ – Difference between first and last columns.

7	Pasture	64.01	74.87	74.30	77.02	13.01
8	Forest	82.92	89.98	93.11	93.55	10.63
9	Residential	84.06	92.46	93.84	93.46	9.40
10	SeaLake	91.86	94.68	96.07	96.67	4.81

Table 4. F1 score on EuroSAT dataset by classes, %.

Adding indexes to RGB channels allowed to increase the F1 score. Δ shows improvement between baseline experiment and after carrying out a grid search. As we can see from Table 4 F1 score increased for all classes in the EuroSAT dataset. The biggest improvement was for River (45.32%), Highway (29.91%), and PermanentCrop (29.55%) classes. At the same time, SeaLake showed only 4.81% up. For the Residential class adding the GNDVI index slightly decreased the F1 score (0.38%).

In [24] was also found that the use of spectral indexes improved the classification performance applied to the problem of classification tree species. In [26] authors got improvements in classification for agriculture problems. They got an overall accuracy of 93.1% based on the reflectance at 4 bands and 8 spectral indexes. On the other hand, for research were used 5 different classes. We expect increasing the F1 score and classification accuracy after optimizing hyperparameters and the architecture of the convolutional neural network.

6. Conclusions

Analyzing and classifying remote sensing images applied in a wide range of issues such as land use, deforestation, climate, urbanization, and agriculture changes. Many research papers demonstrate the efficiency of using spectral indexes. In particular, deep learning neural networks can extract significant features from input data, provided in the form of spectral images.

EuroSAT dataset provides 27,000 remote sensing images and contains a full range of Sentinel2 spectral bands. Such variety allows calculating spectral indexes.

In this paper, we have addressed the challenge of multiclass classification EuroSAT remote sensing. The experiments based on grid search using a deep learning approach were conducted. It is obtained that adding indexes to an input of the proposed convolutional neural network increase classification accuracy and F1 score in comparison with the baseline experiment. The best combination of indexes is NDVI, NDWI, GNDVI with RGB channels.

Our findings also indicate that spectral indexes showed high performance on River (45.32%), Highway (29.91%) and PermanentCrop (29.55%) classes.

The overall accuracy of classification increased from 64.72% to 84.19%. As a result of the experiments, the indexes combination, with an F1 score of 84.05%, outperformed single RGB images in the baseline experiment.

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A Framework of Social Networks Control in Higher Educational Contexts

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Abstract

Educationists are urged to investigate the effect of social networks control. There is a lack of multidisciplinary studies with a focus on coercive social network control in the higher education sector. This exploratory and descriptive study presents a theoretical contemplation of social network control based on ten key elements that influence teaching and learning in higher educational environments.

The paper provides a critical analysis of the impact of an economic model on social networks control and examines social engineering through the tenets of digital presence, psychological strategies and tactics. Insights into user-generated content and the learning process of manipulative assimilation that influence current ways of thinking in higher educational contexts are offered through the lens of social networks control mechanisms. A framework for social network control was derived, signifying the flow and dynamics between key elements which might impact on various aspects of social network security and its applications in Higher Education.

Keywords: social networks, security, cyber control mechanisms, social engineering, Higher Education, UGC, digital inclusion

1. Introduction

According to research findings, there is not an appropriate foundation for social networks security in general [3, 54, 85] owing to the absence of a suitable awareness and appropriate defence infrastructure [53]. Social networks are teams of people informally bound together by shared expertise and passion for a joint enterprise [9, 32]. They are platforms for solving problems in that they share knowledge and collaborate [7, 23].

There is an insufficient application of cyber control mechanisms [40, 68] and a lack of cognisance of methods, techniques and tools for social networks control. This may be attributed to powerless educational policies and authorities [38, 43, 69] an inadequacy of training in higher education [61]; and a misunderstanding of the

underlying basic economics principles and their application in education [17]. Moreover, this may be ascribed to a lack of understanding economy and digital economy [71, 83] as a basis for any human endeavour in society. A model of economics with its three levels of economy and its impact on education has not been taught explicitly. Digital economy is the tendency of most organisations to exclusively use digital information in globally connected systems [71, 83].

There is a lack of studies that present an insight into the underlying issues of social networks control. The researchers Gronke and Cook [41] examined trust in online news, Turcotte, York and Irving [84] reviewed information search, while the researchers Ciochină, et al. [23] investigated students' opinions on trust that depends on the recommendations of friends [33, 95]. Furthermore, researchers [28, 95] highlighted the exploitation of user-generated content (UGC).

Currently there is poor cultivation of awareness of philosophical foundations and knowledge inquiry in higher education [34] that influence critical analysis of social networks control. Students and educationists are not acquainted with the learning process involved during coercive influence and the dynamics of manipulation in formal and informal social networks [7, 9, 19, 32].

Researchers Glezou [38, 39, 43] argue that security in online social environments require urgent attention from educational, government and business organisations. Numerous obstacles undermine safe and productive social network activities [29, 79]. Consequently, educational institutions, in collaboration with other social and economy sectors can authorise different solutions for coercive attacks [39].

Based on discussion above, the main purpose of this study was to create a framework for social networks control (SNCF) that would motivate educational, government and business institutions to act proactively towards minimising endangering the security of social networks. This highlights the specific objectives for this study, namely, to derive a theoretical and conceptual background as a basis for the framework; propose a SNCF framework with its major mechanisms; critically analyse the essential components of the framework; and discuss the learning process, dynamics and the flow within the framework.

Based on the discussions above and the purpose and objectives of the study research, the following questions were set for this study:

- RQ1. *What are major mechanisms of the SNCF applicable to educational environments?*
- RQ2. *What kind of dynamics and the flow exists within the framework?*

The following section presents the research methodology.

2. Research Methodology

This research can be described as exploratory and descriptive with the literature review of major concepts connected to social networks control. This study utilizes scientific method and researchers' reflective practice. Scientific data processing,

logical methods and the scientific method rely on empirical evidence and utilize relevant concepts from the current research [50]. “The scientific method encourages a rigorous, impersonal mode of procedure dictated by the demands of logic and objective procedure” [11, 14, 50]. The researchers of this study delivered an insightful analysis of multidimensional concepts and derived a framework for social networks control in that they analyzed scientific literature and existing practice.

3. Theoretical Foundation for a Framework of Social Networks Control

3.1. An Overview

The focus of this paper was on the elaboration of psychological and social control factors relevant to social networks in higher education contexts. Furthermore, this paper detailed dynamics of social networks control emerged with multiple aspects, technology and underlying economic modelling. Social control is not visible as a conscious rational phenomenon, but rather as a concept for urgent rethinking of its main power through ever-increasing social networks and exploration.

Furthermore, social networks control is a complex topic that requires a multidisciplinary approach and perspectives from a number of disciplines such as economy, psychology, neuropsychology, cyber security and software engineering. Social networks control is applicable to HE environments through digital inclusion, online discourses, user generated content and an augmented vulnerability level of students and academics. Current curriculum lacks an in-depth analysis of social networks treats and the explicit knowledge of psychological and technological means. In the following sections, we describe how social control appears in different modes of being and doing in the interface between the digital and physical.

3.2. A Basis for Social Networks Control in Higher Education Environments

3.3.1. An Economic Model

A basis for social networks control emerges from an elementary economic default model that applies a homological transfer [62] between the science of energy and economics [77, 69, 83] and exemplifies three levels of economy:

1. Economic capacitance – capital (money, stock/inventory, investments in buildings and durables, etc.)
2. Economic conductance – goods (production flow coefficients)
3. Economic inductance – services (the influence of the population of industry on output).

Relations between these three levels are dependent on the economic capacitance that controls economic conductance and inductance through its monopolistic role and decision-making processes without accommodating the possible reactions of others. Economic inductance includes services to people who are vulnerable to social control, despite the poor quality of education and manipulation of production and peoples'

pursuits and political leanings [28, 69, 77, 71, 83]. This economic model has not been taught explicitly at universities and other higher educational contexts.

3.3.2. *The Economic Model in Higher Education*

Contemporary research is silent about the economic model and its influence on higher education, but education and economic engineering work in synergy. Higher education policy is related to economic policy objectives [42, 69, 70]. Consequently, universities contribute to economy as moral symbols, social etalons, education providers and innovation facilitators, promoters of entrepreneurial talent, economic and civic leaders and mostly as knowledge pioneers [72]. Furthermore, universities retain their mission of serving the world's hopes: to solve cross-border challenges; to unlock and harness new knowledge and to build cultural and political cooperation [59, 60, 72, 81].

Nevertheless, university curriculum prevents the understanding of interactions between three crucial factors of the economic model and its impact on social networks control, causing a fruitful environment for youths to become an easy prey of destructive collective conscience [15, 55]. It is necessary to embrace education in the existing economic model, specifically the university and its influence across history. Since economy expand to digital inclusion and user generated content (UGC), the economic model underpins these elements.

3.3.3. *User-generated Content (UGC) relevant to Higher Education*

Ekbja [8] investigated user-generated content (UGC); its role in wealth generation and highlighting the network asymmetry, that does not erase class boundaries through "digital inclusion". Arvidsson and Colleoni, 2012 agree that digital inclusion is exploitation based on the extensive labour time, skills, relationships and commitments.

Ekbja [28, p. 166] states that "the army of digital networkers, gamers, and users keep the powerful computer engines of technology e.g. Google, Facebook companies running the processes of production, distribution, and exploitation that provide for the incessant flow of capital by pervasive computerized information and communication technologies". Sennett [8, p 170, 75] argues that "the archetype of the ideal subject now is the teenage gamer, the obsessed social media member and the permanently reskilled, re-educated, and mobile professional". Although there is a return on investments of in terms of connections, creativity and participation [28], the social crowd lacks control over common pool knowledge, infrastructure and natural resources that contribute to overexploitations, because the creation of value has shifted from paid to unpaid labour [28, 35, 92].

Fuchs [35, 36] in his theory of user exploitation on social media ascertains that the users spend labour time on commercial social media platforms to generate social capital (the accumulation of social relations); create cultural capital (the accumulation of qualification, education, knowledge) and form symbolic capital (the accumulation of reputation). These capitals are in the process of being transformed into economic

capital. This applies to HE contexts through the use of social networking technologies for educational purposes [44, 52, 95, 47, 21]. Educational networking can assist learners in communication and social interactions to perform educational tasks, to publish or share text, photos, videos and music online; be engaged in shopping and studying; and create personal, professional and informal social network contacts.

Based on the economic model and perspectives on the role of universities seven crucial issues of social networks control have been derived, that are applicable to HE environments.

3.4. Critical Aspects of Social Network Control

3.4.1. Psychological aspects of cyber security in higher education

It seems that educators and students have no basic knowledge of psychological aspects that underpin cyber security within social networks [51, 20]. This may be contributed to the stealing of students' private information that happens very often due to their good credit accounts [66]. Attacks are launched by impersonating a scholastic, posing as a known academic figure or a representative of a sponsorship organisation, promising college scholarships and gaining access to campuses without interference [56].

Through immersion and illusion, an intruder becomes an impersonated person, the new personality. It is necessary to create a pretext, the creation of a believable scenario and to build a believable disguise. Additionally, it is important to build a depth of useful expertise, a routine of a suitable language, understanding of the natural features of the victim's facility, knowing psychology how to manipulate targets [90].

The aim of a strategic social network attack is to develop vulnerabilities: create low-quality programmes of education, particularly in mathematics, logic, systems design, technical creativity and economics; and to impose distractions with matters of no real importance and disengagement from matters of real significance [31, 90]. From a strategic point of view, procedural steps are necessary for social network control namely, exploration of current events; disguise, impersonation; infiltration; use of timing; discovering weak points in an area of defences; examination of psychological weaknesses; distraction; the use of concealment devices and covert listening devices; the use of intelligence; surveillance; sabotage; hiding and silent movements [90].

The tactical network attacks rely on existing social network members' vulnerabilities [31, 51, 89, 90]. By homological transfer, in these circumstances, students will be more prone to engage their emotions and increase their self-indulgence in activities of no tangible value to influence the shifting of students' thinking from personal needs to highly fabricate outside priorities [31, 62, 65].

Most studies propose educational, behavioural and structural intervention methods through prevention, education, identification and enforcement [20, 74, 87] and the incorporation of curriculum change in HEIs. Concurrently, education authorities should guard against cyber invasion by passing cyber laws with strong penalties, as done by Germany with its ground-breaking Network Enforcement Act

[68] and software that is able to search, monitor, analyse and manage the content of social media. In order to understand psychological attacks within social networks, it is necessary to elaborate on online language discourse techniques.

3.4.2. *Online language discourse and social networks control*

Learners communicate through a variety of language discourse techniques in online contexts. The mind, language and creativity are primary tools for producing value [12]. These are particularly relevant to youths who are in a disadvantaged position in that they acquire critical thinking necessary for filtering online information and detecting social coercive attacks to the determinant of their own advancements. Students and youths are exposed to manipulative discourse through the use of abusive symbolic written communication, verbal or textual utterances and non-verbal signals, specific visual features of text and talk [22, 49, 86, 93]. Online auditory discourse interactions include specific features of talk in vocal communications that can be modified such as faster pronunciation, unclear expressions, short messages and repetition of blurred communications to hamper understanding and recall [67].

Partial or incomplete illegitimate presenting of text and understanding to targeted individuals and groups in educational settings is in the best interests of a powerful group [86]. Textual language involves general layout, use of colour, photos, drawings and different forms of phonetic, phonological, morphological, syntactic and lexical operations that can be manipulated in a silent manner [86, p. 366, 94]. Social engineering is a major threat in online social media services, as it uses many forms of coercive discourses [31, 94].

3.4.3. *Social Engineering Intrusions*

Social engineering is a major threat in online social media services, as it uses many forms of coercive discourses [31, 94]. Social engineering is the art of manipulating people through the use of psychological tricks, baiting, website spoofing, deception, pretexting and phishing, bribes, blackmail and threats [D. Airehrour, D., N.V. Nair, and S. Madanian, 1998].

Social engineering attackers avoid direct contact with their targets. They favour to exploit emails, the internet, and digital media in order to steal information using a variety of deceptive techniques such as kindness, orthodoxy and empathy. The main causative factors for social engineering attacks [80] are organisational (e.g. insufficient management and security policies), demographic (e.g. gender, age, personality characters and cultural) and human (e.g. uncontrolled emotions, surroundings, habits or physical impairments).

Researchers report that an unspeakable number of social engineering attacks occurs on social media on a weekly basis that can be attributed to human vulnerabilities [3, 6, 31, 51, 94]. Students and academics are vulnerable to losing valuable innovative ideas and patents [10, 58]. Fan, et al. [31, p. 1] proposed a defence model to encounter the process of converting human nature into weaknesses by

external influences. Social engineers need to understand some crucial human flaws that endure social network control.

3.4.4. *Human flaws in Social Engineering*

Researchers Wilhelm and Andress [90] state that social engineers implement deceptive methods to betray victims to gather information and that is easier than to try to compromise a computer network. It is necessary to have a leader who provides financial, resource, or training support for the malicious endeavour [45, 90]. Four crucial human flaws that social engineers need to be aware of during social networks attacks are:

- *Motivation* – develop skills and knowledge; create efficient operating systems; assure workable solutions; have an internal strive to help others, create income.
- *Weaknesses* – laziness, anger, fear, sympathy and vanity.
- *Desires* – to be helpful, greedy, and afraid, avoid confrontation and avoid embarrassment.
- *Needs* – security, sex, wealth, pride, and pleasure.

System administrators and network security engineers should apply subtle mechanisms such as looking unable, inactive; producing geography distortion, hiding own capabilities, including exercising unawareness of slowing down network security devices [45, 90]. Fan, et al. [31] suggest several defence approaches to be employed to fix human weaknesses. Students and academics should be aware of the fact that most strategies and tactics regarding social engineering appear on sub-conscious level.

3.4.5. *Some Subconscious Strategies and Tactics in Social Engineering*

There are multiple sub-conscious strategies and tactics in social engineering, such as applying proper timing in terms of attacks; keeping members of social networks ignorant; lowering their defences; controlling their education; preventing their organisation; infusing more self-indulgence; and assuring minimum resistance to control [8, 31, 84, 90].

Knowing the emotional states of target network members allows intruders to classify the target by emotional type or emotional state that gives a starting point when planning an attack. In addition, the timing and tenacity; skill of lying; making sure that the network security engineers are confused, distracted and under stressful emotional conditions are critical components in social engineering attacks [30, 45].

Whether it because of malformed packets; the use of false identity, or mislabelling malicious data to appear legitimate, it is necessary to use subconscious tactics so that the security personnel would focus more on the facilities in which intruders are not interested [31, 63, 84]. Furthermore, by asking numerous questions about firewalls and internet-facing systems, it is possible to subconsciously influence security engineers to focus on the disruption of a person's daily routines that adds additional stress [25, 54, 90].

Research findings in neuropsychology, such as masking phenomena, can serve for human sub-conscious control within social networks. Fahrenfort [30] introduced the model by Di Lollo, Enns, and Rensink [25] to explain the masking phenomenon. In masking, a stimulus is shortly followed by a second stimulus (the mask), rendering the first stimulus invisible.

This happens in their model because the mask replaces the stimulus representation at input level even before a match can be made between the working space and the input; thus, preventing the stimulus from ever reaching consciousness [30]. This happens when subtle methods are applied to members of a social network, causing a loss of memory since the control of stimulus is prevented and therefore only resides in the sub-conscious mind that can influence memory functioning. Social network control is a learning process of a manipulative assimilation.

3.4.6. The Learning Process of Manipulative Assimilation within Social Networks

For any coercive social network control, manipulation processes play the major role. Manipulation can serve political purposes, ideological purposes, and social engineering purposes [20, 24, 78]. Whatever purpose it serves, there is a final assimilation process [65, 88].

The members of a social network ignore the disturbance of manipulative intrusion, gradually developing full trust in an external control; or they are forced to follow the control mechanism to live together with the manipulating system. When progressing to a level of full trust, the members follow every instruction through a sub-conscious process of extrasensory perception and communication and they reach the “mature” level of assimilation with the imposed control mechanism [24, 63, 76].

Thus, there is a learning process that includes submission, ignoring, trusting, interacting, assimilating and synchronisation with silent forces of manipulation [65, 63]. The victims of a social network learn to keep it secret to ignore chaotic events and are forced to accept involuntary events.

The learning process induced through manipulation contains the voiceless stage, ignoring stage and observant stage, reflecting three major learning phases: submission, defensive/reasoning phase and accepting/surviving phase [24, 76]. They emotionlessly learn how to respect, cope and co-exist with the manipulation system that drive sub-conscious progression towards synchronisation between an external control and internal complete submissive state of mind [19, 20, 46]. There are multiple technological means that can be deployed to aid social networks control.

3.4.7. Surveillance and Electromagnetic Frequency (EMF) in Social Networks Control

Social surveillance through the use of technology has caused resistance [3; 7] because of its covert intention to detect or prevent behaviour that is prohibited. Furthermore, technological means include a combination of offline and online monitoring, real-time surveillance, penetration into personal data; utilising voice acquisition; and applying remote technological means.

Surveillance and manipulation systems were devised, exploiting emotions and using contagious methods within social networks aimed at social movement mobilisation to determine the “critical mass” by studying “digital traces” of members [19, 20, 78]. In online environments these could be bots and applications running to provide us with a comprehensive understanding of the target social network [45].

A little research exists on electromagnetic frequencies and their applications in social engineering and social networks control. Technology has double utility, as it can be used as a surveillance online tool but also serves as a means to exert social control, for example, by transferring discourse communications utilising low electromagnetic frequencies. It is not clear how surveillance and EMF influence social network control if learners and academics don’t understand the learning process of manipulative assimilation.

In summary, research indicate that the foundation for social network control is not explicitly taught in HE contexts, and academics and students have a fragmented picture and no clear understanding of the whole process. Therefore, they cannot successfully detect and avoid this permanent threat to their individual personalities and their networks.

The role of economics thinking and the model influence seven major factors of social network control that work in a synergy within HEIs as a multidisciplinary context. Based on the theoretical framework and critical reflections originated in literature, ten factors were integrated to elaborate the framework for social networks control (SNCF) as follows.

4. The Framework of Social Networks Control (SNCF) in Higher Education

Because social network control is organised by different entities in order to fulfil a variety of aims, for instance, political, religious, scientific and economic motivations, their interest is to expand influence to educational institutions. A lack of awareness related to social control techniques have profoundly influenced students’ and academics incorrect perception of social networks subtle attacks.

4.1. Background and the Rationale of Social Networks Framework

The framework shapes its structure and flow from perspectives on the basic economics model [79, 83] the relationship between the model, economic features and the role of universities [42, 69, 64]; the impact of user-generated content and exploitations [28’ 8, 35]; the role of online language discourse [12, 22, 84]; the knowledge of psychological aspects [31,62]; understanding of social engineering intrusions and human flaw [2, 31]; awareness of sub-conscious strategies and tactics in social engineering [25; 13, 26, 27, 28]; characteristics of the learning process and manipulative assimilation [24, 63, 76, 88]; the use of technological means in social networks control [25].

Owing to the presence of multiple aspects of social networks control, it was necessary to elaborate the framework, highlighting the interplay between economic,

psychological, technological and human aspects. This resulted in the identifying crucial mechanisms/elements and structuring the framework for social network control.

4.2. The Structure and the Mechanisms/Elements of the Framework

This section presents the structure and the mechanisms/elements of the framework of social networks control (SNCF) based on the literature analysis. See figure 1.

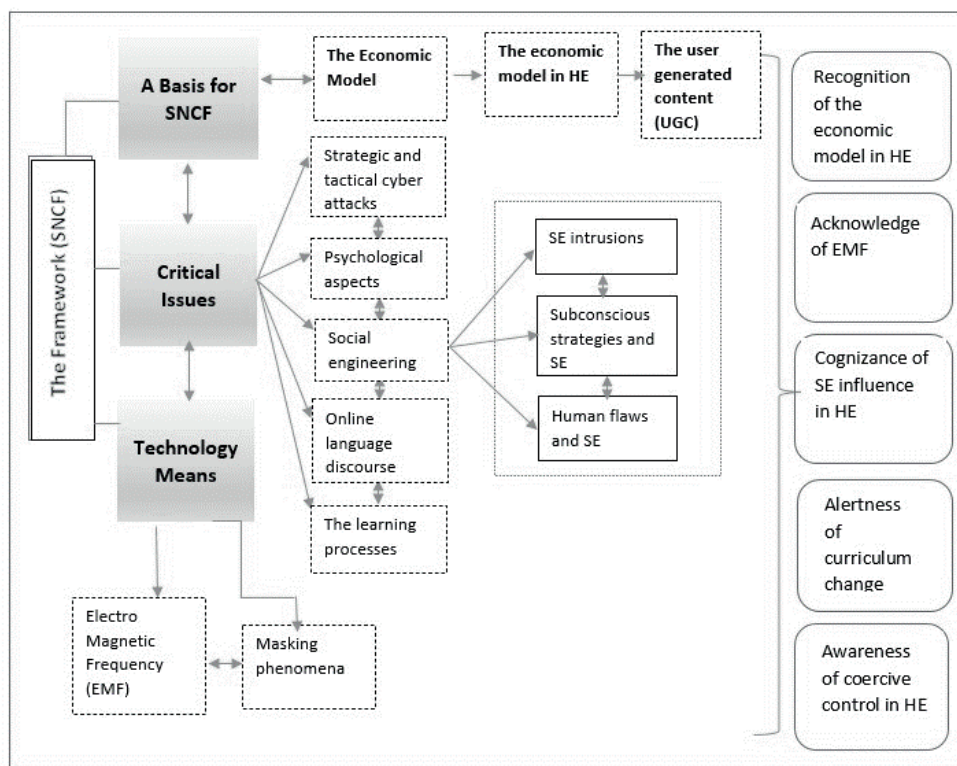


Figure 1. The framework of social networks control (SNCF)

The subsequent mechanisms/elements of the framework were elaborated (see figure 1):

1. A basis for social networks control
 - a) *An economic model*
 - b) *The economic model in higher education*
2. Critical aspects of social network control
 - i. *Psychological aspects of cyber security in higher education*
 - ii. *User-generated content (UGC)*
 - iii. *Online language discourse*
 - iv. *Social engineering as the art of social network control*

- v. *Human flaws in social engineering*
- vi. *Some subconscious strategies and tactics in social engineering*
- vii. *The learning process of manipulative assimilation within social networks*
- viii. *Surveillance and electromagnetic frequency (EMF)*

The conceptual framework identified multidisciplinary features of social network manipulation, underpinning the choice of the framework key elements. The 10 key mechanisms/elements of the framework emerged from the voluntary, informal and multidisciplinary nature of social networks control (see figure 1). A synergy between elements is necessary, since they are interrelated and form a complex array of human, technological and organisational issues.

The framework with its mechanisms discloses the covert learning process that is not explicitly noticed by members of a social network including educational networks. Vital psychological features [31, 90] and procedural steps [45] were incorporated in the framework (see figure 1). The framework was created with the aim to deeply engage educationalists, students and stakeholders in conquering the vulnerabilities of social networks [31, 51, 89].

A deeper insight into social networks through the prism of digital economy [13, 83, 71] with their role as “knowledge intermediaries” predisposed the formation of the framework. The framework provides a building block for further examining of social network control elements that could influence HE policy and practice. The framework may promote awareness among educationists to take proactive steps and further interest in social network security features. In the next sections the flow, the dynamics and the process of social network control within the framework will be debated.

4.3. The flow and dynamics within the Framework

The flow of social network control starts from the basis namely the economic model, the role of university and UGC. These three fundamental elements are interconnected and have a profound influence on HE environments. The essential key elements further influence the flow between seven critical factors (*Psychological aspects, online language discourse, social engineering, human flaws, subconscious strategies and tactics, the learning process of manipulative assimilation, surveillance and electromagnetic frequency*). These elements work in a synergy within HE as a multidisciplinary and interdisciplinary environment. The flow designates a logical connection between key elements as motivated previously.

The dynamics of the framework elements are invisible to an untrained observer, because of its sub-conscious features [25, 30]. The aim of covert influence is to induce negative changes, through continuous distractions and clashes, downgrading members’ communication skills [73, 86]. The aim is to weaken the network and its members through constant conflicts, blaming, and other intimidating behaviour patterns. This cause the members of a social networks to feel helpless, surrounded and speechless [70].

Social network covert control also include offline attacks and a terrain environmental circumstances must be arranged, in this instance; and the controllers/monitors must be repeatedly present at the same pre-planned places to monitor the movements of member(s) of the network and alternate their actions [76]. The social networks are programmed as any establishment unit.

Social network intrusions make no noticeable fiery sounds; cause no apparent physical or mental harms and do not evidently affect daily collective activities [63]. Hitherto, the intrusion creates a distinctive blast, which causes unambiguous physical and mental devastation and undoubtedly affects the daily social routine to a trained observer [71; 25; 65]. The social network intrusion has everlasting consequences, but on completion of the planned intrusion, a memory decay wipes out all traces of evidence. This is achieved through covert actions and the default power of the invisible economic model.

During the learning process, students and educators believe or realise that there is an external human power able to control their behaviour or thoughts. They might instinctively feel that something is wrong, but they cannot express their feeling in a intelligible way with their colleagues as they are not thought to identify sub-conscious manipulative intrusions; and they are not trained how to associate and, how to ask for an assistance [57, 93].

When coercive control is applied gradually, the educators and students adapt to its existence and slowly endure its violation until the psychological pressure via invisible economic means becomes too great to tolerate. The process of social networks control will largely depend on how effective the powerful economic elements have been in controlling the social media; subverting education and keeping the public distracted with matters of no real importance.

Although there are negative consequences of social networks control, the users including learners and educators generate social capital, create cultural capital and form symbolic capital [35, 36]. Also, there is a return on investments in terms of connections, creativity and participation [28].

5. Discussion

The theoretical and conceptual backgrounds provided a basis for forming the social network control (SNCF) that can promote an awareness in terms of solving social network security problems. Through the framework, students and educators are empowered to collaborate on the issue of social networks control, including curriculum and policy changes.

In response to the first research question (RQ1), “*what are major mechanisms/elements of the SNCF framework applicable to higher educational environments?*”, it was ascertained that the following crucial mechanisms/elements emerged from the basic economics model, UGC and the role in higher education: psychological features, online language discourse; social engineering intrusions; human flaws; the learning process of manipulative assimilation; subconscious strategies and tactics; technological means for surveillance and electromagnetic frequency (as the answer to research question one).

In response to the second research question (RQ2) “*what kind of dynamics and the flow exist within the framework*”, it can be said that the flow is determined by interactions between key mechanisms/elements that are logically interconnected within multidisciplinary and interdisciplinary HE contexts. The dynamics is reflected through constant conflicts, blaming, distractions, and other intimidating behaviour patterns; downgrading members’ communication skills; planned activities, roles, communication modes, outputs and gradual application of covert methods (as the answer to research questions two).

HEIs require a modification of their policies, curriculum in terms of economic tenets and digital economy features to enable students and academics to prevent social network attacks [37, 77, 83, 71]. Decision-makers can be motivated to create secure online environments in collaboration with government, businesses and the community. Understanding the dynamics within social networks and underlying programming features serve as motivation.

6. Conclusions, Limitations and Further Research

This study presented an innovative vision into social networks control and elaboration of the framework and its underlying mechanisms of covert control. The economic model presents a basis for any social network control due to its default features and influence on education and general society. Understanding of connection between educational policies, curriculum and security issues in terms of economic factors is essential to proactively counteract online and offline social intrusions.

The discussion above intensely supports the succeeding general conclusions:

- It is critical to understand the economic model and its influence at universities and other HE contexts
- It is necessary to re-examine philosophical foundations and knowledge inquiry in higher education.
- The nature of educational social networking and coercive intrusions lacks its critical discussions as well as a deeper understanding of ideologies and their doctrines in educational settings.
- Educators and students lack a thoughtful awareness of crucial dynamic, flow and psychological factors that present an entrance to any social invasion particularly in social engineering.
- It is necessary to re-examine procedural steps, strategies and tactics for network control in social engineering.
- Educators and students need an understanding of user-generated content (UGC) and its exploitation features.
- There are many technological means for social network control such as electromagnetic frequencies (EMF), masking phenomena that aid social network intrusion, but its nature is unclear in higher education context.
- Educators and students must recognise their own vulnerabilities and an external attempt to develop further vulnerabilities in order to weaken their social network.

- The learning process of manipulative assimilation have been unknown within HE contexts.
- Curriculum change can fortify students and academics defence against social network control.

Educators and students should have the knowledge of the science of control; they should be aware of the basic economic model and its default influence and know how to apply such knowledge to protect their vulnerable online and offline social networks, due to the lack of economic capacitance and economic conductance and misunderstanding of the role of economic inductance. Social networks control will largely depend on how effective the economic model has been in controlling the social networks and media; subverting education and keeping the public distracted with matters of no real importance.

6.1. Contributions/originality and value added

The conceptual outline provides a solid basis for social networks control framework. Twelve critical key elements of social networks control were derived to form SNCF that could provide a deeper insight into security features of social networking in HEIs.

6.2. Limitations and Recommendations for Further Research

The conclusions of this study should be tentatively applied in educational institutions on a wide scale and the results are rather limited in generalisability due to the requirement for empirical examinations and testing of the framework in real environments. This study doesn't cover semantic aspects and access control features, automation and other hardware and software aspects which present the research limitations.

The framework could be further examined in terms of its strategy, structure, flow and functionalities. Further testing of the framework in the practice is necessary for strengthening the claims for the relevance to HEIs. This conceptual paper and the framework drawn would benefit from its empirical validation.

With our paper we want to highlight the role of social network control features that influence contemporary higher education environments. There is a real treat that this contagious manipulation process can spread within many formal and informal social networks due to its silent spontaneous and gradual intrusion.

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Use of Augmented Reality with Game Elements in Education – Literature Review

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Abstract

This paper reviews the literature and analyzes the research topics on the use of augmented reality technology in education with possible integration of game elements, in order to obtain a synthesis of previous knowledge related to the topic in the period from 2010 to 2020. Fifty-two papers describing different aspects of augmented reality used in the field of education were selected for the analysis. The main conclusions of the systematization and synthesis were: a) five basic thematic categories were identified; b) 2019 was recognized as the year with the largest publication of papers; c) the use of augmented reality in teaching activities, and especially with game elements, improves student efficiency, stimulates attention and interest, brings improvements in collaboration and perception of fun, improves teaching and learning processes and in general encourages innovation and improvement through educational technology.

Keywords: augmented reality, education, learning, game, school, formative assessment

1. Introduction

In order to modernize the teaching process, teachers apply the educational trends that put students in an active relationship with the content of learning and encourage independence and responsibility for learning. Information and communications technology (ICT) provides many opportunities that can be used in the process of teaching and learning [1], so today it is almost impossible to imagine formal and non-formal education without the use of computers and new technologies that bring teachers a range of new tools, and provide a new and innovative approaches to teaching [2]. Therefore, new technologies such as augmented reality (AR) and Digital game technology (DGT) are considered to have great potential for education [3].

AR is combining the physical and virtual worlds, offering unique display capabilities for the user with a combination of the actual scene the user is watching and computer-generated virtual scenes. It is an interactive environment in which

reality is enhanced by real-time virtual objects [4]. According to [5] AR must have three characteristics and properties: 1) Combines real and virtual objects in a real environment, 2) Runs interactively, and in real time, and 3) Registers and aligns real and virtual objects with each other.

When DGT is mentioned, two concepts are meant: Game-based learning (GBL) and gamification. Gamification is defined as the application of digital game mechanics in a non-gaming context for the purpose of engaging students, motivating activities, improving learning, and problem solving [3]. The concept of gamification is sometimes mistakenly equated with the concept of GBL, which is actually a supplement to classical teaching through the application of technology and games for the purpose of acquiring knowledge and skills, and in this case it is most often educational video games [6]. Thus gamification tries to make a game out of the learning process, while GBL includes the game as part of the learning process [3].

Although this new approach involving the use of AR with digital game technology certainly increases the efficiency and attractiveness of teaching and learning, in order to gain a detailed insight into their application in education, a literature review was conducted. We analyzed which areas are using AR technology with game elements and what are the results of its usage, but also which year, in the period from 2010 to 2020, is the greatest interest in this topic given the number of papers. The analysis of previously researched topics will result in a synthesis of previous knowledge on the use of AR with game elements in education.

This is also the primary goal of the research, and based on it, we defined three research questions:

Q1: What thematic categories can be identified in the analyzed papers?

Q2: What is the representation of the papers in a certain thematic category considering the year of publication?

Q3: What common conclusions can be drawn from the synthesis of papers obtained by analysis in each thematic category?

2. Methodology

The research methodology was conducted following the steps proposed by J. W. Creswell [7].

1. Identifying keywords. In the first step we defined the basic keyword phrase "augmented reality", which was searched in combination with the keywords: education, mobile, game, learning and school. Since Creswell [7] proposes to select about 50 papers, the combination of keywords depended on the search result, and the number of papers obtained. If the number of papers as a result of the search have been too large, additional keyword phrase "formative assessment" has been included in the search.

2. Search the scientific databases. The search was performed in the Web of Science Core Collection (WoSCC) and Scopus databases, as they contain the scientific papers of the first group (a1)¹ in the field of social sciences according to

¹ Regulation book on the conditions for election to scientific titles

the Croatian legislation that is relevant to the field of research. WoSCC is a multidisciplinary bibliographic and citation database available through the Web of Science (WoS) research platform, and Scopus is the world's largest bibliographic and citation database that includes European journalism, especially in the social sciences and humanities [8]. The search also included a free scientific literature search engine Google Scholar, and Hrčak - Portal of scientific journals of the Republic of Croatia in order to search the literature in the Croatian language [9].

3. Defining papers related to the research topic. As the field of using AR in education is changing very quickly, an additional criterion for searching databases within a time period in the last 10 years has been included in the search. The search began by entering the basic keyword phrase "augmented reality", and adding keywords education, mobile, game, learning and school in the exact order as stated. The initial search according to the previously mentioned keywords and time criteria resulted in an excessive number of papers in the Scopus database (964 papers) and the Google Scholar search engine (18,000 papers) in relation to the set goal of about 50 papers. Therefore, the additional search criteria was included in the Scopus database: Computer Science and Social Science were singled out as the areas of research, as a type of document an Article and a Conference Paper were selected, English was chosen as a language, and also an additional keyword phrase "formative assessment" was included. Although all the keywords were entered in the Google Scholar search engine as in the Scopus database, the result was still too large for analysis (3,380 papers), so the search was narrowed down to the term augmented reality in a different combination with keywords, but in the titles of the papers. First, the keywords education and game were added to the keyword phrase "augmented reality". Then a new search was performed, in which the keywords game and learning were added again to the keyword phrase "augmented reality". And in the last search, the keywords phrase "formative assessment" also was added to the keyword phrase "augmented reality". The obtained results in all three previously mentioned research steps were taken into the analysis. Since the initial search of the Hrčak database just with the keyword phrase "augmented reality" and keyword education resulted in 4 papers, no additional keywords were introduced into the search.

4. Selection of papers relevant to the research topic. In order to select papers relevant to the research topic, some papers have been eliminated. Those are papers dealing with the technical aspects of AR, those related to the use of AR in some activities, e.g. in tourism and health, those that consider the impact of AR on only a certain group of users, most often with some developmental difficulties, those that do not have concrete research results and those papers that appear in several databases.

5. Creating a literature map - a visual image of grouping literature. The papers selected for analysis are presented in a table instead of a literature map for clarity and are grouped according to the established thematic structure. The categorization of the use of AR in the field of education depending on the level of education was also included in the review, in order to investigate the possible difference depending on whether it is primary, secondary or tertiary educational level.

6. Analysis of selected papers. Based on the thematic grouping, an analysis of the selected papers was performed to determine their common conclusions.

7. Summary creation and final literature review. The last step of the research is the final review of the literature, which is organized according to the identified important concepts, and is obtained by synthesizing all the relevant conclusions of the selected papers.

3. Research results

Considering the previously defined keywords and search criteria for individual databases described in the previous chapter in the part “Defining papers related to the research topic”, the results are 39 papers from the WoSCC database, 29 papers from the Scopus database, 103 papers from the Google Scholar search engine, and 4 papers from the Hrcak database. These results are shown in Table 1.

Search criteria - keyword phrase AR + keywords:	WoSCC	Scopus	Google Scholar	Hrčak
+education	1,883	6,753	119,000	4
+mobile	553	3,977	54,100	
+game	113	1,933	21,300	
+learning	85	1,677	18,300	
+school	39	964	18,000	
+formative assessment		29	3,380	
In the titles of the papers:			25 +	
a) AR + education + game			76+	
b) AR + game + learning			2	
c) AR + formative assessment			= 103	

Table 1. Database search flow and obtained results

Having selected out the papers relevant to the research topic, the final results are 52 papers describing different aspects of the AR usage in the field of education, the initial analysis of which identified five basic thematic categories. Thus we distinguish I) papers that provide an overview of the literature related to the use of AR in education, II) those that deal with its impact on the effectiveness, motivation and achievement of students with or without game elements, III) those that focus on designing and testing learning application based on AR and games elements, IV) those that examined the impact of applications based on AR on formative assessment, and V) those that consider the interests and attitudes of professors, students and faculty on the use of AR in education. This division is also the answer to the first research question.

Their mutual relationship with regard to such an established thematic structure is shown in Table 2. In the category describing the impact of AR on the effectiveness, motivation and achievement of students with or without the use of game elements, a division was made according to the level of education, where 1 is primary, 2 is secondary, and 3 is tertiary educational level. Along with each thematic division, the

authors dealing with that topic are listed in a separate column under the reference number.

Thematic category		Year [Reference]
The review of the literature on the use of AR in education		2016 [10], 2016 [11], 2017 [13], 2018 [12], 2019 [14]
The impact of AR on the effectiveness, motivation and students achievements with or without game elements	Educational level 1	2014 [18], 2016 [16], 2016 [19], 2017 [15], 2018 [20], 2018 [21], 2018 [23], 2019 [22], 2019 [24], 2020 [17]
	Educational level 2	2010 [25], 2013 [32], 2014 [26], 2015 [27], 2015 [28], 2015 [29], 2017 [30], 2018 [31]
	Educational level 3	2016 [35], 2018 [37], 2019 [33], 2019 [34], 2020 [36]
Designing and testing learning applications based on AR and games elements		2013 [38], 2013 [41], 2016 [42], 2016 [51], 2017 [39], 2017 [40], 2017 [43], 2017 [46], 2017 [47], 2018 [50], 2019 [44], 2019 [48], 2019 [49], 2019 [53], 2020 [45], 2020 [52]
Formative assessment using an application based on AR		2014 [56], 2018 [54], 2019 [57], 2020 [55]
Interests and attitudes of professors, students and faculty on the use of AR in education		2017 [58], 2019 [59], 2019 [61], 2020 [60]

Table 2. Thematic structure and division of selected papers

Table 2 shows that the largest number of papers is classified in the category that deals with the designing and testing learning applications based on the elements of AR and games. This is followed by a category in which the impact of AR on the effectiveness, motivation and achievement of students with or without game elements is examined, mostly in the first level of education, while a smaller number of papers are distributed in the other categories.

Observing Figure 1 and the distribution of selected papers in each thematic category according to the year of publication in the paper reference, we can conclude that the number of papers dealing with AR and game elements in education has increased in the last 5 years. From 2010 to 2015, only 10 papers were published, while from 2016 to 2020, the number of published papers was 42. The largest number of analyzed papers was published in 2019, which means that the publication of papers has decreased in the last year. At the same time, we can see that in all categories there is a tendency to increase the publication of papers after 2015, except in the category of examining the impact of AR on the effectiveness, motivation and achievement of

students with or without game elements at the Educational level 2. The results of this analysis are the answer to the second research question.

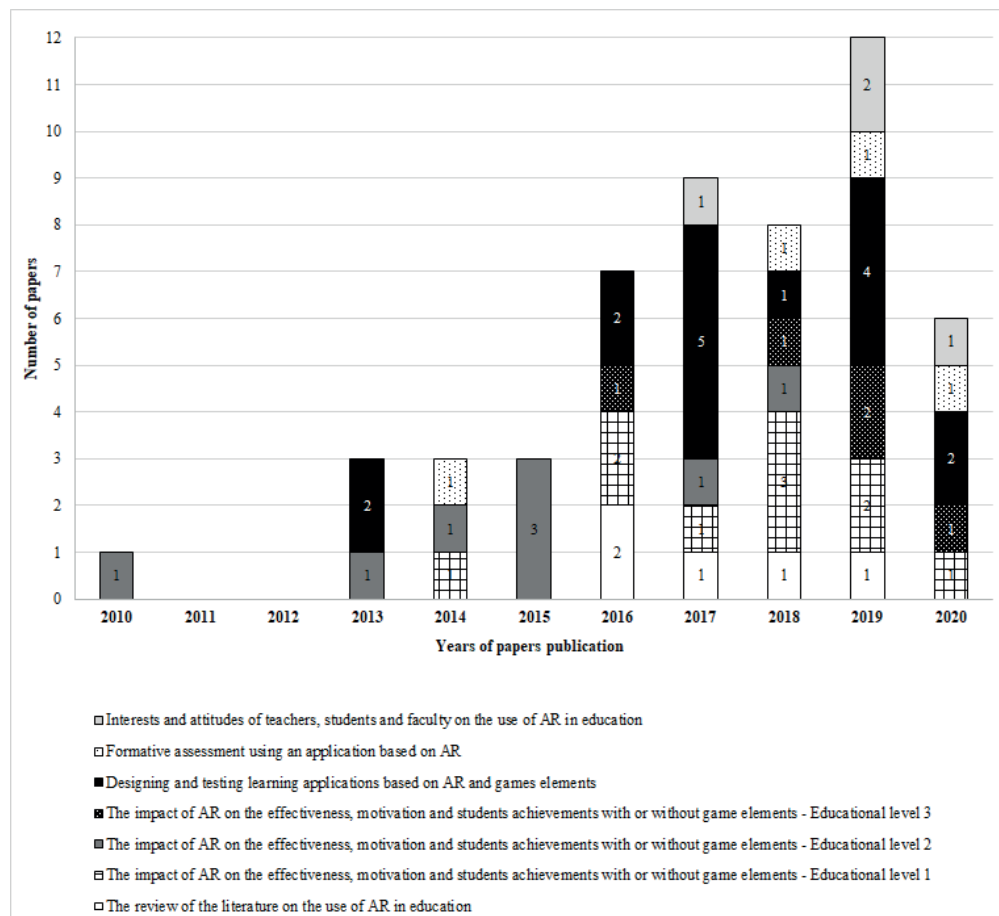


Figure 1. Graphic presentation of the papers distribution from thematic categories by years

3.1. Analysis, review and synthesis of papers according to the established thematic classification

Based on the presented thematic grouping of selected papers, the following is their analysis, review and synthesis in order to identify and single out commonly important conclusions. In each thematic group, the papers are grouped according to whether they apply only AR or use some game elements in addition to AR, but also according to similar concepts of research.

3.1.1. The review of the literature on the use of AR in education

Analyzing the use of AR in science education in papers published between 2006 and 2016, Swensen [10] identified four key factors that may directly or indirectly have a

positive effect on learning outcomes in science: cognitive effort, motivation, situated learning and inquiry based learning.

Lin i Tsai [11] in the analysis of papers conducted in Taiwan during the period 2003 - 2012 related not only to the use of AR technology, but also to the use of other innovative technologies such as mobile and game-based learning. The paper shows trends and successful experiences of Taiwanese teachers in the field of technological learning in science education. In the papers published in the period from 2012 to 2017, in addition to AR, we also find the use of game elements. Thus, Laine [12] in the results of his systematic literature review indicates that EMARGs have been used around the world for various pedagogical purposes in a variety of ways. The paper results by Fotaris, Pellas, Kazanidis and Smith [13] indicated that AR with Game-Based Learning (ARGBL) applications are mainly used to document the design and development process, as well as to share preliminary findings and student feedback. The findings of this paper are also that ARGBL can positively affect students' attendance, knowledge transfer, skill acquisition, hands-on digital experience, and positive attitudes in laboratory experimental exercises for different courses. This group of authors was joined by Wells [14] in the analysis of ARGBL, related to the review of new trends and experiences. These researchers have taken notice that the published papers about ARGBL, particularly in primary education, have significantly increased in the last couple of years. They also find that ARGBL was mostly applied in STEM subjects, and that motivation and enrichment of the learning experience when using ARGBL, can lead to clear enjoyment, knowledge gain, augmented interaction, increased engagement, and enhanced collaboration.

In this category different authors analyze various aspects of the usage of AR in education. It can be concluded that the number of published papers related to EMARG and ARGBL in primary and secondary education is gradually increasing as well as the number of teachers using them for various pedagogical purposes. Also, AR generally has a positive effect on students' attitudes, motivation and therefore on learning experience.

3.1.2. The impact of AR on the effectiveness, motivation and students achievements with or without game elements

a) Educational level I

The results of an experiment conducted by Chien-Hsu, Chun-Yen i Yin-Yu [15] related to the understanding of growth pattern of the leaves, showed that students enjoyed the learning activities with the AR-based Blended Learning (ARBL) approach and that they were interested in the learning course. Solak and Cakir [16] have investigated the effectiveness of the AR application in a language classroom. They concluded that the AR application increases academic performance of learners and helps store new vocabulary items in memory longer than with the use of traditional methods. Chih-Hung [17] comes to similar results, with the designed AR video-enhanced learning (ARVEL) method to assist students' learning English as a foreign language (EFL). The results show that the ARVEL method significantly

improved students' learning achievements and their intrinsic motivation and satisfaction, compared to the students learning in a conventional video-based way.

In addition to AR technology, the integration of ubiquitous games is common. Leitão, Rodrigues and Marcos [18] in their paper presented the development of a game in a teaching and learning context, aiming to help students acquire knowledge in the field of geometry. The authors showed that by using the game students have improved around 35% the hits of correct responses to the classification and differentiation in 3D solids. Young, Kristanda and Hansun [19] also wanted to create visualization effects with an application which can attract more attention from learners in geometry. The implementation of AR has been shown to improve students' motivation to learn, and students prefer to use AR in this game. To help students learn maths, Pritami and Muhimmah [20] explored the development of a Digital Game Based Learning application using AR for learning mathematics. The purpose of this application is to sharpen counting ability as well as to train children's motor nerves so they can become more active, and the result is that students claimed to be glad and enthusiastic to learn maths using this game. For learning English Chen, Hung, Chang, Lin and Lai [21] in their paper focus on development of a GBL system with the AR technology. Through the interactions of voice, graphics and real-world environments, students can learn the common vocabulary of each English letter. The results showed that this way of learning is significant in improving students' motivation and effectiveness. Also for learning English language, Hao and Lee [22] developed four AR games by integrating theories of digital game-based learning, the attention relevance confidence-satisfaction (ARCS) model, and different types of digital games. The results showed that students who used AR games in learning were significantly higher motivated to learn than students who learned in the traditional way, but no significant differences in their learning effectiveness were observed. The finding of this study is also that 3D graphics is the most important element in the design of AR games, and the most popular type of AR game is role-playing. Herpich, Nunes, De Lima and Tarouco [23] in their paper presented an orientation activity, combined with the use of technological accessories like AR in the teaching-learning process of Geography, that not only contributed to the visualization of the content but also to establishing the relationship between theory and practice. All these previous conclusions are confirmed by the results of research presented by Sáez-López, Sevillano-García and Pascual-Sevillano [24] in Art Education. They showed that the experimental group achieved statistically significant improvements in academic subject performance, motivation, information retrieval and analysis, level of entertainment, and collaboration.

The analysis of published papers shows that the use of AR, and especially with the game elements, has a positive impact on student motivation and satisfaction, improves their efficiency, stimulates attention and interest, brings improvements in collaboration and perception of fun, and often in student achievements in the learning area in which the research was performed.

b) Educational level 2

In their paper Spikol and Eliasson [25] reported on the findings from a mobile geometry project pilot designed together with teachers. The project consisted of outdoors and indoors activities with an aim that combines mobile and 3D technologies that allow students to collaboratively explore and discuss geometrical concepts. The results showed that teachers believed that the learning goals have been met, but all have mentioned the impracticability of this activity in everyday practice, as well as that they have expected greater ease of the technology usage. Students find this aspect of learning a good way to experience maths even with technical problems. Of the analyzed papers, the most research is focused on teaching chemistry. One of them is from the authors Cai, Wang and Chiang [26] in which students were able to use markers to control, combine, and interact with a 3D model of micro-particles and conduct a series of inquiry-based experiments. By analyzing the data, they concluded that AR has a significant effect as a computer-assisted learning tool, that AR tool is more effective for low-achievement students, and that students' attitudes toward learning are positively correlated with their evaluation of software. Boonterng and Srisawasdi [27] also presented a chemistry teaching strategy as learning with AR, where an AR-oriented model-based inquiry learning environment can improve the way students learn chemistry and engage them to criticize and think meaningfully about natural phenomena. They also found that there is no significant difference between genders in fostering their perceptions to learn chemistry with the mobile AR. The attitude towards chemistry with regard to gender is also examined by Kumta and Srisawasdi [28]. Their results showed that there is no significant correlation between attitudes towards chemistry and perception towards the AR. There was also no significant correlation between the genders and their perception toward the AR. The same results were reached by Sakulphon, Srisawasdi and Preeya [29] by examining attitudes toward the mobile AR with respect to gender but in biology. The results of their paper showed that student perception toward AR technology was not defined by their attitudes toward biology, and disparity of gender did not affect their perception toward learning with mobile AR.

If we include the use of educational games in addition to AR technology, then the results of research conducted by Hou and Lin [30] show that students significantly improved their learning after playing an educational game on a mobile device combining AR and a virtual laboratory for chemistry experiment learning. Meekaew and Ketpichainarong [31] compared the results of using mobile game-based learning (MG) and mobile game-based learning integrated with AR (MGAR) on understanding biodiversity and motivation to learn in the museum. The result showed that MGAR had a greater impact on improving students' understanding of biodiversity and provided more motivation than MG significantly. Salazar, Gaviria, Laorden and Bringas [32] also presented a game in their paper, but that serious game was designed to enhance an information security presentation. This was achieved through the use of AR to shape intangible cybersecurity concepts and allow the students to interact with them. The results showed that this serious game is a valid learning tool that helps

to consolidate information security concepts, by making them “tangible” to the users and providing them an interactive context for experimentation.

In papers dealing with the use of AR in secondary educational level, the results show that despite the possible technical problems of applying AR as a computer-assisted learning tool, learning objectives are met and students regardless of gender positively perceive the learning experience in this way. With the inclusion of game elements, students significantly improved their learning, but also their activity through collaboration with other students.

c) Educational level 3

In his paper Lee [33] comes to the conclusion that AR training has helped students to improve their 3D visualization, and also to improve their understanding of carpentry skills and of the complicated mortise–tenon joint structure. Chin, Wang and Chen [34] stated that AR finds its effective usage beyond traditional classrooms. They designed an AR-based mobile learning system to teach a liberal arts course at a Taiwanese university. This system helped students to engage in authentic learning activities independently without direct teacher assistance, and it provided an opportunity for teachers to improve on the effectiveness of conventional outdoor instructional approaches.

The potential of the location-based AR game on engagement and enhancing learning experience for advanced level EFL learners, is confirmed by the results of research presented by Richardson [35]. Also for EFL learning, Lee [36] in his paper compared the effects of an AR mobile game and a printed game on student engagement and attitudes, and the data obtained show that students may sustain high levels of engagement and positive attitudes regardless of the medium (AR technology versus print). But, although AR technologies provided authentic and immersive learning environments, EFL students perceived print reading as more useful for learning English than digital reading. Kazanidis, Tsinakos and Lytridis [37] examined the potential of using a game-based AR mobile application to teach mobile programming, and the first students' feedback about the application was very positive. They considered application as a useful and fun tool for their study.

By analyzing these papers, it can be concluded that AR is applied mostly in vocational subjects where it is important to achieve improved visualization. But greater motivation to learn, better learning outcomes and the ability to understand were also achieved. In combination with games, AR is used for the purpose of engaging students and improving the learning experience.

3.1.3. Designing and testing learning applications based on elements of AR and games

Ferrer, Perdomo, Rashed-Ali, Fies and Quarles [38] developed and evaluated an application of mobile phone AR for passive solar energy education (AR-SEE). Their findings are: a one-marker design with a touchscreen interface may have a usability advantage over a touchscreen-tangible hybrid design for AR serious games, in some

cases, a one-marker AR design may have increased learning benefits over a multi-marker design, and despite decreased usability, AR serious games can enhance motivation to learn over desktop interfaces. The same authors [39] extended their existing educational simulation AR-SEE to include virtual human inhabitants. The results showed that virtual human visualization of temperature data enabled higher motivation than the particle visualization for learning in the tangible AR environment. In their paper Alakärppä, Jaakkola, Väyrynen and Häkkinen [40] present a concept, prototype and in-the-wild evaluation of a mobile AR application in which physical items from nature are used as AR markers. Teachers found the use of natural objects to be an appealing approach and a factor contributing to the learning experience.

Ștefan and Moldoveanu [41] have analyzed how game concepts and design principles can be applied or adapted to the AR, and how the AR technology affordances can be leveraged in order to implement a new class of educational and simulation games. They also present a concept of an educational AR game as a teaching and learning tool, which can stimulate students' creativity, competitiveness, social interaction and critical-thinking. But, the integration of curricula in serious games is a difficult task, so they suggested that it can be facilitated if the learners (students) can participate in game development and content production. Tobar, Fabregat and Baldiris [42] agree with that, but instead of cooperating with students, they suggested cooperating with teachers and in their paper they introduce Co-CreARGBL as a method for Co-Designing ARGBL learning experiences involving teachers and designers as well. They have found that teachers find the process very useful and feel satisfied with the resulting tools and experiences, and are ready to use them in the classroom. The same authors [43] devised an AR game using a design-based research approach, but with the help of teachers. Their findings are that although there is no difference in results in reading comprehension using the game to results from the more traditional approaches, students do display greater motivation and interest in the activity, and the activity is enriched as it promotes problem solving, exploration, and socialization behavior.

Furthermore, Sudarmilah, Ustia and Bakhtiar [44] in their paper utilize AR Educational Game (AR EduGame) as a learning media that can cognitively stimulate students. The results of the implementation showed that AR EduGame can be considered as a quality and feasible learning media, especially in learning Indonesian culture regarding gamelan and traditional dances. Costa, Manso and Patrício [45] presented a mobile AR platform *PlanetarySystemGO* which consists of a location-based game targeted to promote learning about the Universe. Authors concluded that the game promotes students' interest and engagement to play it and to learn about the Solar System, and that this platform may be used as a resource to be implemented in informal and formal learning environments. Learning through outdoor activities Mozellius, Eriksson Bergström and Jaldemark [46] demonstrated in their paper through the usage of the Pokémon Go game in which in order to catch Pokémon figures, players must physically move to where the character is located. The results showed that Pokémon Go can be seen as a learning-stimulating game that could augment traditional teaching sessions in formal education. Students reported that they enjoyed catching the Pokémon figures the most, and some students also mentioned

that they appreciated the maths assignments. But, the most positive findings were that there were concrete learning outcomes and that this mobile game encourages students to engage in collaborative learning.

Very often, the papers mention the game EduPark, which is designed for outdoor learning settings by applying the principles of geocaching² and AR mobile technologies. The aim of the game is to develop authentic learning on various interdisciplinary topics in a smart urban park. Pombo, Marques, Lucas, Carlos, Loureiro and Guerra [47] presented the game prototype development. The evaluation allowed identifying positive characteristics of the game, such as immediate feedback and collaborative dynamics, but some questions included in the learning guides were perceived as difficult to understand. Two authors from this group, Pombo and Marques [48] in their paper are focused particularly on data of participants attending the first four years of primary education. The results showed that the EduPARK game achieved good usability and has educational value for primary education students. The same authors [49] in a new study using the EduPARK game as well, analyzed mobile learning through students' opinion regarding the use of mobile devices for learning, as well as the educational value of a specific mobile learning strategy. The results showed that most students owned a mobile device and were able to use them to learn. They had a positive perspective regarding mobile learning, they valued the advantages of being easy to find up-to-date information, and easy to carry mobile devices. But there were some difficulties, and they are related to the use of mobile devices, such as requiring an internet connection, its slowness and prohibition of mobile devices in schools.

In order to assess the effects of combining ARGBL and a multiplayer approach, the authors Ortiz, Vitery, González and Tobar-Muñoz [50] built an ARGBL multiplayer video game where learning takes place indirectly, motivated by the use of components such as AR and social interaction. They concluded that competition integrated in the game allowed students to learn the educational content in a fun way as they looked to get advantage over their opponent, however some students still preferred to play in a collaborative way. Teachers emphasized that the use of that game supports learning by association, provides a fun experience that captures students' attention and increases their motivation. Hwang, Wu, Chen and Tu [51] proposed a competitive gaming approach to support AR-based learning activities conducted in a real-world context. The results showed that the AR-based gaming approach can improve not only students' learning attitudes, but also their learning performance. To assess the usability of the two game styles competitively and collaboratively, and their impact on user communication and motivation. López-Faican and Jaen [52] tested the mobile AR game EmoFindAR. They concluded that both ways of playing are satisfactory for students and trigger positive emotions such as enthusiasm, pleasure and curiosity that improve participants' mood and help increase the degree of involvement. But they noted that the collaborative game version has a greater impact on emotional affection, social interaction and interest. Based on

² Cambridge dictionary: the activity of using GPS to search for small hidden prizes
<https://dictionary.cambridge.org/dictionary/english/geocaching>

these findings, Bressler, Bodzin, and Tutwiler [53] examined whether player's flow experience differed by achievement track, gender, or gender composition of working groups in a collaborative mobile game. The paper found that gender was related to flow experience, and specifically girls reported higher flow experience scores. But, flow experience did not have a statistically significant relationship with achievement track showing that the activity engaged all observed students similarly.

The results of the analyzed papers show that an AR game based approach can improve not only students' learning attitudes, but also their learning performance. Both styles of play, competitive and collaborative, encourage positive emotions such as enthusiasm, enjoyment, and curiosity that improve participants' moods and help increase the degree of involvement. But some students prefer to play as a team, and playing together has a greater impact on emotional affection, social interaction, and student interest. Also, designers are not always aware of the specifics of learning or curriculum design, and teachers lack expertise and time, so a method to jointly create an ARGBL learning experience has been proposed. The results of the evaluation of the analyzed applications show that they all have educational value, have positive characteristics of the game such as current feedback and dynamics of cooperation, and that they can be considered as a quality learning media.

3.1.4. Formative assessment using an application based on AR

The effectiveness of using formative assessment based on AR to improve achievement and motivation in primary school has been examined by Bhagat, Liou, Spector, and Chang [54]. The results showed that the use of AR-based formative assessment improved not only student learning performance but also their motivation to learn, compared to the traditional formative assessment approach. Stylianidou, Sofianidis, Manoli and Meletiou-Mavrotheris [55] in their paper reported on the main experiences gained from a teaching intervention which utilized the alternate reality game 'Helping Nemo' in an AR environment for formative assessment. The findings suggest that such formative assessment contributes towards higher levels of engagement and participation in learning of all students, including bilingual students, students with learning disabilities, and students who are currently disengaged.

Formative assessment at the higher level of education is explored by Chao, Lan, Kinshuk, Chang and Sung [56]. In their paper they propose a framework that incorporates mobile peer assessment and AR technology to enhance interaction and learning effectiveness. The results showed that the system helped students in acquiring useful information, proposing their viewpoints, and further fostering critical thinking skills and reflection. Similar results that AR-based learning with a formative assessment mechanism significantly improved student achievement and motivation in learning, while reducing their cognitive load, were obtained by Chu, Chen J.-M. Hwang and Chen T.-W. [57]. They proposed an AR system for learning in a university architecture course based on a formative assessment mechanism, by leading students to find answers on their own and giving them hints when they fail to answer questions correctly.

Although two papers analyze the effectiveness of using formative assessment based on AR in primary education, and the other two in tertiary education, the common conclusion is that the use of such formative assessment affects learning performance and motivation to learn, contributes to engagement and participation in the learning of all students, and helps students in acquiring useful information and further encouragement of critical thinking.

3.1.5. *Interests and attitudes of professors, students and faculty on the use of AR in education*

All analyzed papers are related to higher education. Tebeanu, Chicioreanu, Amza and Macarie [58] in their paper conducted at Higher Education centers in Romania, Malta, Iceland, and Lithuania analyzed the need of students and professors regarding AR in technical disciplines. The results showed that one third of the respondents indicated the use or prior knowledge of AR in the educational environment, and that they are enthusiastic about the future implementation of the activities. Alsadoon and Alhussain [59] examined the possibility of implementing the AR application in higher education in faculties at Saudi Electronic University. They concluded that faculties have a positive attitude towards the use of the AR in the educational environment, but results also showed that there are concerns about some barriers such as the lack of technical support. I. Stojšić *et al.* [60] in their paper researched the students' attitudes toward the application of mobile AR (MAR), and the results showed that the students have mostly a positive attitude.

Durão, Moreira, Ferreira, Santos-Pereira and Annamalai [61] investigated the perception that higher education professors in the area of technology, across South Europe, South America, and Asia countries have about the use of mobile technologies such as gamification and AR, and how they can be used to promote student's engagement inside and outside of the classroom. The results of the study indicate a similar situation in all countries with small differences in terms of student participation, engagement, and mobile use in the classroom. As a general conclusion, they state that most professors have excellent knowledge of how to perform certain trivial tasks.

The results of all four analyzed papers show the positive attitudes of professors and students about the usage of AR in colleges.

3.2. Discussion

Based on the analysis of papers by categories, it is possible to draw several conclusions and also answer the third research question: *What common conclusions can be drawn from the synthesis of papers obtained by analysis in each thematic category?* In the first thematic category where the papers related to the usage of the AR in education are analyzed, the conclusion is that the number of published papers related to EMARG and ARGBL in primary and secondary education is gradually increasing and also the number of teachers using them. That can be related to positive attitudes of professors and students on the use of the AR in the faculties determined

in the last thematic category. The conclusion in the first category is also that the AR, and especially with the game elements in general, have a positive effect on students' attitudes, as well as on the learning outcome. This is mostly confirmed in the category in which the analyzed papers confirmed the positive impact of the AR on the effectiveness, motivation and achievement of students with or without the use of game elements in all three levels of education. Regardless of gender, students like that kind of way of learning. The results of effective motivation, but also the higher levels of engagement of all students were found in the category in which an application based on the AR with or without game elements is applied for the purpose of formative assessment. Such engagement through collaboration when playing games promotes motivation, but also increases student involvement and it is recognized in most thematic categories. All analyzed applications show that they all have educational value, have positive characteristics of the game such as current feedback and dynamics of cooperation, and that they can be considered a quality learning media.

Although the negative aspects are mentioned very little, some that are present in certain categories can be singled out. These are possible technical problems of the AR usage, impracticability of certain activities in everyday practice, lack of expertise and time by teachers to design and implement ARGBL applications, and difficulties associated with the use of mobile devices, such as the need for internet connection, slowness and prohibition of mobile devices in schools.

4. Conclusion

The aim of this paper was to give a literature review and analyze already researched topics in the field of using AR technology in education in the past 10 years, from 2010 till 2020. But because of the frequent use of game elements with the AR, both aspects were included in the research. The research methodology was carried out following the steps proposed by J. W. Creswell [7]. After the papers relevant to the research topic have been selected, the final result is 52 papers describing various aspects of the usage of augmented reality in the field of education.

Answering the first research question: *What thematic categories can be identified in the analyzed papers?*, the initial analysis identified five basic categories. Thus we distinguish I) papers that provide an overview of the literature related to the use of AR in education, II) those that deal with its impact on the effectiveness, motivation and achievement of students with or without the game elements, III) those that focus on designing and testing learning applications based on AR and game elements, IV) those that examined the impact of applications based on AR on formative assessment and V) those that consider the interests and attitudes of professors, students and faculties on the use of AR in education. In the category describing the impact of the AR on the effectiveness, motivation and achievement of students with or without game elements, a division was made according to the level of education, where level 1 is primary, level 2 is secondary, and level 3 is tertiary education.

Observing the distribution of selected papers in each thematic category with additional consideration of the year of publication according to paper reference, we can conclude that the number of papers dealing with the AR and game elements in

education has increased in the last 5 years. From 2010 to 2015, only 10 papers were published, while from 2016 to 2020, 42 papers were published. The largest number of analyzed papers was published in 2019, which means that the publication of papers has decreased in the last year. This analysis is the answer to the second research question: *What is the representation of the papers in a certain thematic category considering the year of publication??*

In order to answer the third research question: *What common conclusions can be drawn from the synthesis of papers obtained by analysis in each thematic category?*, after the analysis of the selected papers, which were grouped according to the established thematic structure, their synthesis followed according to the recognized important concepts on the basis of which several conclusions described in Chapter 3.2 were drawn. However, the main idea that extends through all analyzed papers is that the use of AR in teaching activities, and especially with game elements, improves student efficiency, encourages attention and interest, brings improvements in collaboration and perception of fun, improves teaching and learning processes and generally encourages innovations and improvements through educational technology.

The use of AR in education is a new area that requires further research, especially about formative assessment usage where the positive impact of AR has been identified, but only a few papers dealing with that thematic have been found. Just one of them is using AR with game elements for formative assessment, which indicate insufficient research in this area. Also, detailed research about interest and attitudes of professors and students according to the use of AR in education were found only in papers focused on higher levels of education. Given all of the above, further research should be focused on primary and/or secondary level of education with the above mentioned focus.

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Inverted Sparse Discriminant Preserving Projection for Face Recognition

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Abstract

Image classification and face recognition has been a popular subject matter for the last several decades. Images are usually handled as transformed as vectors which makes their classification a dimensionality reduction task. Some of the well-known algorithms in the area, such as the Sparsity Preserving Projection (SPP), create new theoretical concepts families, while other successfully modify or combine useful properties of the former ones. Compiled algorithms like Sparse Discriminant Preserving Projections (SDPP) employ the properties of the Sparse Representation (SR) as in their objective functions they include a supervised modification of the sparse weight matrix that considers the intra-class relations. By examining the construction of the SDPP algorithm and by providing some arguments on the supervised SR, in this paper we propose a new subspace learning algorithm, called Inverted Sparse Discriminant Preserving Projection (ISDPP). Likewise SDPP, ISDPP integrates supervised SR with the Fisher's criterion. In contrast to SDPP, ISDPP incorporates a *between-class* SR with the Fischer's within-class scatter matrix. A preliminary round of experiments support the initiative and provide an expectation for possible superior performance of the proposed ISDPP that is confirmed in the next round of empirical examinations.

Keywords: Dimensionality reduction, Sparse Representation, Face Recognition

1. Introduction

Image classification and face recognition have received a lot of attention for the last several decades already. The interest in it stems from its wide practical applicability in numerous fields in science and life like medical research, public safety, space science, documents manipulations and many others. The images' pixels matrices, converted as vectors – one of the main approach of handling images objects – are classical examples of high-dimensional data objects. In addition, the improving technical devises produce more and more qualitative and sizable images. This makes the task of image classification a dimensionality reduction problem, which is the essence of the subject of the algorithms in the area, prior to a final classification with a standard classifier. As a differentiated machine learning subject matter, the dimensionality reduction (DR) includes numerous theoretical concepts and algorithms that are applied for the solution of various problems in both unsupervised and supervised context. In general, the DR does simultaneously 1) work for the detection

of a new valuable variables-subspace that is much smaller than the original one, and 2) dramatically reduce the required computational recourses.

Since the images are large and complex data objects for a DR, the problem resolution has many aspects. Therefore, the numerous methods in the stream can be analysed and classified by some of their main characteristics (properties) and/or by the data structure they consider, like the following proposed: A) globality-locality reflection (representation) B) linearity-non-linearity C) presence (requirement) of parameter(s) D) unsupervised-supervised E) having the small-sample-size problem (SSS) F) having the out-of-sample problem.

Principal Component Analysis (PCA) [1]-[4] and Linear Discriminant Analysis (LDA) [3],[4] are fundamental bases of the DR subject matter. They have natural intuitive concepts that are a ground of the composition of many of the following DR algorithms. PCA and LDA are based on the Euclidian distances and reflect the global structure of the data. They have immediate and quite simple application. PCA, however, does not consider the input data label information, which may lead to a loss of a critical pattern information. Contrarily, LDA takes into account the classes labels, which makes it more effective than PCA in many applications. Unfortunately, LDA cannot be applied directly to a data with the so called small sample size problem (SSS) when the number of the features is greater than the training observations – something that is very common in the image classification). To address this, Belhumeur et al. [3] propose a two stage PCA+LDA method, in which PCA is exploited to make the within-class scatter matrix nonsingular. However, this causes a loss of an important discriminative information. On the other side, the proposed by Li et al. [5] maximal margin criterion (MMC) overcome the SSS more efficiently.

All the above methods capture the global Euclidian structure of the images and cannot characterize their local structure. To address this many manifold learning algorithms have been proposed based on the idea that the data points are samples from a low-dimensional manifold embedded in a high-dimensional space. Some representative algorithms are locally linear embedding (LLE) [6], Isometric Feature Mapping (ISOMAP) [7], Laplacian eigenmaps (LE) [8], etc, whereas each of them attempt to preserve a different geometrical property of the underlying manifold. Unfortunately all these methods suffer from the so called out of sample problem, consisting in the difficulty to find new sample images in the embedding space by utilizing the low-embedding results of the training data set.

To overcome this, some improved methods like the introduced by He et al. Neighbourhood preserving embedding (NPE) [9] and Locality preserving projection (LPP) [10] have been proposed. NPE and LPP work with Euclidian distances as well, which makes them sensitive to data noise and outliers. To address this, Yu et al. [11] present the ILPP-L1 that is based on the l_1 -norm-distances reaching a better robustness towards undesired outliers' impact on the cost of a bit more complicated subspace extraction, whereas the new space's vectors are extracted one by one consecutively. As NPE and LPP consider only the local structure of the data, some extended methods like the presented by Yu et al. Discriminant Locality Preserving Projections (DLPP) [12] integrate "global" with "locality" information by taking into account the data labels. However, DLPP suffers from the small sample size problem

as well. To overcome this Lu et al. [13] propose the DLPP/MMC that embed the concept of the maximal margin criterion (MMC) and thus elegantly eliminates the SSS.

The introduced by Qiao et al. Sparsity Preserving Projection (SPP) [14], sets the creation of a very attractive DR theory family. SPP seeks for a projection that preserves the sparse reconstruction relationship of the data points. Its main idea is imbedded in the computation of a *sparse reconstruction weight matrix* (also shortened as *sparse weight matrix*), whereat each row of the matrix is the observation x_i presented as a reconstruction from the remaining data points with the requirement for *sparsity*.

A lot of DR algorithms combine verified beneficial properties and techniques of different models. For instance, the Discriminant Sparse Neighbourhood Preserving Embedding (DSNPE) of Gui et al. [15] compiles parts of SPP and MMC. DSNPE tries to simultaneously preserve the sparsity property and to maximise the margin between the classes, whereas the sparse weight matrix is calculated within the classes. Similarly, the Sparse Locality Preserving Discriminative Projections (SLPDP), proposed by Zhang et al. [16], assembles LPP with the MMC and aims preservation of the neighbourhood together with a between-classes margin maximisation, whereas, in the computation of the Laplacian matrix, the adjacency weight matrix is replaced by the within-class sparse weight matrix. On the other hand, the Sparse Discriminant Preserving Projections (SDPP), suggested by Zhang et al. [17], employs the relationship of the within-class sparse representation, to the between-class scatter matrix, seen is a carrier of the global structure of the data.

The remainder of this paper is organized as follows. Section 2 introduces related works. The proposed Inverted Sparse Discriminant Preserving Projection algorithm is introduced in section 3. We show our experimental results in section 4 and the paper is concluded in section 5.

2. Related works

2.1 Linear Discriminant Analysis (LDA)

The objective function of LDA is defined as:

$$\max_w \frac{w^T S_B w}{w^T S_W w}$$

where:

$$S_B = \sum_{i=1}^C n_i (m^{(i)} - m)(m^{(i)} - m)^T \quad (1)$$

$$S_W = \sum_{i=1}^C n_i \sum_{j=1}^{n_i} n_i (x_j^{(i)} - m)(x_j^{(i)} - m)^T \quad (2)$$

The $\mathbf{S}_B$ and $\mathbf{S}_w$ are called between-class scatter and within-class scatter matrices, respectively, $m^{(i)}$ is the mean vector of class i , m is the total mean of all observations and n_i is the number of observations from class i .

2.2 Sparsity preserving projection (SPP)

Sparsity Preserving Projection (SPP) belongs to the generalized graph embedding framework [17]. It aim is to preserve the sparse reconstruction relationship of the data [16].

Given a data set of n samples $X = [x_1, x_2, \dots, x_n] \in \mathbb{R}^{m \times n}$, SPP seeks for a reconstruction of each sample x_i by as few as possible from the remaining observations from X , or:

$$\min \|s_i\|_0, \text{ s. t. } x_i = Xs_i, \mathbf{1} = \mathbf{1}^T s_i \quad (3)$$

$\|\cdot\|_0$ is the l_0 -norm, denoting the number of non-zeros in the coefficients' vector, $s_i = [s_{i1}, s_{i2}, \dots, s_{i(i-1)}, 0, s_{i(i+1)}, \dots, s_{in}]^T, s_i \in \mathbb{R}^n$, where its i -th coefficient equals zero as an observation can not be presented by itself and $\mathbf{1}^T \in \mathbb{R}^n$ is a vector of all ones. Unfortunately Eq. (3) is NP-hard to solve as the function is not convex [14]. This difficulty is overcome as the optimization is translated into a l_1 -minimisation problem or:

$$\min \|s_i\|_1, \text{ s. t. } x_i = Xs_i, \mathbf{1} = \mathbf{1}^T s_i \quad (4)$$

Further, in many practical problems when the data X is noisy, the constraint $x_i = Xs_i$ does not always hold [14]. Therefore, Qiao et al. [14] propose two stable extensions of the optimization. One of them is to relax the constraint $x = Xs$ as $\|x - Xs\| < \varepsilon$, where ε can be viewed as an error tolerance. Thus Eq. (4) is modified as:

$$\min \|s_i\|_1, \text{ s. t. } \|x - Xs\| < \varepsilon, \mathbf{1} = \mathbf{1}^T s_i \quad (5)$$

The objection function of SPP seeks to best preserve each optimal vector s_i by:

$$\min_w \sum_{i=1}^n \|w^T x_i - w^T Xs_i\|^2 = \min_w \frac{w^T X S_\alpha X^T w}{w^T X X^T w},$$

where:

$$S_\alpha = I - S - S^T + S^T S \quad (6)$$

and $S = [s_1, s_2, \dots, s_n]^T$, where $s_i, i = 1, 2, \dots, n$, is the optimal solution of Eq. (5). SPP owns some important characteristics:

- it is linear and doesn't suffer from the out of sample problem;
- it is parameter-free;

- it does naturally preserve some discriminant information of the data;
- it is robust to data noise;

2.3 Sparse Discriminant Preserving Projection (SDPP)

Sparse Discriminant Preserving Projection (SDPP) combines features of SPP and LDA. The discriminant ability of the sparse representation is further strengthened as the vectors of the sparse weight matrix $\mathbf{S}$ are constructed within the classes. According to the authors of SDPP, Zhang et al. [17], SPP does not consider the global structure of the data. Therefore in SDPP they involve the Fisher's between-class scatter matrix $\mathbf{S}_B$ as a carrier of information of the global structure of the data and construct the model's objective function as following:

$$\min \frac{\text{tr } \mathbf{W}^T \mathbf{S}_\alpha \mathbf{W}}{\text{tr } \mathbf{W}^T \mathbf{S}_B \mathbf{W}} \quad (7)$$

where $\mathbf{S}_\alpha$ is obtained by Eq. (6) after Eq. (5) has been modified as:

$$\min \|s_i^k\|_1, \text{ s.t. } \|x_i - \mathbf{X}_k s_i^k\| < \varepsilon, 1 = \mathbf{1}^T s_i^k, \text{ label}(x_i) = k, \quad (8)$$

where if n_k is the number of samples with label k ,

$$s_i^k = [s_{i,1}^k, \dots, s_{i,i-1}^k, 0, s_{i,i+1}^k, \dots, s_{i,n_k}^k]^T \text{ and } n = \sum_{k=1}^c n_k.$$

Thus the sparse weight matrix is:

$$\mathbf{S} = \text{diag}(\mathbf{S}^1, \mathbf{S}^2, \dots, \mathbf{S}^c)$$

where

$\mathbf{S}^k = [s_1^k, s_2^k, \dots, s_{n_k}^k]$, and $k = 1, 2, \dots, c$, are the available classes. $\mathbf{S}_B$ in Eq. (7) is the LDA's between-class scatter matrix from Eq. (1).

3. The proposed Inverted Sparse Discriminant Preserving Projection

3.1 Motivation

The motivation of the new proposed algorithm comes with an observation of the construction idea of SDPP and has two main aspects. First, we challenge the extend of a discriminative information that the sparsity preserving element in that model contributes and provide a suggestion of the increase of its potential. Secondly, we try to keep the construction idea of SDPP in which a supervised sparsity element is integrated with a supervised "global" part.

On the first aspect: In the unsupervised sparse representation an observation is reconstructed by the remaining samples where it is excluded from its own reconstruction. Analogically, when the classes' labels are available, a class should be reconstructed by the remaining classes from the dataset. One can expect that a sample,

representing a class, will be “described” better by the observations from the different classes than by the observations from its own class as its reconstruction will reflect its relation to samples that defer from it a priori (as belonging to another classes). In contrast, in the within-class sparse representation case, an observation will be represented only by the same group members which may lead to an omission of discriminative information.

Another reason for the expectation for a better discriminative information preservation when the sparse weight matrix is defined between the classes, is related to the number of observations that participate in the obtainment of the sparsity weight vectors $\mathbf{s}_i$. In general, it is more likely that the count of the observations from all remaining classes will exceed the same class’ one and therefore would contribute more discriminative information to the particular $\mathbf{s}_i$. We can demonstrate this with the following illustrative example: if we consider a training dataset that has fully equally distributed classes – e.g. containing 10 classes with 10 samples each – in the computation of the between-class sparsity vector $\mathbf{s}_i$ of each sample x_i will participate 90 instead of only nine observations.

On the second aspect: As LDA is a “global” method we expect that the within-class scatter matrix $\mathbf{S}_w$ Eq. (2) would similarly work for the inclusion of global structure preservation, the way the between-class scatter matrix $\mathbf{S}_B$ Eq. (1) does in SDPP.

By taking into account the above considerations we propose a new subspace learning algorithm called Inverted Sparse Discriminant Preserving Projection (ISDPP). Similarly to SDPP, ISDPP simultaneously utilize the properties of SPP with the addition of an information on the global structure of the data contained in the Fisher’s criterion. *In contrast* to SDPP, ISDPP embeds a SR with a sparse weight matrix, the sparse weight vectors of which are computed *between the classes*. On the other hand, the preservation of the global structure of the data is achieved by the inclusion of the LDA’s *within-class scatter matrix* Eq. (2). Thus, while the optimization problem of SDPP is to minimize the objective function Eq. (7), ISDPP seeks a projection that maximises the ratio between the Sparse Representation element – derived by sparsity weight vectors computed between the classes – and the Fisher’s within-class scatter matrix.

Thus, the objective function of the proposed ISDPP is formulated as:

$$\min \frac{\text{tr } \mathbf{w}^T \mathbf{S}_\alpha \mathbf{w}}{\text{tr } \mathbf{w}^T \mathbf{S}_w \mathbf{w}} \quad (9)$$

Where $\mathbf{S}_\alpha$ is obtained from Eq. (6) and the sparse weight matrix $\mathbf{S}$ and its vectors are constructed as following:

$$\min \|\mathbf{s}_i^k\|_1, \text{ s.t. } \|\mathbf{x}_i - \mathbf{X}_{\bar{k}} \mathbf{s}_i\| < \varepsilon, 1 = \mathbf{1}^T \mathbf{s}_i^k, \text{ label } (x_i) = k. \quad (10)$$

The $\bar{k}$ stands for *is not class k*. The notation $\mathbf{X}_{\bar{k}}$ means that to the obtainment of the sparse weight vector $\mathbf{s}_i^k$, corresponding to sample i from class k , contribute the samples from all classes other than k . If n_k is the number of samples with label k and

$n_{\bar{k}}$ is the number of samples with different label ($\bar{k}$), the length of s_i^k will be $n_{\bar{k}}$. The vector s_i^k , the optimal solution of Eq. (10), is completed with n_k -zero coefficients on the places of the respective samples from class k . If we denote the final reconstruction weight vector corresponding to sample i with $\hat{s}_i^k$ and $n_k + n_{\bar{k}} = n$, then:

$\hat{s}_i^k = [0_{(m)}, s_{i(j)}^k]^T$, where m denotes all indexes of the observations from class k as they are ordered in the dataset $\mathbf{X}$ and j denotes all indexes of the remaining observations from the other classes with an order in $\hat{s}_i^k$ the same as the order of $\mathbf{X}_{\bar{k}}$ in $\mathbf{X}$. The sum of the m -elements is n_k and the sum of the j -elements is $n_{\bar{k}}$, respectively. Then for the sparse weight matrix $\mathbf{S}$ we have:

$$\mathbf{S} = [s_1^k, s_2^k \dots, s_n^k]^T \quad (11)$$

4. Experimental results

4.1 Experiments on the sparse representation

In this experimental round we examine if the between-class sparse weight matrix does add a valuable discriminative information to the SPP, when supervised, how the two alternated supervised SPP's compare to each other and also to the unsupervised SPP.

To evaluate this, we compare the classification results after a subspace learning done by SPP with sparse weight matrices' vectors computed by Eqs. (5), (8) and (10), respectively. We set the value of the parameter ε as 10. For a better differentiation, we denote the algorithm with Eq. (8) as SPP-W and the one with Eq. (10) as SPP-B ("W" and "B" for a within- or between-class notation, respectively).

For the above proposition we involve the public face images database ORL. ORL contains 400 grey scale images of 40 persons with a resolution of 112×92 pixels. Each person has 10 images that have variations in the lightning, facial expressions (smiling/not smiling, open/closed eyes) and/or other details (glasses/no glasses) – **Fig. 1** shows the images of the first one person. All images are cropped and resized to 32×32 pixels. The experiment is conducted as the SPP, SPP-B and SPP-W are trained over the sampled training set for features extractions. The test samples are projected over the generated subspaces and evaluated with the application of kNN classifier. We choose to use 1-nearest-neighbor which is consistent with the literature in the area. The procedure is performed with a random sample of three and five images per person for training with 10 runs for each case. As a pre-processing step we perform PCA and retain 98% of the images' energy. **Tables 1-2** show the obtained average recognition accuracies (RA) – up to the 150th dimension – and their standard deviations over the 10 independent runs for the two scenarios. These are also plotted on **Fig. 2** and **Fig. 3**.



Figure 1. All 10 images of person 1 from the ORL database.

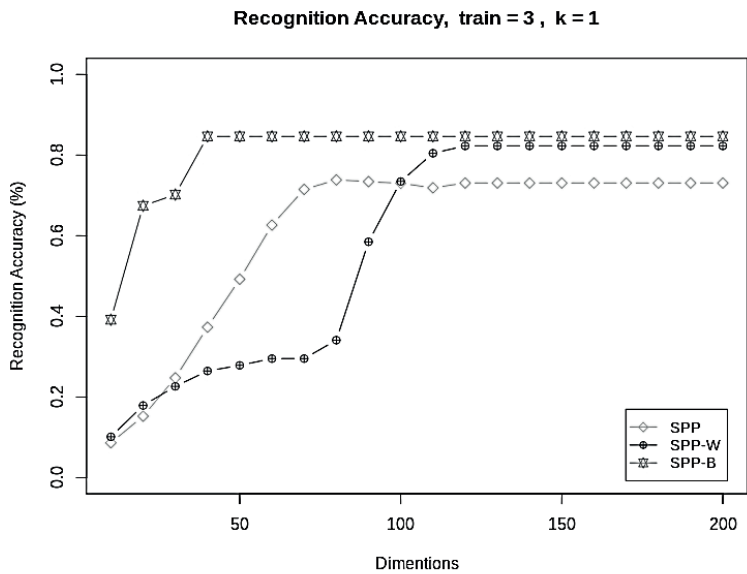


Figure 2. Recognition accuracy (%) vs. number of projected vectors of the SPP’s algorithms on the ORL database with a sample of 3 images per subject for training.

Method/ Dim.	Avg/ Std.	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
SPP	Avg.	8.6	15.3	24.8	37.3	49.2	62.6	71.5	73.9	73.4	73.0	71.9	73.1	73.1	73.1	73.1
	Std.	1.7	2.1	3.6	3.4	3.4	2.8	1.7	3.1	3.5	3.5	3.9	3.5	3.5	3.5	3.5
SPP-W	Avg.	10.1	17.9	22.6	26.5	27.9	29.5	29.5	34.1	58.5	73.5	80.5	82.3	82.3	82.3	82.3
	Std.	1.9	2.0	1.5	3.0	3.3	2.9	3.4	3.1	5.2	2.5	2.6	2.5	2.5	2.5	2.5
SPP-B	Avg.	39.2	67.4	70.2	84.6	84.6	84.6	84.6	84.6	84.6	84.6	84.6	84.6	84.6	84.6	84.6
	Std.	3.2	2.9	2.6	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0

Table 1. Recognition accuracy (%) vs. number of projected vectors of the SPP’s algorithms on the ORL database with a sample of 3 images per subject for training.

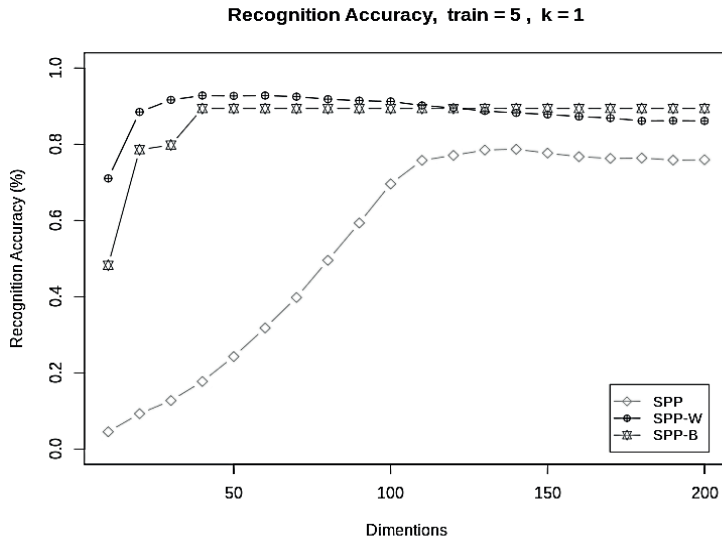


Figure 3. Recognition accuracy (%) vs. number of projected vectors of the SPP's algorithms on the ORL database with a sample of 5 images per subject for training.

Method/ Dim.	Avg/ Std.	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
SPP	Avg.	4.6	9.3	12.8	17.8	24.3	31.8	39.8	49.6	59.4	69.6	75.8	77.1	78.5	78.7	77.7
	Std.	1.3	1.3	2.7	3.5	3.7	4.8	5.4	7.1	6.4	4.8	3.6	3.2	2.6	3.0	3.5
SPP-W	Avg.	71.1	88.5	91.7	92.8	92.7	92.8	92.5	91.9	91.5	91.3	90.2	89.6	88.8	88.3	87.9
	Std.	6.4	3.2	2.1	2.4	2.3	2.4	3.1	2.9	2.8	3.0	2.8	2.3	2.7	2.1	2.5
SPP-B	Avg.	48.3	78.6	79.8	89.4	89.4	89.4	89.4	89.4	89.4	89.4	89.4	89.4	89.4	89.4	89.4
	Std.	4.2	3.8	4.3	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7

Table 2. Recognition accuracy (%) vs. number of projected vectors of the SPP's algorithms on the ORL database with a sample of 5 images per subject for training.

4.1.1 Results

In this experimental phase we observe a clear advantage of the supervised modifications of SPP over the classical SPP. This is in line with the expectations and demonstrates explicitly the additional discriminant information contribution of the SR when it is embedded as supervised in compiled algorithms. In regard to the SPP-W versus SPP-B comparison, SPP-W reaches higher absolute recognition accuracy in the 50%-training-samples case. On the other side, SPP-B stays more robust when the training sample decreases. That confirms the considerations that the out-of-the-class samples approach could provide a stable preservation of discriminant information.

4.2 Experiments on the introduced ISDPP

To evaluate the performance of the proposed ISDPP algorithm we conduct further experiments on the public ORL and AR databases and compare it with the effectiveness of other well-known algorithms like DSNPE, SLPDP and SDPP.

4.2.1 Experiments with the ORL database, experimental design.

This experimental round involves the ORL database, described above. In order to simultaneously examine the robustness of the proposed ISDPP we decide to occlude the 112×92 pixels training samples with a random 24×24 pixels square, in which each pixel of the square takes a random value from the interval $[0, 1]$, whereas a value of zero represents pure black and a value of one pure white color, respectively – **Fig. 4** shows an example of three original and randomly “occluded” images from the database. Further, the images are cropped to 32×32 pixels and a PCA with 98% energy retention is performed. Similarly to the first experimental round above, we define training sets with three and five random images per subject, respectively, and do 10 runs for each case. The new proposed ISDPP is executed together with the other three algorithms for a subspace learning over the so defined training subsets. The parameter ε in the sparse representations has the value of 10 and for the parameter γ in SPNPE we take the value of 1 (as in [15]) and the value of 0.1 in SLPDP (as in [16]), respectively. The test samples are mapped to the respective projections and evaluated with 1-NN classifier. The obtained classification results are presented in **Tables 3-4** and visualised on **Fig. 5, 6**.



Figure 4. Example of three original and randomly “occluded” images from the ORL database

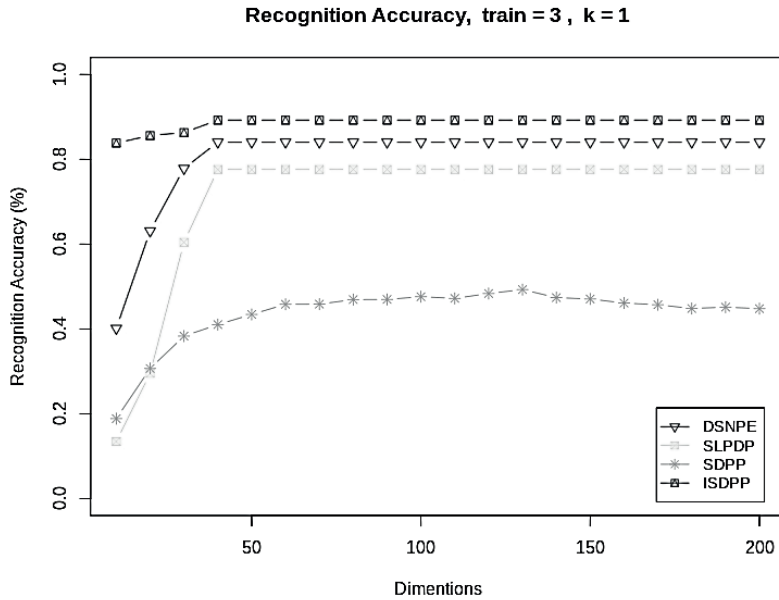


Figure 5. Recognition accuracy (%) vs. number of projected vectors of the proposed ISDPP together with another algorithms on the ORL database with a sample of 3 images per subject for training.

Method/ Dim.	Avg/ Std.	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
DSNPE	Avg.	40.1	63.1	77.9	84.1	84.1	84.1	84.1	84.1	84.1	84.1	84.1	84.1	84.1	84.1	84.1
	Std.	4.1	5.6	2.8	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
SLPDP	Avg.	13.5	29.5	60.4	77.6	77.6	77.6	77.6	77.6	77.6	77.6	77.6	77.6	77.6	77.6	77.6
	Std.	2.5	5.4	4.0	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
SDPP	Avg.	18.9	30.7	38.3	41.0	43.4	45.8	45.9	46.9	47.0	47.6	47.2	48.4	49.3	47.4	47.1
	Std.	8.5	11.1	13.6	14.6	14.7	14.3	16.2	15.6	16.6	17.6	18.8	19.1	19.1	19.1	19.5
ISDPP	Avg.	83.9	85.6	86.3	89.3	89.3	89.3	89.3	89.3	89.3	89.3	89.3	89.3	89.3	89.3	89.3
	Std.	2.9	3.0	2.7	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

Table 3. Recognition accuracy (%) vs. number of projected vectors of the proposed ISDPP together with another algorithms on the ORL database with a sample of 3 images per subject for training.

4.2.2 Experiments with the AR database, experimental design.

The AR face database contains over 4000 color face images of 126 individuals (70 men and 56 women). In our experiment we use a subset of the AR face database provided and preprocessed by Martinez et al. [18]. This subset contains 1400 face images, with a resolution of 165 x 120 pixels, corresponding to 100 person (50 men and 50 women), where each person has 14 different images with illumination change and expressions – **Fig. 7** shows the images of one person from the database.

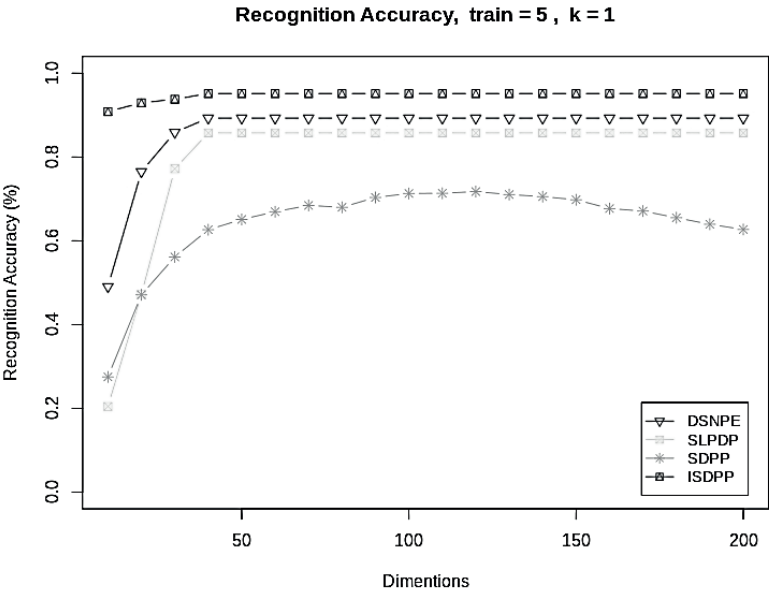


Figure 6. Recognition accuracy (%) vs. number of projected vectors of the proposed ISDPP together with another algorithms on the ORL database with a sample of 5 images per subject for training.

Method/ Dim.	Avg/ Std.	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
DSNPE	Avg.	49.1	76.5	85.9	89.3	89.3	89.3	89.3	89.3	89.3	89.3	89.3	89.3	89.3	89.3	89.3
	Std.	5.6	5.4	3.4	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
SLPDP	Avg.	20.5	47.2	77.2	85.8	85.8	85.8	85.8	85.8	85.8	85.8	85.8	85.8	85.8	85.8	85.8
	Std.	4.6	6.3	5.1	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
SDPP	Avg.	27.5	47.1	56.2	62.7	65.1	67.0	68.5	68.0	70.4	71.3	71.4	71.8	71.1	70.6	69.8
	Std.	7.5	11.0	9.4	10.5	10.5	11.3	10.5	11.3	11.6	10.3	9.5	9.9	10.8	11.1	12.5
ISDPP	Avg.	90.9	93.0	93.8	95.2	95.2	95.2	95.2	95.2	95.2	95.2	95.2	95.2	95.2	95.2	95.2
	Std.	2.3	1.4	1.8	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5

Table 4. Recognition accuracy (%) vs. number of projected vectors of the proposed ISDPP together with another algorithms on the ORL database with a sample of 5 images per subject for training.

We design two scenarios with four and seven images per subject for training. Similarly, we occlude the training images with a random 32×32 pixels square – **Fig. 8** shows an example of three original and randomly “occluded” images from the database – and perform a PCA over the training set with a 98% energy retention. For the sparse representations we use the second modified sparse representation, Eq. (16) from [14] and the parameter γ in SPNPE takes the value of 1 and 0.1 in SLPDP, respectively. The obtained recognition accuracies of the methods are presented on **Tables 5-6** and **Fig. 9, 10**.

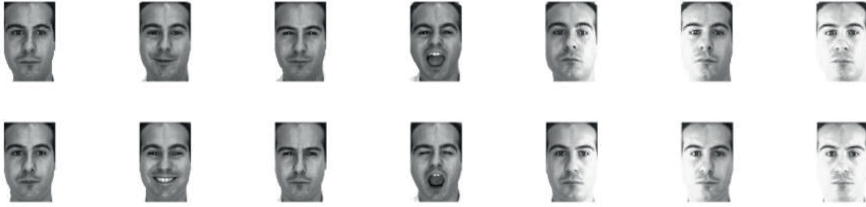


Figure 7. The images of one person from the AR database.

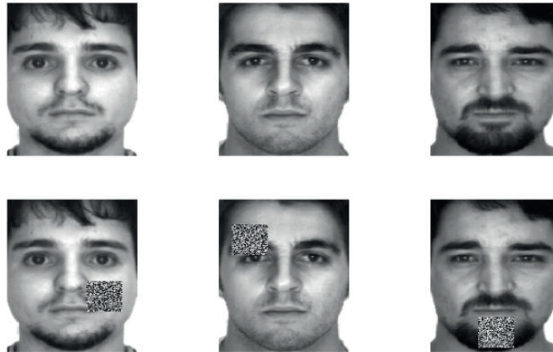


Figure 8. Example of three original and randomly “occluded” images from the AR database

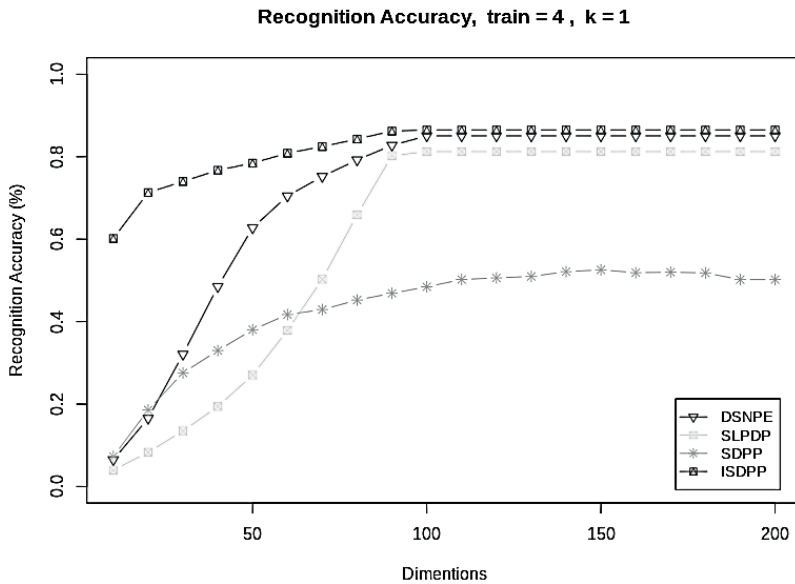


Figure 9. Recognition accuracy (%) vs. number of projected vectors of the proposed ISDPP together with another algorithms on the AR database with a sample of 4 images per subject for training.

Method/ Dim.	Avg/ Std.	10	20	30	40	50	60	70	80	90	100	110	120	130	140
DSNPE	Avg.	6.5	16.5	32.1	48.5	62.8	70.5	75.2	79.2	82.8	85.1	85.1	85.1	85.1	85.1
	Std.	1.3	2.6	3.5	3.9	2.4	2.0	2.1	1.7	1.7	1.1	1.1	1.1	1.1	1.1
SLPDP	Avg.	4.0	8.3	13.5	19.4	27.0	37.9	50.3	65.9	80.3	81.2	81.2	81.2	81.2	81.2
	Std.	0.8	1.0	2.2	3.0	2.9	4.7	6.8	6.2	1.5	1.4	1.4	1.4	1.4	1.4
SDPP	Avg.	7.3	18.6	27.6	33.0	38.0	41.7	42.9	45.2	46.9	48.5	50.2	50.6	51.0	52.1
	Std.	1.7	1.6	2.9	3.4	2.7	2.5	3.1	4.2	4.1	4.2	4.2	3.8	3.8	4.6
ISDPP	Avg.	60.2	71.3	74.0	76.7	78.5	80.9	82.5	84.3	86.2	86.5	86.5	86.5	86.5	86.5
	Std.	1.9	2.5	2.7	2.7	3.0	2.5	2.5	2.4	1.7	1.8	1.8	1.8	1.8	1.8

Table 5. Recognition accuracy (%) vs. number of projected vectors of the proposed ISDPP together with another algorithms on the AR database with a sample of 4 images per subject for training.

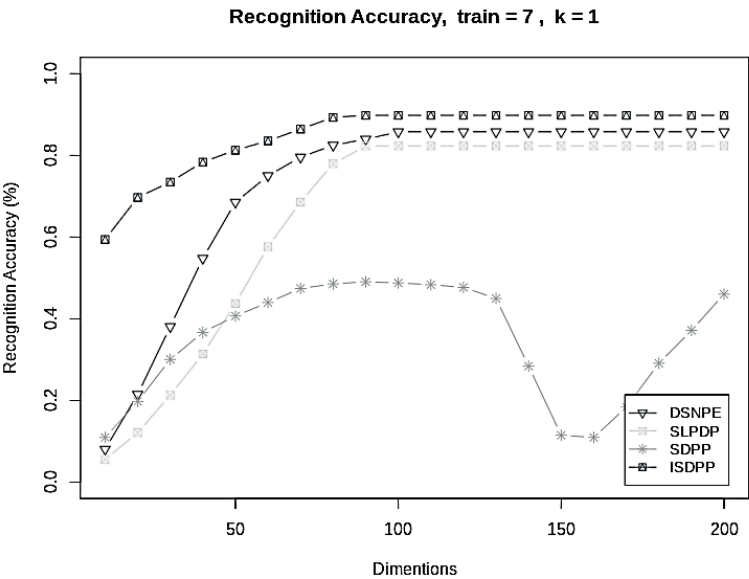


Figure 10. Recognition accuracy (%) vs. number of projected vectors of the proposed ISDPP together with another algorithms on the AR database with a sample of 7 images per subject for training.

4.3 Experiments on the ISDPP - results

In these experimental runs we register a clear advantage of the ISDPP algorithm over the comparison ones. In addition, the maximal recognition accuracy of the ISDPP is reached faster or, in the worst case, together with the maximal RA of the other models and with the minimal average standard deviation in the half of the cases. The significance of the results is further increased by considering the circumstance of the sizable artificial occlusion of the training data.

Method/ Dim.	Avg/ Std.	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
DSNPE	Avg.	8.1	21.5	38.1	54.8	68.5	75.0	79.6	82.5	84.0	85.8	85.8	85.8	85.8	85.8	85.8
	Std.	0.7	1.9	1.4	1.9	2.7	2.4	2.0	1.9	1.0	0.9	0.9	0.9	0.9	0.9	0.9
SLPDP	Avg.	5.6	12.1	21.3	31.4	43.7	57.7	68.6	78.0	82.3	82.3	82.3	82.3	82.3	82.3	82.3
	Std.	1.0	1.0	1.9	1.9	3.3	0.6	1.3	1.5	0.8	0.8	0.8	0.8	0.8	0.8	0.8
SDPP	Avg.	10.9	19.8	30.1	36.7	40.7	44.0	47.4	48.5	49.1	48.8	48.3	47.7	45.0	28.4	11.5
	Std.	1.5	3.0	4.2	4.1	2.4	3.1	2.9	2.7	3.1	2.6	2.9	2.9	1.7	12.0	6.0
ISDPP	Avg.	59.4	69.7	73.5	78.4	81.3	83.6	86.5	89.3	89.8	89.8	89.8	89.8	89.8	89.8	89.8
	Std.	1.4	1.8	2.0	2.0	2.1	1.7	1.1	1.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 6. Recognition accuracy (%) vs. number of projected vectors of the proposed ISDPP together with another algorithms on the AR database with a sample of 7 images per subject for training.

5. Conclusion and further work

In this paper we propose a new subspace learning algorithm, called Inverted Sparse Discriminant Preserving Projection (ISDPP). ISDPP borrows the conceptional idea of SDPP and likewise combines a supervised sparse representation (SR) with the Fisher's criterion. Prior to the ISDPP construction, we argue the way a supervised SR may be constructed and assume that the contribution of a discriminant information of the between-the-classes SR could exceed the intra-class one. As it is difficult for one to define the effect of a component of a model in the productivity effectiveness of the assembled algorithm it is part of, we decided to compare separately the classification performance of the SR under the three scenarios when the sparse weight matrix remains unsupervised or is built within- and between-the-classes, respectively. The results on the public images ORL database in this preliminary experimental phase support the construction idea of ISDPP. In the following experiments on the ORL and AR database we observe a stable and robust superior recognition accuracy of the new proposed algorithm compared to other well-known successful algorithms like DSNPE, SLPDP and SDPP, that is achieved under the conditions of randomly occluded training data. As our experiments are conducted on well-structured, taken in controlled environment, face images data, the recognition accuracy we observe may have a big gap from a real face recognition application. However, we argue that the proposed method could serve as a useful pattern recognition tool in more complex face recognition strategies applied on images with higher variations and/or such taken in the wild. As a further work, we intend to conduct experiments on face images with higher variations or images from another, various, types.

Acknowledgements

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Digital Transformation of Agencies for Students' Part Time Jobs in the Republic of Croatia

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Abstract

Digital transformation (DT) of agencies for students' part time jobs in the Republic of Croatia (RC) began to be mentioned through the adoption of the Act of student activities (Act). The work of students in the Republic of Croatia is regulated by the Act [1], which provides the legal basis for the DT system of mediation in employment. The Act and the Ordinance oblige the mediator to keep all records in electronic form and define the possibility of issuing student contracts in electronic form, but up to now this form of contract has not been experienced in practice [1], [2]. The distinction between digitization and DT in part led to the fact that the electronic student contract currently implies the issuance of an online student contract, which was not signed by an advanced electronic signature. Changes in business caused by COVID-19 contributed to greater utilization of existing online contracts and pointed to inconsistencies in the work of intermediaries. The aim of this paper is to present, based on a literature review and analysis of the existing situation through the case study, the conceptual model of the DT system for mediation in employment and to test the digital maturity of the current system. The scientific contribution of the paper is in presenting a model that can be implemented in the daily practice of all students employment agencies, while the social contribution is reflected in the attempts of DT public institutions that should be used as an example to the private sector.

Keywords: digital transformation, digitalisation, agencies for students' part time jobs

1. Introduction

Digital transformation (DT) is a term that is increasingly present in the everyday life and work of every individual, whether it is a private or business sphere of life, it is a long-term process, which will never be comprehensive and complete, precisely because DT implies continuous adjustment to new digital tools and technological innovations. Digital transformation must be applied to both business processes and human resources in order to be successfully applied and implemented, with the aim of bringing digital technology closer to users in the best possible way, to obtain the

information and services they want, how and when they want them. Since each individual is an individual for himself, so each business organisation or public institution is specific, so there can be no single DT that will absolutely be the same for all business entities.

The European Commission's (EC) programme, Digital Europe, represents a multiannual financial framework for the period between 2021-2027, in order to ensure a quality instrument, adapted to all and represents a comprehensive response from the EC to the complexity of the DT process. The programme aims to provide funds for the targeted digital transformation of Europe's society and economy, covers five priority areas DT: supercomputing, artificial intelligence, cyber security and trust, advanced digital skills and ensuring the widespread use of digital technologies throughout the economy and society as a whole. According to the EU analysis, DESI of the Digital economy and Society Index in Croatia for 2019 the Republic of Croatia (RH) was only the 21 st out of 29 EU member States. When considering category DT, integration of digital technology within business entities, the Republic of Croatia ranked the 18 th, while in the category of digitisation of public services it ranks the 22 nd [3], [4].

Student work in RC represents a special category of employment and is enabled through the mediation of student services, as institutions that act as separate components within universities and polytechnics and are authorized to mediate in temporary and occasional work of students. The work of students in the Republic of Croatia is regulated by the Act [1], which provides the legal basis for the DT system of mediation in employment. This paper represents a conceptual framework for DT services of mediation in student employment, created as a result of a systematic review of literature and analysis of case studies. After the introduction, we follow the chapter that explains the materials and methods used and the motive and goal of the research itself. After that, the paper presents the results of the literature review through individual research methodologies of the degree of DT, explains the very concept of DT and DT of public administration, and an example of the case study itself and the conclusion.

2. Material and methods

The Web of Science platform was used as the starting point for the systematic review of literature. The keywords used in the search were: "digital transformation, at the title level, in the last 5 calendar years, in the management category. The test resulted in 200 papers (on 24 Jan 2021) and was additionally narrowed down to 47 open access works. The content was extrapolated on the basis of thematic content, the basic inclusion and exclusion criterion was the very topic of scientific work and research area [5]. After collecting and analysing the papers, synthesis [6] results of qualitative research were made and the empirical part was presented, the case study was presented as a proposal of the model DT system for mediating student services, agencies for students' part time jobs in the Republic of Croatia. This case study was made on the basis of an analysis of the existing system and years of experience in working with the same author of the paper.

Literature review and systematisation is the starting feature of every scientific paper because it facilitates the development of theoretical knowledge, indicates areas of high relevance and offers guidelines for future research [7] [8]. Case studies help in analysing existing situations and predicting future trends, in order to understand the research issue more clearly, they use qualitative, quantitative or mixed research methods [20], [21].

2.1. Motives and the aim of research

The author's motivation is to know the existing system of mediation employing students and to point out the need of DT and to adapt the system to new market requirements and modernisation of operations. The aim of this paper is to raise the quality of mediation services, i.e. to answer the question of whether there is a real need for student services (agencies for students' part time jobs) in the Republic of Croatia? The purpose of the paper was to present the case study, but before the case study itself, the literature had to be examined, with the aim of creating a framework of research with regard to comprehensive, non-harmonised and varied literature that includes DT terms. In order to achieve the aim of the research, a theoretical model will be defined based on literature review, and a DT model proposal will be developed for the purpose of presenting the case study.

3. Individual research methodologies, individual methods and tools used to investigate the degree of digital transformation and maturity

To achieve the digital competitiveness, it is first necessary to identify the degree of DT and maturity of an individual business entity. A review of the literature led to some methodologies that detect the degree of digital transformation. Conceptual frameworks for DT and business *model innovation (BMI innovation)*, help to see the broader picture and provide answers to questions about digitalisation, DT and business models and what similarities exist between them [11].

Enterprise's business strategy should ensure that digital transformation is put in the forefront, but without investment in capabilities and human resources, the upgrading of digital skills, knowledge and capabilities cannot provide DT [11], [9], [10]. Business model *CANVAS BMC* consists of nine basic, interconnected, dependent elements that visualise processes in the enterprise: key partners, key activities, key resources, value proposals, customer relations, channels, customer segments, cost structure and revenues. The idea is that each element of the BMC gives its view, which does not necessarily have to be related to other elements, each element has its specific characteristics [8] [9].

The business model presented by P. Gomber to better understand fintech innovation is based on the key elements of several previous frameworks to give a clearer picture of innovation and financial services over the past few years.

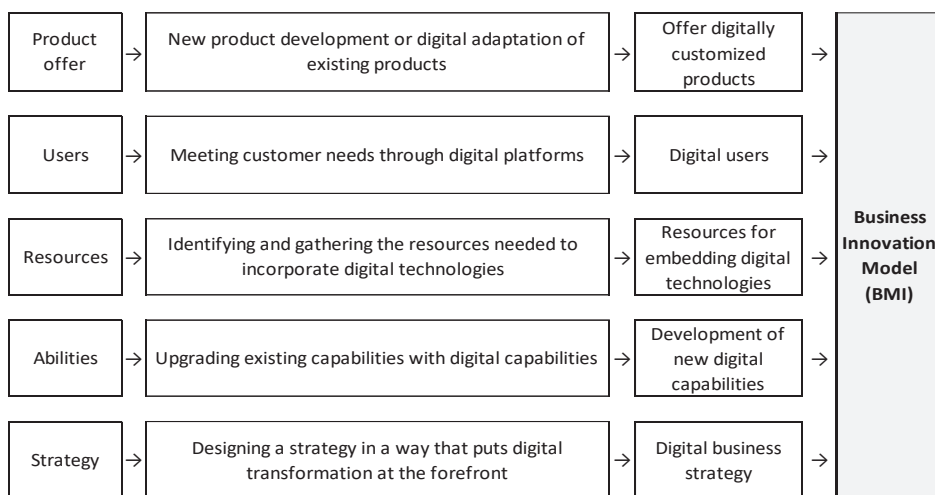


Figure 1. Conceptual framework for digital transformation of business model elements, according to C. Tonder [7]

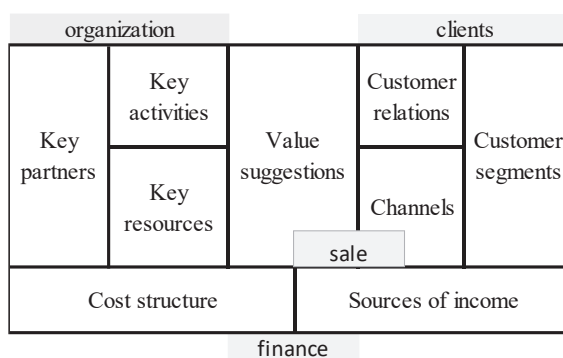


Figure 2. Basic elements of the BMC, according to Osterwalder [8]

The business of financial services always includes a large number of different users, repeated service interactions and the use of state-of-the-art technological developments, and new fintech approaches create new reductions in human involvement on purely transactional aspects, supported by machine intelligence, and human involvement when providing added value to the product or services [10]. Relying on theoretical perspectives, Fredrickson's theory of expansion and construction (2001) and the theory of preserving resources (Hobfoll, 1989, 2001), P. Malik and P. Garg point out that the learning organisation can prove to be an important driver for encouraging positive feelings among employees [11]. Through the Global Bank project, a group of authors studied its impact on organisational changes through the idea of a broken balance [12]. The analysis of digital reporting using XBRL (*extensible business reporting language*) technology, with the aim of digitising traditional reports according to the governing structures, has shown that digital business reporting has significant implications on the rationalisation of business methods in the general administration [13].

Market competition customer experience	Contrasts between the observed Fintech innovations	Client experiences with new financial services	
		Improved experiences with new products, services and functionalities	Complementing the experience with innovations in existing functionalities
	Devastating effects		
	New business models	Blockchain market, initial money supply (ICO), cryptocurrencies, global remittances, FX applications, high frequency trading (HFT), crowdfunding, P2P lending, online brokers, cross-border payments, open banking	Open banking / API, faster payment settlement, increased blockchain efficiency, smart contracts in trade services and crediting, cross-border custody services, e-services addition, payment cards with greater functionality
	New market mechanisms		
	Shared tech infrastructures		
	Disintermediation of banks		
	Segment of-one marketing		
	Cross-border innovations		
	Complementary effects		
	Improved business models	Social trade, digital wallets, commodity advisory services, unlimited banking services, significant data-supported customer trust, personal financial management (PFM), financial research exchange	Investor communities, mobile payments, blockchain-based general ledger functionality, risk management technology, regtech solutions, unlimited account deposits, fintech supported trading
	Additional access from the client		
	Hybrid customer service		
	Common technological infrastructure		
	Open Application Programming Interface (API)		

Figure 3. Fintech innovation review from the point of view: market-competition-customer experience, according to Gomber [10]

SWOT analysis (*strengths - weaknesses - opportunities - threats*), in a simple but sometimes subjective way, gives an overview of internal strengths and weaknesses and external circumstances and threats, is based on the assumption that the basis of any successful strategy, the exploitation of existing strengths and opportunities, and the minimisation of expected weaknesses and threats [14] [15].

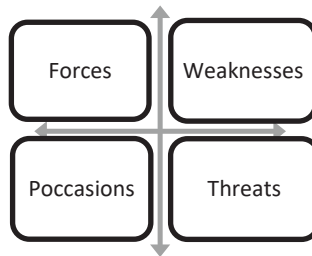


Figure 4. SWOT analysis model according to A. S. Humphrey

The interpretative framework created on the basis of the case study of the international employers shows one of the ways of the DT implementing in order to achieve international competitiveness through the idea offering opportunities for combining and strengthening tradition and innovation, both local and global ones [16].

Apsolon, a regional company based on the collected data from 300 large and medium-sized Croatian companies through the research company, has developed a tool that serves to evaluate or self-evaluate the digital transformation of companies, known as the Croatian Digital Index (HDI) [17].

3.1. The concept of digital transformation

There is no universally accepted definition of digital transformation that would comprehensively define all areas and all transformations that digital transformation (DT) covers. DT also implies that “fundamental new capabilities are created in the business, public administration and in the life of people and society, while digitalisation represents only a 'transition to online business, i.e. the transition from analogue to digital business, but without any changes in kind in the process itself’ [18] [19]. The goal of the DT is to create new values and new opportunities in the future, not simple technological changes that merely try to overcome business shortcomings and correct historical errors. The DT business models include 'networking of all actors in all segments of the value-added chain, application of new technologies, DT requires skills that include both finding and exchanging data, as well as the analysis and conversion of these data into concrete information, in order to increase the success and progress of the company. DT includes enterprises, business models, processes, relationships, products, etc. [20], [7]. These are organisational changes that condition the application and dissemination of digital technology from four different perspectives, namely: technological impact, fragmented adaptations, systematic changes and perspectives and holistic evolution, and DT can be best understood as a continuous change that can be activated and shaped by occasional outbursts, while each incident stimulates a further course of continuous changes [21], the way of modifying and adapting business models, resulting from the dynamic pace of technological advancement and innovation that trigger changes in both social and consumer behaviour [9]. Philosophical approaches view DT as the reflex ability to think differently about a problem in order to identify constraints and provide practical reasoning and challenges of DT society force us to look at a broader picture outside our comfort zone [22]. The term DT implies the combined effects of several different digital innovations that necessarily bring with it new actors, structures, practices, values and measurements that change or complement existing rules within the organisation while implementation requires substantial changes in the business model that typically arise as a result of evaluation of some previous concepts due to technological advancement or innovation. DT implementation platforms are typically enabled through basic technologies such as the Internet, but also social aspects such as networking and social networks. By copying DT to the business model canvas (BMC), it eases the assessment of digital maturity [22], [9], [23].

Digital transformation strategy (DTS) by itself does not constitute a break with the conventions of any pre-planned IS strategy, but only the need to develop a new strategy, since DTS is a very dynamic process that implies the continuous exchange of learning and work cycles [24]. DT transforms both innovation and entrepreneurship, digital technologies not only open up great opportunities for innovators and entrepreneurs, but indirectly affect the increase in value, affects the working habits and health of each individual, contributes to greater use of information and communication technology (ICT), affects performance and management of talents, but also the organisational hierarchy, carries openness, availability and generalisation of information. The conceptual platform enables the connection of problems between different levels, as well as the integration of ideas from different

fields and disciplines [25] [26]. Global standards regarding open science contribute to faster innovation and public services [27]. DT of financial services takes place in four different areas: management of financial services, technological innovation, cryptocurrency, blockchain and cross-border payments [10]. Chantias and associates represent a DT model consisting of 6 phases through change of strategy from the bottom up. Depending on the planned scope of digitisation, the focus level of the business model [24] is also selected [28]. Investments in human resources in order to maintain competitive advantage are inevitable, while at the same time there are certain resistance, organizations that cultivate continuous learning and adaptation to DT have a positive effect on overcoming employee resistance and increasing work engagement, employees who are strongly opposed to DT because they believe in their abilities are even more trying and employing to prove this. It is not enough to focus only on increasing the skills and knowledge of human capital, but also on developing the psychological forces of human resources, it is necessary to invest in learning organisations [11].

In RC, the term DT is still more connected with digital than with the development of new digital models. Despite the optimism of respondents is noticeable when evaluating the state of digitalisation of the Croatian economy as a whole when evaluating the evaluations from the previous period, no significant deviation was observed in responses between large and medium-sized enterprises [17].

3.2. Digital transformation of public administration

Accepted digital technology and information technology (IT) in everyday life of an individual also leads to different convictions of individuals towards IT technology, and these convictions in the long run change employee activities related to it, resulting in a mismatch in IT management. Three basic dimensions of IT management are highlighted: focus, scope and patterns, while the use of IT in the workplace depends greatly on the perception of the user, i.e. employees transfer their personal convictions and experience in working with digital technology in the workplace [12]. The DT of traditional forms of reporting reduces the administrative burden of business entities, but is largely hampered by different laws and regulations of institutional bodies. A group of authors, using a comparative approach to analyse qualitative data from three different countries, which were at the international level leading in transformations between businesses and governments, came to the conclusion that the development of digital reporting is greatly influenced by both international and local factors of each country and every enterprise. Those actors who initially did not consider DT a necessity were nevertheless involved in the processes in response to the concessions offered by the regulatory authorities rather than reacting with proactive action. The government regulators in all the surveyed countries initially had to ensure the availability of effective applications before they could and required the use of digital reporting [13]. The key factors needed in the DT of the public administration are anticipating leadership and investment in human resources. An appropriate strategic choice for the transformation of the public administration is a digital strategy, which

focuses on operational efficiency with user data and on improving the tools for cooperation and exchange of views [29].

The Strategy e-Croatia 2020 is a strategic framework for DT of public services in line with the EU directives which should ensure functionality and interoperability between existing and new ICT systems in the public administration. The interoperability system is not yet functional although it should ensure that all public information systems are connected on the principle of silo into a single system, thus enabling the legal, organisational, technical and all other barriers to be bridged so that all public services and other services can exchange unique information [15]. In RC, the state and society as a whole have a great influence on the DT business sector. The measures required under the HDI for 2020 are the digitalisation of administration (e-services for citizens and legal entities, shared service centres; education digitalisation and the broadband internet [17]. Positive developments are visible. We are dealing with the availability of new e-services for citizens and business entities, we are dealing with the development of new school curricula that contain the essential determinants of digital transformation of education, and the Ministry of sea, transport and infrastructure has launched a Strategy for the broadband internet development. In spite of that regulatory framework and learned behaviour and policies of public institutions are hampering faster implementation of DT public administration in the Republic of Croatia. Smart cities represent a local government issue because it should ensure a better quality and more satisfied life for its citizens, but a targeted focus on citizens' needs is lacking. Most initiatives related to studies of cases of smart cities are still in successful stages of planning, but since these are long-term processes it is necessary to present key stages of progress openly and regularly, the lack of focus on end users, consumers, citizens is highlighted, because there are no measurable indicators of quality of life. Smart cities are present, but in the future these goods and services should focus on the expectations of the citizens themselves [30].

3.3. Guidelines for digital transformation

With its programmes, the European Commission encourages targeted DT of the economy and society as a whole, the digitalisation of business systems is to a lesser or greater extent already present in all business spheres and private lives of individuals, but should also be an integral part of public policy of governments and States. It is also necessary to connect public and non-profit organizations with all other stakeholders on the market, that is, the connection between public policy and economists and the adjustment of all business models towards the end user of our service, towards the customer of our services, towards the citizens if we look from the point of view of the public administration. It is necessary to strengthen the psychological side of the individual, educate the employees and overcome resistance to change, since in human nature, there is a fear of new and unknown, but by educating employees and continuously investing in the organizations they learn, all benefits of DT business are considered in human capital [9] [11].

World Digital Competitiveness scale *World digital Competitiveness ranking* (IMD) on the global level shows progress, it is formed based on research of important

DT factors and determinants: knowledge factor, technology factor and readiness factor for the future. The leading position is the USA, Singapore and Sweden, while the Republic of Croatia ranks 52, which is one place down from the previous year in the total of 63 countries [31]. The digital gap between the EU Member States, which also affects the social and economic progress of the EU as a whole, is linked to the dimensions of national intellectual capital (NIK), and is largely reflected in social capital, knowledge and education and working skills as dimensions of human capital [32].

Looking at DESI index 2020 RH ranks 20th among the 28 EU members in the category of less successful countries. There is no progress compared to the previous year, and it is the weakest results in terms of connectivity and digital public services, which indicates that it is not sufficient to convert individual analogue forms only into digital ones, but that a complete DT of all processes is necessary [4]. The index of digital transformation of the Croatian economy shows that finances, existing business priorities and lack of time to focus DT are the main obstacles that hamper business people in DT, but also that changing the overall corporate governance culture is essential for the success of DT [17]. Without broadband internet and without DT of the entire public administration in the RC, it is not possible to achieve more visible economic growth and progress. Linking Osterwalder's canvas to the business model and R. W. Gregory research, it can be said that the adoption of new patterns of behaviour as a precondition for digital transformation of business processes depends greatly on the perception of the user himself, i.e. that the employee also transfers his personal convictions and experience in working with digital technology to the workplace, and that in this case the approach towards the end user [9] is also applied [12].

Crisis situations force both businessmen and public institutions and governments of States to accelerate the adaptation of their business to new imposed conditions, COVID crisis in a way has forced many public institutions to turn to e-ways of doing business, online education and online teaching have become common ways of education overnight. Many are only now seeing the advantages of such an approach. Unfortunately, the mere digitalisation of certain segments of public services will not yield the expected results in the long if it is not based on the DT of the entire system. According to the recommendations of the European Commission, DESI and the conclusions of Apsolon, a comprehensive curriculum is necessary in RC and its complete and systematic implementation at the national level and investments in the development of ICT experts in order to make use of all available resources offered by the digital economy. The development of new and revised study programmes at Varazdin's Faculty of Organization and Informatics, which are harmonised with the needs of the demanding digital market, is also on the sidelines of these guidelines [4], [17], [33].

Digital platforms for new ideas, technologies and knowledge transfer are drivers and catalysts of the digital transformation of a particular enterprise and society as a whole, because knowledge exchanged and upgraded through digital platforms implies a high degree of interaction between participants, both internally and externally [34]. The human-dominated national intellectual capital has a statistically significant

impact on the country's economic growth rate, significant differences have been identified between the EU Member States regarding NIC and there is a clear division between the north and south of the EU, while the largest resources are intellectual capital in the countries of Northern Europe [32]. It is necessary to adjust public services to both economists and citizens, so that DT can live in practice, as well as to change the entire mental structure of public institutions and accompanying services. The public sector needs to turn to its users, open up and adapt to the digital time in which we live and be the main driver and promoter of changes in society and economy, DT in the private sector cannot be complete without interaction with citizens and the public sector.

4. Digital transformation of student services - agencies for students' part time jobs in the Republic of Croatia, the example of case studies

The purpose of public institutions of student services - agencies for students' part time jobs in the Republic of Croatia is to be an adequate service to their users, that is, students and business subjects who use the services of occasional and temporary student work. Today we can talk only about digitization of these services, although some agencies for students' part time jobs are working fast on the DT of their systems. The crisis caused by COVID-19 prompted the accelerated digitalisation of public administration services and public institutions, thus showing that even relatively three systems of public institutions can be digitised successfully. DT public student services - agencies for students' part time jobs should bring basic new business processes or redesign of the existing ones, conditions and strategies for the implementation of long-awaited and necessary, justified digitisation projects in a way that will contribute to the digital maturity of the system in the long run. Current digital solutions involving the issuance of online student contracts in electronic form may indicate that the system is to a certain extent digitised but not that it is indeed a DT system [9]. The work of students in the Republic of Croatia is regulated by the Act [1], and until its adoption [35], the Directive of regular student employment was in force in 1996 [5]. Student centres act as other components within universities and polytechnics and are also authorised to mediate in the part time jobs of students [6].

Until the adoption of the Act, which formally regulated the possibility of electronic student contract, the student centre Rijeka has had the possibility of issuing an online contract since 2008, and the student centre Varazdin since 2017, and by adopting the Act the electronic contract became a legal obligation of all mediators (all agencies for students' part time jobs). For the purpose of work, it is also necessary to distinguish the concept of an electronic contract defined by the Act from the current possibility of the online issuance of a student contract. For the full application of the electronic student contract, all legal requirements have not been fulfilled yet, i.e. all participants in the tripartite relationship should also have advanced electronic signatures, which is not the case in practice. Although online contracts were expected to completely suppress the issuance of forms at the physical location of intermediaries, this did not happen, and COVID-19 pandemic prompted most of the working-hired students and employers to turn to online issuance of contracts. The survey showed

that employers used the online contract issuing system only to a lesser extent, 60% of them used the system from the date of application of the Act, while 10% of employers accepted the possibility of online contract issuance only with the appearance of the virus corona. Students were slightly better acquainted with the possibilities of online contract issuance, so 19.73% said they had been using the system for years, 47.37% began using online contracts after the application of the new law, while 27.63% sought an alternative to issuing contracts at physical locations only COVID 19. According to the available data from mediators, it is necessary for a longer period of time to root out old habits and for users to accept more modern ways of doing business [36].

Participation in online student contracts				
	Rijeka	Varaždin	Osijek	Zagreb
2015.	26,65%			
2016.	28,68%			
2017.	32,08%	2,37%		
2018.	34,95%	12,63%		
2019.	32,12%	15,71%	18,60%	
2020.	51,53%	35,49%	50,98%	67,00%

Table 1. Participation of online student agreements concluded online from 2015 to 2020 in individual student services in the RC

It is currently possible to speak exclusively about digitization of this system and it is necessary to present a model of the complete DT mediation system of agencies for students' part time jobs.

4.1. Conceptual framework of DT student services - agencies for students' part time jobs

According to the Act, the mediators, in this case they are among agencies who mediate between students and employers and are obliged to keep all electronic databases. The status of a student is proven by insight into electronic data evidences about the students in the Information system of high schools (ISVU) [35], while the contract can also be concluded in the electronic form.

As a public institution, the first amendments to the legal and regulatory framework should lay down the necessary preconditions, although in practice the model itself is relatively simple to implement. There are already building information systems in which the necessary e-databases exist, and the DT system could unify the intermediation of all student services – agencies for students' part time jobs in the Republic of Croatia, thus leading to greater transparency, simplicity, uniformity and cost reduction.

FORCES	WEAKNESSES
Existing legal framework	The system unnecessarily wastes the time of all parties to the tripartite contractual relationship and other financial resources
Existing available electronic database electronic systems	The legal framework does not provide for the possibility of electronic enrollment of students in the databases of users of student services
Possibility of financing academic education, raising the quality of life of the student population	Public e-systems are not electronically connected, information on natural persons or legal entities is not consolidated, it is not interoperable
Acquisition of work habits, responsible behavior towards work	Electronic systems such as the REST API and the ISVU student rights database are dependent on data from higher education institutions
Performing professional practice, gaining work experience	Insufficient awareness of the need for a DT system by the competent public institutions
A system that enables employers to hire a quality workforce without employment, lower costs of hiring temporary workers	Users who do not use the available advanced electronic signature
The legal framework enables the financing of cultural, sports, scientific and educational activities of students	Necessary financial resources for investment in technology and human capital
OCCASIONS	THREATS
Recognition of student work experience as meeting the requirements for the required work experience when entering employment	Neglect of academic obligations due to work during academic education, focus on education funding
Unification of the student labor market, strengthening of competitive advantage, better market coverage	Some users of student services (in the category of crafts, family farms and small entrepreneurs) would be less competitive, due to the lack of (non-use) of advanced electronic signatures
Reduction of costs and necessary resources on the part of all participants in a tripartite contractual relationship	Protection of personal data, GDPR
Uniformity of the system, reduction of the possibility of abuse	Resistance of managers and employees in student services, fear of losing existing job positions within the existing system.
An employment model that could be applied in a wider region of countries that recognize the category of work during academic education	Abolition of the category of student work, due to the impact on the labor market

Figure 5. Overview of the situation through SWOT analysis of student services' - agencies for students' part time jobs operations



Figure 6. Basic model of student enrolment (part time job employees) into student service base – agencies for students' part time jobs

The current student registration performs at the physical locations of student services as the mediator. As a result of COVID 19, there has been a slight shift, which could conditionally be considered as the digitisation of the system, under the notion of digitisation in this case only the sending of documents by email can be considered. There are all technical preconditions for DT of this part of the system: status of student or other person (high school graduate) can be electronically checked in the ISVU database (Information system of high schools in RC) and e-registers (centralised system of the Ministry of science and education that serves for all students' data input. The status of compulsory health insurance in the electronic HZZO database of insured people (Croatian administration of health insurance in RC). In the tax Administration e-database (unique portal of tax administration in RC) it is possible to check whether the person is in employment and whether the owner of the craft or free occupation. In the Police Administration e-database (e-PU) the domicile or residence, while data on a business bank can be requested from the person who wants to join the student service system. In this way, all legal presumptions would be fulfilled, the possibility of possible manipulation and abuse of the system would be reduced, the system simplified and there is no need for the physical contacts.



Figure 7. Basic model for the enrolment of employers (procuring entities) into the student service base - agencies for students' part time jobs

As regards employers (demanders of students' part time jobs), their registration in the user database can be done in a very simple way by linking the system from existing electronic databases: e-tax (tax Administration e-database), e-court registry and e-fina (Financial agency in the state ownership for giving financial and electronic services). Only an electronically signed employer's consent to allow access to data checks in existing registers would be sufficient. There is no need for physical contacts, the need to fill in printed form, authenticate them and send them by e-mail. An insight is gained into employers' business operations and the possibility of preventing business operations with employers who have blocked business accounts would be gained. The mediator - agencies for students' part time jobs and student would also be protected, because the possibility of irrecoverable debts would be reduced to a much smaller extent.

Currently, the student employment contract is published (concluded) either at physical locations or through the individual student service - agencies for students' part time jobs web interfaces in a conditionally stated electronic format.

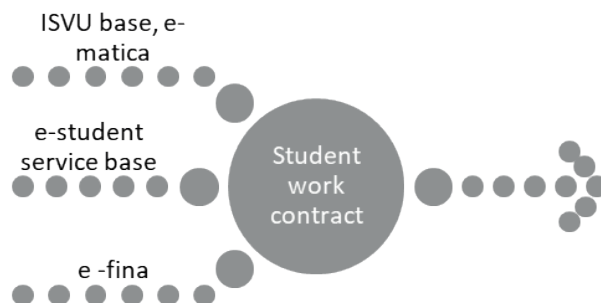


Figure 8. Basic model for the conclusion of the e-contract for the performance of student work

These contracts are only created online, at the service user's place, and they must be printed in a physical form, signed and stamped by all participants in a tripartite contractual relationship, and in a physical form and delivered to mediators - agencies. This online form of student contract is basically a novelty, since 12 student services authorised agencies for students' part time jobs) of the currently registered 14 in the Republic of Croatia started to apply it only by force of the Law [1]. With the appearance of COVID-19 pandemic, this kind of contract prevailed and is currently being used to a greater extent from contracts concluded at the physical locations of mediators. For the contract to be truly electronic, a full DT system is required, i.e. all three sides of a triangular relationship (employers, intermediaries and students) should be users of an advanced electronic signature. The student center as the agencies for students' part time jobs and the client sign the document by qualified electronic signature (application certificate), while the student signs the document by advanced electronic signature.



Figure 9. Basic model of prerequisites for issuing e-invoices based on e-contracts

The contract signed in this way is purely digital, it is harder to misuse, the system would be more functional, practical, rational and cheaper. Such an electronic contract is a prerequisite and completely digitised, i.e. an electronic invoice and consequently an e-archive. The current contradiction of the existing system is that the e-invoice for performing student's part time jobs should be accompanied by a printed copy of the online student contract, which should also be physically verified by a stamp by the employer (contracting entity) and of course signed by the student in other words a part time employee.

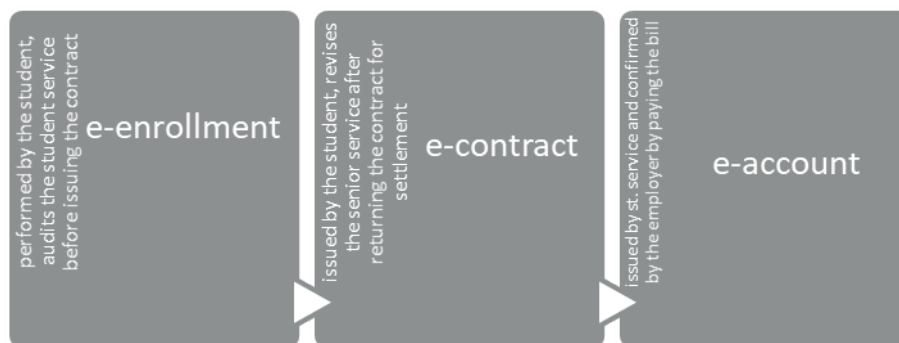


Figure 10. Basic model of digital transformation of the existing system

There is a legal framework, which, with slight changes and upgrades, can enable simple and very useful DT system of agencies for students' part time jobs. Since all registered student centres in which student services (agencies for students' part time jobs in RH) also operate already have an existing information system, and 11 student services use almost identical software solutions for student enrolment and issuing student contracts and related accounts, DT of the existing system would provide a clear and complete picture of mediation in the part time jobs of students and other persons during their academic education.

4.2. Assessment of digital maturity of student services - agencies for students' part time jobs using BMC

Analysis of the existing situation shows that agencies for students' part time jobs as public services that are responsible for performing employment mediation activities during academic and post-academic education of students do not fully follow the central interoperability system.

Through the application of Osterwalder's BMC on the example of agencies for students' part time jobs, and according to the conclusions of Kotarba, conclusions are drawn [8], [9]:

- the updated strategy through the overall application of e-business digitally transforms the entire business,

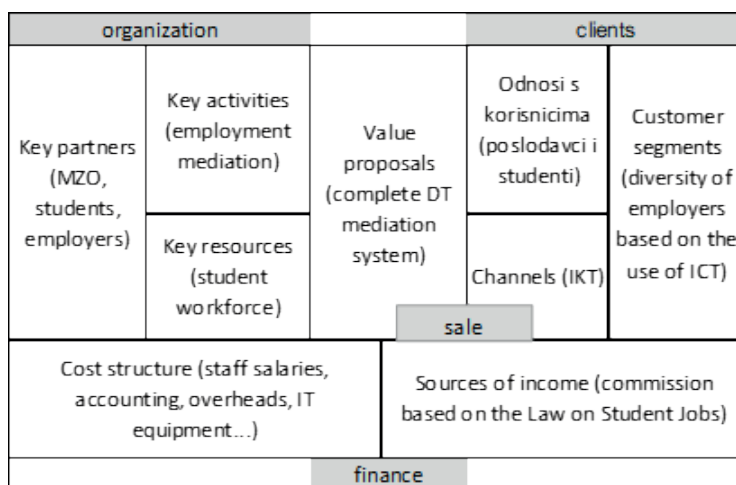


Figure 11. Basic elements of the salary model agencies for students' part time jobs, according to Osterwalder [6]

- the assessment of organisational business models leads to the conclusion that it is necessary to accept the news, make a distance from the usual way of doing business, modernize the existing system,
- changes in business models are the result of: application of the new Act and Ordinance, progress of ICT, harmonisation with client wishes and needs following technological advances, generation of economies of scale (equal opportunities for access to agencies for students' part time jobs to all users),
- all necessary platforms are provided through basic technologies, the internet, e-citizens systems and advanced electronic signatures, but also through social aspects (social networks such as Facebook and Instagram),
- BMC can be used as a reference point for the overall DT of all agencies for students' part time jobs in the Republic of Croatia.

Student services such agencies for students' part time jobs are currently in the phase digitisation thanks to the application of online student contracts and the use of the REST API databases (program interface for access to data and procedures at higher education institutions in the Republic of Croatia), which uniquely defines the student status, it is necessary to harmonize the legal preconditions for targeted DT systems, adjust software packages, invest in technology, target marketing activities to educate users (employers and students) and employees who will work on the implementation itself. Starting point are clients, the emphasis is on how optimally adapt to both students and employers, respecting legal frameworks with targeted application of digital technology and assuming profit maximization. On one hand, we have employers, business buyers, from a wide range of activities and business scope. It is also necessary to adapt to small employers craftsmen who use student services, to be made available and flexible to them, as well as too large business partners and corporations, public institutions and establishments. Until the advanced electronic signature (application certificate) is the employer's legal obligation, the assumption is

that smaller business partners will not use an advanced electronic signature, because at the moment they have a simpler and cheaper contract to sign and certify by physical signature. Students, agencies for students' part time jobs users use advanced electronic signature to a very small extent, although they are provided with an e-ID card. Targeted DT and adjustment of the legal framework for all users of student services should make one option an advanced electronic signature (application certificate) of all participants in the tripartite mediation process and the other option would be the existing version of the online student agreement with scanned signatures of all participants in the process, without insisting on physical signatures and verification of the same documents and physical archiving of paper documents.

5. Conclusion

The digital transformation of the public administration still does not follow the DT of business entities, although public administration and public services should form the basis on which business entities should build the DT of their business processes [12]. The need for DT as a key driver of financial, economic and economic progress has also been recognised by the European Commission and, therefore, a multi-annual financial framework for Digital Europe has been created. Within the framework of its e-Strategy, the Republic of Croatia defines the DT plan which aims to ensure the functioning of the public administration within the framework of tomorrow. The operation of public institutions of student services - agencies for students' part time jobs in the Republic of Croatia, acting as a component of universities and polytechnics requires DT in order to comply with the needs of modern business. Technical and legal presumptions exist, most of the necessary public e-services have already been developed, they only need to be combined, considering all aspects of data security and confidentiality. It is necessary to systematically invest in human resources while investing in ICT, for the DT system to be effective, a competitive advantage can only be maintained by investing in a resilient and engaged workforce, i.e. it is necessary to develop psychological forces of existing human resources [11]. The organisation that learns, which adapts to the transforming environment, always encounters resistance from employees and the environment in which it operates, but precisely these employee resistance stimulates employment and motivation of employees, it is sufficient that one agency for students' part time jobs goes to DT of the entire business, the potential resistance of the remaining thirteen registered agencies for students' part time jobs will be broken, because the greater competitive advantage entails higher revenues. Although these are public institutions, the operations of agencies for students' part time jobs are financed from the basis of the mediation commission, so it is logical to expect that the economic nature of operations, the need to generate higher business revenues in order to cover operating costs and improve the student standard will also contribute to the DT system. The digitally transformed employment mediation system could be applied in other public services, higher education institutions and agencies providing employment mediation services. Restrictions on labour are reflected in the fact that they are public institutions that can base their business exclusively on legal regulations and procedures. The scientific

contribution of the paper is presenting a model that can be implemented in the daily practice of all student employment agencies, while the social contribution is reflected in the attempts of DT public institutions that should be an example to the private sector.

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Hybrid Recommendation Using Temporal Data for Accuracy Improvement in Item Recommendation

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Abstract

Recommender systems have become a vital entity to the business world in form of software tools to make decisions. It estimates the overloaded information and provides the suitable decisions in any kind of business work through online. Especially in the area of e-commerce, recommender systems provide suggestions to users on the items that are likely based upon user's true interest. Collaborative Filtering and Content Based Filtering are the main techniques of recommender systems. Collaborative Filtering is considered to be the best in all domains and always outperforms Content Based filtering. But, both the techniques have some limitations like data sparsity, cold start, gray sheep and scalability issues. To overcome these limitations, Hybrid Recommender Systems are used by combining Collaborative Filtering and Content Based Filtering. This paper proposes such kind of hybrid system by combining Collaborative Filtering and Content Based Filtering using time variance and machine learning algorithm.

Keywords: Recommendation Systems (RS), Collaborative Filtering (CF), Content Based Filtering (CBF), Hybrid Recommender System (HRS, Machine Learning (ML).

1. Introduction

The aim of a Recommender System (RS) is to suggest a meaningful recommendations to maximum number of users on the items they are interested upon [1]. RS is used maximum in E-Commerce sites which offers many number of products to the customers and customers face the challenging of choosing the right product [2]. Existing RS demands the evolution of hybrid techniques which collaborates the best available techniques in order to get the best result [3].

Generally, CF reports the better results than CBF since it directly depends upon the user ratings on the items [4]. Concept of CF is very simple like a user who had similar interest in past will also have similar interest in future [5].

In contrast, content-based filtering techniques rely on item descriptions and generate recommendations from items that are similar to those the target user has liked

in the past, without directly relying on the preferences of other users[6]. CBF could be much more easily understood as users who were interested on particular items with certain attributes will have interest on same kind of items in future [5]. Machine learning algorithm is used for text categorizing in producing the accurate RS in content based book recommendation system[7].

Generally, collaborative systems report a better performance than content-based approaches, but their success relies on the presence of a sufficient number of user ratings [4]. Such systems have the drawback that they suffer from the item cold-start problems which occur when recommendations must be made on the basis of few recorded ratings [5]. These problems arise because the similarity analysis is not accurate enough [8]. In these situations the use of a content-based approach appears as an alternative. Nevertheless, this approach has its own limitations. For example, the keywords used to represent the content of the items might not be very representative. Also, content-based approaches suffer the limitation of making accurate recommendations to users with very few ratings [5]. These limitations can be overcome by combining both the CF and CBF which leads to HRS [6]. In this paper, an algorithm is proposed to overcome the limitations of CF and CBF to provide better recommendations. This is possible by proposing a new framework by combining both the CF and CBF. Here, time variance and a machine learning algorithm are used in the implementation of HRS.

2. Literature Survey

New Bayesian model is proposed to overcome the problem in making the perfect hybrid RS by combining the CBF and CF [4]. Content based collaborative filtering (CCF) is an approach proposed by combining both the similarities by a neighborhood model [9]. Three way aspect model is proposed to consider the rating data, content data and user preferences of web services [10]. Recommender system based on collaborative Filtering (RECF) algorithm is built to explore the similarity between the semantic relations and short item descriptions [11]. Most of the hybrid techniques combine with collaborative filtering with other techniques in a weighted way [5]. Additional stacked de-noising auto encoder (aSDEA) is proposed as a novel deep presentation learning approach to overcome the problems of cold start and data sparsity problems [8]. Influence of visual information in restaurant recommendation system is advocated using CBF and CF by modelling the heterogeneous items in same space [12]. Hybrid CF method for multiple interests and multiple content proved the CF applied simultaneously on user and items performs better than the CF on user and CF on items [13]. A Hybrid content based and item based technique for recommending TV programs is proposed by to eliminate the issues in CF by using matrix factorization technique [14]. Cinema screen recommender agent provides hybrid RS engine to predict the interest of viewers on actors, directors and film genres. CBF lets the data space to include new films in recommendations [15]. iExpand is a novel collaborative-filtering-based recommender system by expanding user interest in the way of personalized ranking [16]. iExpand introduces three layer scheme which

performs more accuracy in ranking recommendations. Fuzzy preference tree-structured is a comprehensive tree matching method, which matches two tree structured data by considering all its information of the properties of the tree [17]. Two categories of hybrid recommendation methods are proposed for restaurant recommendation system. One is by taking visual features and user preferences and another is taking visual features as intermediate to update pocket matrix [12].

3. Proposed Methodology

User profiles and items are the basic infrastructure of the methodology to be proposed. Proposed methodology consists of three phases, i) collaborative filtering with time variant, ii) Content based filtering with winnow algorithm, iii) Combing content based filtering, collaborative filtering and time variance.

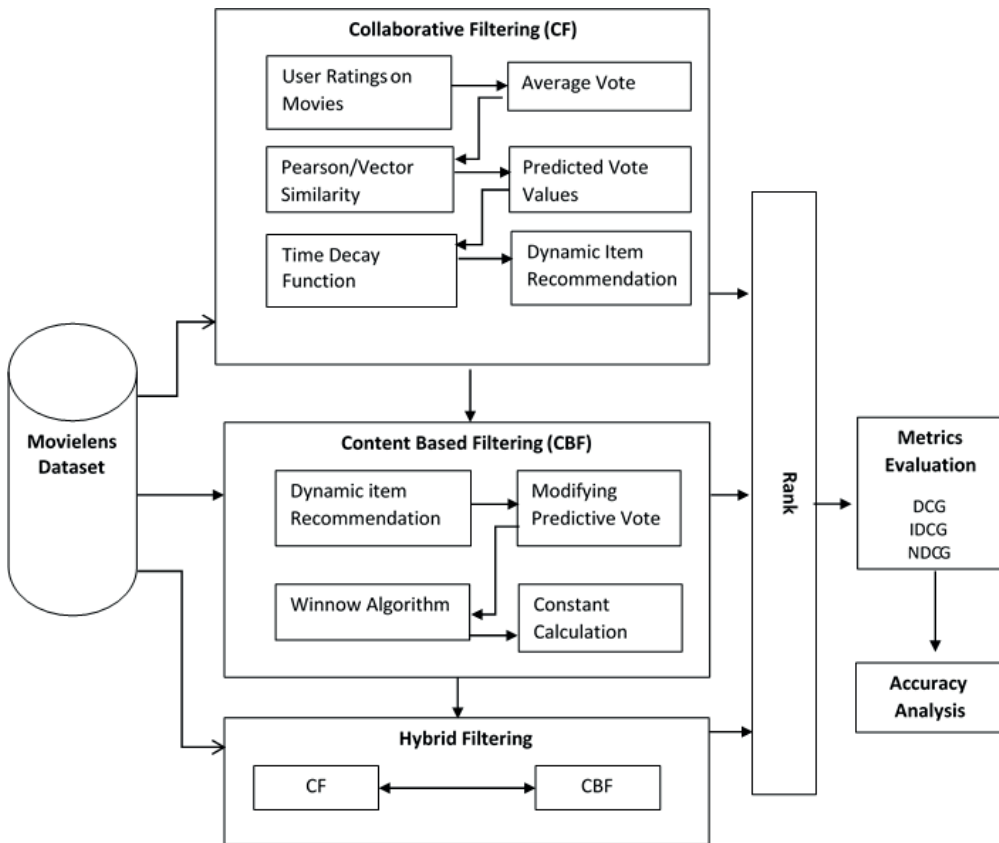


Figure 1. Proposed Approach

i) Collaborative Filtering with Time Variance

Normally, traditional item-based collaborative filtering is performed for item recommendations which never considers the dynamic interest of the user [3]. So, a dynamic item-based collaborative filtering is needed to outperform the traditional item-based collaborative filtering [6]. User profile and item profile are the basic information required to perform this methodology [3]. However, user's interest on different items will be available in user profile [18]. Finding the similarity between the users is the initial job.

RS will prioritize the users which has most similarity with active users. Most similar users will prefer most of the same items [1]. The question is how to find the priority of each user towards active user. Priority weightage is normally calculated using traditional Pearson correlation coefficient technique in collaborative filtering [19].

Though Pearson correlation coefficient is the traditional way to calculate weight of an entity technically, there are many other equations which can be used for the calculation of the similarity between users, one of them being Vector Similarity [20]. Vector similarity is used to measure how similar a content is suitable to the contents selected by a user [21]. Based on the research done, vector similarity outperforms the Pearson Correlation when the number of users is very large to predict the similarity [22].

In the dataset, set of items with their corresponding features information is available [23]. Here, Pearson correlation coefficient is applied to the dataset to find the priority weightage of each items on others and we get $P_{x,y}$. Users predicted vote on all items is derived using vector similarity. Standard method to calculate the weight W and average vote $\bar{\vartheta}_i$ is expanded using vector similarity $w_{a,j}$ and the predicated vote $P_{a,j}$ is derived finally. Once the users vote predicted by applying vector similarity, time delay is set for each and every day by fixing a decay rate λ . Average of the votes are calculated for traditional method without considering the time. So, the time decay λ (item) is incorporated on the average of the votes. By subtracting the normal vote average λ (item) from time decay vote average vote (item), the time variance outperform with the lesser values. So, the latest interest of users on items is recognized in collaborative filtering using time variance [6].

Step 1: The average vote $\bar{\vartheta}_i$ can be calculated for any user i is as

$$\bar{\vartheta}_i = \frac{1}{|C_i|} \sum_{j \in C_i} \vartheta_{i,j}$$

Where C_i is the set of items user i has voted for and $\vartheta_{i,j}$ is the vote of user i over the item j .

Step 2: Weight using vector similarity can be calculated as

$$w_{a,i} = \frac{\sum_{j=1}^m \vartheta_{(a,j)} \left(2^{-\lambda(t-t_{a,j})} \right) \vartheta_{(i,j)} \left(2^{-\lambda(t-t_{i,j})} \right)}{\sqrt{\sum_{j=1}^m \left(\vartheta_{(a,j)} \left(2^{-\lambda(t-t_{a,j})} \right) \right)^2 \sum_{j=1}^m \left(\vartheta_{(i,j)} \left(2^{-\lambda(t-t_{i,j})} \right) \right)^2}}$$

Step 3: The normalizing factor N as

$$N = \frac{1}{\sum_i |sim(a, i)|}$$

Step 4: Augment the vote value with the time variant factor

$$\vartheta_{i,j} = \vartheta_{i,j} * 2^{-\lambda(t-t_{i,j})}$$

Step 5: Time dependent factor will arrive when the average vote appended in equation (1)

$$\bar{\vartheta}_i = \frac{1}{|C_i|} \sum_{j \in C_i} (\vartheta_{i,j} * 2^{-\lambda(t-t_{i,j})})$$

where,

t - Current time stamp

$t_{i,j}$ - Time stamp when the user i voted for the item j .

λ - Decay rate.

Higher the value of λ faster will be the degradation of the vote.

Step 6: The weight calculation by the Pearson correlation co-efficient will be modified as

$$w_{a,i} = \frac{\sum_j \left(\vartheta_{a,j} \left(2^{-\lambda(t-t_{a,j})} \right) - \bar{\vartheta}_a \right) \left(\vartheta_{i,j} \left(2^{-\lambda(t-t_{i,j})} \right) - \bar{\vartheta}_i \right)}{\sqrt{\sum_j \left(\vartheta_{a,j} \left(2^{-\lambda(t-t_{a,j})} \right) - \bar{\vartheta}_a \right)^2 \sum_j \left(\vartheta_{i,j} \left(2^{-\lambda(t-t_{i,j})} \right) - \bar{\vartheta}_i \right)^2}}$$

Step 7: Finally, the predicted vote will also be modified as

$$P_{a,j} = \bar{\vartheta}_a + N \sum_{i=1}^n w_{(a,i)} \left(\left\{ \vartheta_{i,j} * 2^{-\lambda(t-t_{i,j})} \right\} - \bar{\vartheta}_i \right)$$

ii) Content based filtering with winnow algorithm

Based on the past research in content based fileting, the popular algorithms used are Rocchio's Algorithm and Bayesian Classifier [9]. Both the algorithms require pre-specification of number of items used in dataset. Hence, a better option is needed to calculate content based filtering. Here, latest machine learning algorithm called winnow algorithm is able to serve the situation since it is a perceptron algorithm [24] and [1]. It converges quickly as it uses multiplicative scheme instead of additive scheme in weight update. Content based filtering vote is appended with collaborative filtering by multiplying with a constant μ .

$$\sum_{i=1}^n w_i x_i > \theta$$

where θ is the threshold

- i) If the sample is correctly classified and do nothing.
- ii) If the prediction is 1 but result was 0 perform a demotion step (like divide by α)
- ii) If the prediction is 0 but the result was 1 perform a promotion step (like multiply by α)

$$\sum_{i=1}^n w_i x_i = \mu$$

iii) Hybrid Recommender System – combining content based filtering, collaborative filter, and Time Variance

Result of dynamic item-based collaborative filtering with time variance is considered as the initial step at this point. Winnow algorithm is applied on user ratings i.e. votes of users on items derived in collaborative filtering. Based on the observation, the input for winnow algorithm should be either 0s or 1s [25]. So the user votes ϑ are converted to 0s and 1s by elevating 1 to 3.9 as 0s and 4 to 5 as 1s.

The result of winnow CBF $\mu_{a,j}$ is calculated for content based filtering using online conversion tools. Later, the average of winnow is termed as a constant μ . Finally, by multiplying the constant with the winnow result $\mu_{a,j}$ and summing it with collaborative filtering gives the end result. The results of collaborative filtering, content based filtering and combining content based and collaborative filtering are ranked.

$$P_{a,j} = \bar{\vartheta}_a + N \sum_{i=1}^n w_{(a,i)} \left(\left(v_{i,j} * 2^{-\lambda(t-t_{i,j})} \right) - \bar{\vartheta}_i \right) + \mu * w_{a,j}$$

where, μ = constant.

3.1. Algorithm

Input: *ItemSetVector* $IV = \langle i_1, i_2, \dots, i_n \rangle$, *UserVector* = $\{A, B, \dots, P\}$

Output: *ItemRecommendationRanks* $\{R_1, R_2, \dots, R_n\}$

01. For each element j in IV

a. For each active user a in U

i. Augment the rating of an active user “a” over a particular item j as

$$\vartheta_{i,j} = \vartheta_{i,j} * 2^{-\lambda(t-t_{i,j})} \quad (3)$$

- ii. Let the time Augmented Predicted rating of an active user “a” over a particular item j be

$$P_{a,j} = \bar{\vartheta}_a + N \sum_{i=1}^n w_{(a,i)} (\{\vartheta_{i,j}\} - \bar{\vartheta}_i) \quad (1)$$

where (i varies from 1 to n users, j varies from 1 to m items)

$$\bar{\vartheta}_i = \frac{1}{|C_i|} \sum_{j \in C_i} (\vartheta_{i,j} * 2^{-\lambda(t-t_{i,j})}) \quad (2)$$

store it in array v []

- iii. Calculate the similarity weight of an active user over a particular item j using Pearson Similarity method/Vector Similarity as

$$w_{a,i} = \frac{\sum_{j=1}^m \vartheta_{(a,j)} (2^{-\lambda(t-t_{a,j})}) \vartheta_{(i,j)} (2^{-\lambda(t-t_{i,j})})}{\sqrt{\sum_{j=1}^m (\vartheta_{(a,j)} (2^{-\lambda(t-t_{a,j})})^2) \sum_{j=1}^m (\vartheta_{(i,j)} (2^{-\lambda(t-t_{i,j})})^2)}} \quad (4)$$

(OR)

$$w_{a,i} = \frac{\sum_j (\vartheta_{a,j} (2^{-\lambda(t-t_{a,j})}) - \bar{\vartheta}_a) (\vartheta_{i,j} (2^{-\lambda(t-t_{i,j})}) - \bar{\vartheta}_i)}{\sqrt{\sum_j (\vartheta_{a,j} (2^{-\lambda(t-t_{a,j})}) - \bar{\vartheta}_a)^2 \sum_j (\vartheta_{i,j} (2^{-\lambda(t-t_{i,j})}) - \bar{\vartheta}_i)^2}} \quad (5)$$

store it in array w []

- iv. Calculate the normalizing factor N as

$$N = \frac{1}{\sum_i |sim(a,i)|} \quad (6)$$

b. End For

02. End For

03. Call WinnowDriver(w[],v[], n,m,w_output[],v_output[])

04. For each element j in IV

a. For each active user a in U

- i. Recalculate predicted vote as $P(a,j) = P(a,j) + (w_output[j] * \mu)$

$$P_{a,j} = \bar{\vartheta}_a + N \sum_{i=1}^n w_{(a,i)} (\{v_{i,j} * 2^{-\lambda(t-t_{i,j})}\} - \bar{\vartheta}_i) + \mu * w_{a,j} \quad (7)$$

$$\sum_{i=1}^n w_i x_i > \theta \quad (8)$$

$$\sum_{i=1}^n w_i x_i = \mu \quad (9)$$

where μ is the average of w_output[j],

b. End for

05. End For

4. Experiments and results

Movielens dataset ml-20m is used to implement the proposed approach [23]. Dataset consists around 20 million records of ratings, 465564 tag applications across 27278 movies and holds the data of 138493 users, links, tags, relevance, genres and genome scores. Dataset was created by users from January 09, 1955 and March 31, 2015. Timestamp is recorded at the time of user rating an item. That timestamp is one of the promoting element of our approach. Time stamp given in the dataset is in form of seconds whereas, we have converted into years for time decay since the dataset generated across 60 years. Since it is a 20 millions of records, we loaded the entire data in Oracle database in order to fetch the relevant information by writing SQL and PLSQL queries. The main requirement of our approach is sufficient data of the users, movies and ratings. We fixed a condition that, maximum number of items with the ratings of maximum and unique users. In this case, PLSQL queries are called to find out the required data and it’s found that, 16 unique users have given rating for as many of 106 items.

Average of all users ratings are considered to calculate traditional CF by finding the predicted votes of Pearson correlation similarity and vector similarity. Both the similarities are calculated using python code and the values are stored in database. By analyzing the similarities, it is found that the Pearson similarity outperforms the vector similarity. So, we consider only the values of person correlation in the remaining part of the implementation of our approach. Now, the results of traditional CF is obtained and we consider only Pearson results and neglect vector similarity results from this step. Same method is followed for the proposed approach by implementing time decay. The current timestamp and rating time stamp is converted into years and the values obtained is again computed using Pearson similarity and stored in the database. Now, the predicated weights are derived by the average weight obtained from traditional CF and dynamic item based collaborative filtering by using time variance by using the equation (2). The end result of predicted weights by the traditional CF and proposed CF are converted to 0s and 1s as the inputs for winnow algorithm to obtain the results of CBF in equations (8, 9). Winnow algorithm is implemented by using c# code and the predicted weights for CBF is derived. Combining CBF with CF to obtain HF is attained as per the equation (7).HF is also computed for traditional HF and HF with time decay. The results of the proposed approach i.e. ranking of all items are shown in table 1 and figure 2.

Mov ie Id	Rating Rank	CF Ran k	CBF Rank	HF Ran k	Mov ie Id	Rating Rank	CF Ran k	CBF Rank	HF Ran k
1	31	32	1	14	1197	15	17	1	9
10	80	76	3	59	1198	2	7	1	6
19	106	106	4	106	1200	20	15	3	25
32	51	51	1	18	1208	34	54	4	72

34	59	60	3	51	1210	24	52	3	46
39	99	98	4	98	1214	6	8	3	21
47	20	19	1	10	1221	18	31	3	34
50	3	14	1	8	1222	32	37	1	15
110	12	39	1	16	1240	43	24	4	66
150	69	55	3	47	1258	47	59	3	50
153	103	103	4	103	1265	59	63	3	53
165	80	75	4	80	1270	27	6	1	5
208	105	104	4	104	1291	32	40	1	17
231	103	102	4	102	1387	20	16	3	26
253	65	58	3	49	1517	77	64	4	75
260	10	5	1	4	1527	47	56	3	48
296	1	2	1	1	1580	51	25	3	30
316	95	95	4	95	1682	69	50	3	45
318	3	11	3	24	1704	43	65	3	54
344	87	89	3	62	1721	77	79	4	82
356	43	33	3	35	1732	12	4	1	3
364	75	81	4	84	1923	87	80	4	83
367	94	93	4	93	1961	34	57	4	73
377	86	73	3	57	1968	47	23	4	65
380	90	88	4	90	2011	56	41	3	39
457	77	90	3	63	2028	43	72	3	56
480	51	35	3	36	2115	40	42	3	40
500	96	94	4	94	2174	59	25	3	30
527	20	43	3	41	2571	12	12	4	64
541	27	18	3	27	2617	87	86	4	89
586	101	99	4	99	2628	102	105	4	105
588	34	46	3	43	2683	84	71	4	79
589	40	20	1	11	2716	27	29	3	33
590	73	87	3	61	2762	51	78	4	81
592	69	53	4	71	2858	69	83	4	86
593	15	38	4	67	2916	76	49	4	70
595	59	70	4	78	2918	51	60	3	51
597	100	101	4	101	2959	6	1	3	20
608	27	27	1	12	2987	58	34	3	36
648	96	97	4	97	3578	34	48	3	44

733	80	82	4	85	3793	65	77	3	60
736	98	100	4	100	3996	59	47	4	69
780	90	84	4	87	4022	90	96	4	96
858	5	13	1	7	4027	47	66	3	55
924	84	91	4	91	4226	34	28	3	32
1036	24	10	3	23	4306	56	45	4	68
1073	80	85	4	88	4886	65	74	3	58
1089	24	22	3	29	4993	9	30	1	13
1097	34	36	3	38	4995	59	67	4	76
1101	90	92	4	92	5349	73	62	4	74
1136	18	9	3	22	5445	65	69	4	77
1193	10	21	3	28	5952	15	44	3	42
1196	6	3	1	2	7153	40	68	1	19

Table 1. Ranking of movies - Result of proposed approach

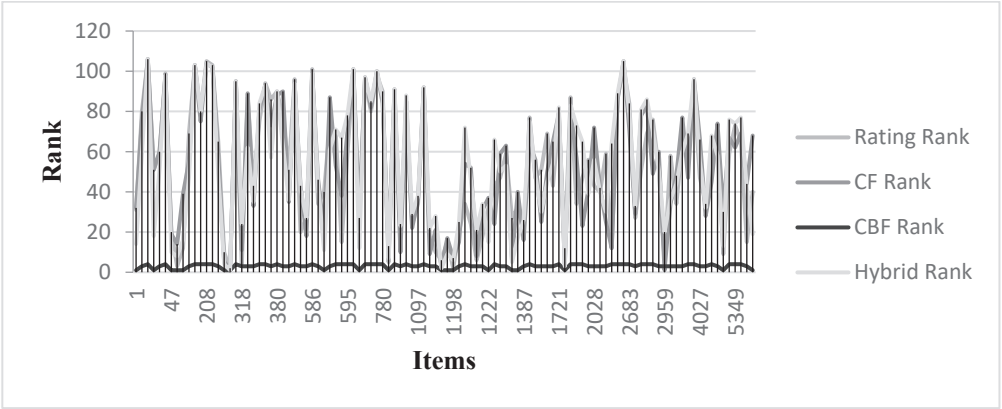


Figure 2. Ranking of movies - Result of proposed approach.

5. Discussion

Main objective of the proposed approach is to rank the items in each filtering techniques. Compare the results of traditional CF, CBF and HF with CF, CBF and HF with time decay and to prove the hybrid approach can recommend the items to the user more efficiently. Table 1 and figure 2 illustrate the ranking of movies with traditional method and proposed approach. Here, for Movie Id 1, the rating rank i.e. the rank of traditional method is 31. Whereas in proposed approach, CF rank is 32, CBF rank is 1 and HF rank is 14. This result explains that the Movie Id 1 has obtained 31st rank in traditional method and 14th rank in proposed approach for the purpose of recommending to the users. Therefore, the Movie Id 1 is elevated due to time decay

implementation and highlighted to the user with priority while recommending. Moreover, in order to prove the accuracy in ranking items, we used the ranking metrics like DCG (Discounted cumulative gain), IDCG (Ideal discounted cumulative gain) and NDCG (Normalized discounted cumulative gain) which are the most efficient metrics used in the area of item ranking. DCG is a weighed sum of the degree of relevancy of the ranked items [26]. Weight is a decreasing function of a position or rank of the item and it is called as discount [26]. IDCG represents the list of relevant items ($|REL|$) in the corpus up to position p [26]. DCG and IDCG rewards good rank that return good answers or the items which come up with maximum gain comparing with other positions [26]. the ranks which NDCG normalizes DCG by IDCG and NDCG always measure in between 0 to 1 and the values which is near to 1 is termed as good in quality of rank [26].

$$DCG_p = \sum_{i=1}^P \frac{rel_i}{\log_2(i+1)}$$

$$IDCG_p = \sum_{i=1}^{|REL|} \frac{2^{rel_i} - 1}{\log_2(i+1)}$$

$$NDCG_p = \frac{DCG_p}{IDCG_p}$$

where,

P - Position of rank

rel_i – Relevancy of ranked items

$|REL|$ - list of relevant items

Therefore, the results are tabulated in order with the ranking metrics and results ensure that the proposed system is accurately recommending the items by ranking the items in all three recommendation techniques. The results of the ranking metrics are showed in table 2, 3, 4 and figures 3, 4, 5 respectively. Here, the accuracy of ranking metrics shown in table 2, 3, 4 is listed with top N movies i.e. Top 10, 20, 50, 70 and 100. The table 2 contains the result of DCG metric of proposed and traditional approaches comparing the techniques. For example in top 100, the DCG-CF, DCG-CBF and DCG-HF are 80.0, 43.15 and 173.21 in proposed approach and the DCG-CF, DCG-CBF and DCG-HF are 78.96, 42.01 and 170.21 in traditional method. The table 3 contains the result of IDCG metric of proposed and traditional approaches comparing the techniques. For example in top 100, the IDCG-CF, IDCG-CBF and IDCG-HF are 84.54, 49.68 and 191.55 in proposed approach and the IDCG-CF, IDCG-CBF and IDCG-HF are 83.98, 47.25 and 189.22 in traditional method. The table 4 contains the result of NDCG metric of proposed and traditional approaches comparing the techniques. For example in top 100, the NDCG-CF, NDCG-CBF and NDCG-HF are 0.94, 0.86 and 0.90 in proposed approach and the NDCG-CF, NDCG-

CBF and NDCG-HF are 0.94, 0.83 and 0.88 in traditional method. Since the NDCG measure from 0 to 1 [26], the result which is near to 1 is observed as the highest cumulative gain. The results of all the metrics used infers that in top N movies (with top 10 to 100 movies), the ranking accuracy in terms of cumulative gain of proposed approach is high comparing to the traditional method.

Based on the results of ranking metrics used (DCG, IDCG and NDCG) in the proposed approach, it is proved that the CF, CBF and HF with time decay outperforms traditional recommending approaches. Moreover, the ranking metrics of proposed and traditional approaches results ensure that the cumulative gain of the ranks is higher in HF comparing to CF and CBF. Also, the cumulative gain of CF is higher than CBF. Hence, the proposed approach also proves the universal myth that the HF outperforms CF, CBF and CF outperforms the CBF.

Proposed Approach				Traditional Method		
TOP N Movies	DCG - CF	DCG - CBF	DCG - HF	DCG - CF	DCG - CBF	DCG - HF
TOP 10	17.06	12.99	45.13	17.11	12.12	43.54
TOP 20	26.11	17.65	64.23	25.78	16.23	63.21
TOP 50	47.89	27.40	107.07	47.17	25.01	105.21
TOP 70	61.89	35.67	138.95	61.12	33.26	135.21
TOP 100	80.0	43.15	173.21	78.96	42.01	170.21

Table 2. Results of DGC ranking metric

Proposed Approach				Traditional Method		
TOP N Movies	IDCG - CF	IDCG - CBF	IDCG - HF	IDCG - CF	IDCG - CBF	IDCG - HF
TOP 10	20.59	18.17	59.58	20.53	18.03	58.24
TOP 20	31.38	27.70	90.50	31.47	26.32	87.25478
TOP 50	55.45	39.42	140.01	55.40	37.90	137.21
TOP 70	68.33	45.01	165.00	68.17	44.015	160.05
TOP 100	84.54	49.68	191.55	83.98	47.25	189.22

Table 3. Results of IDGC ranking metric

Proposed Approach				Traditional Method		
TOP N Movies	NDCG - CF	NDCG - CBF	NDCG - HF	NDCG - CF	NDCG - CBF	NDCG - HF
TOP 10	0.82	0.71	0.75	0.79	0.69	0.71
TOP 20	0.83	0.63	0.70	0.81	0.60	0.68
TOP 50	0.86	0.69	0.76	0.85	0.66	0.73

TOP 70	0.90	0.79	0.84	0.89	0.75	0.82
TOP 100	0.94	0.86	0.90	0.94	0.83	0.88

Table 4. Results of NDGC ranking metric

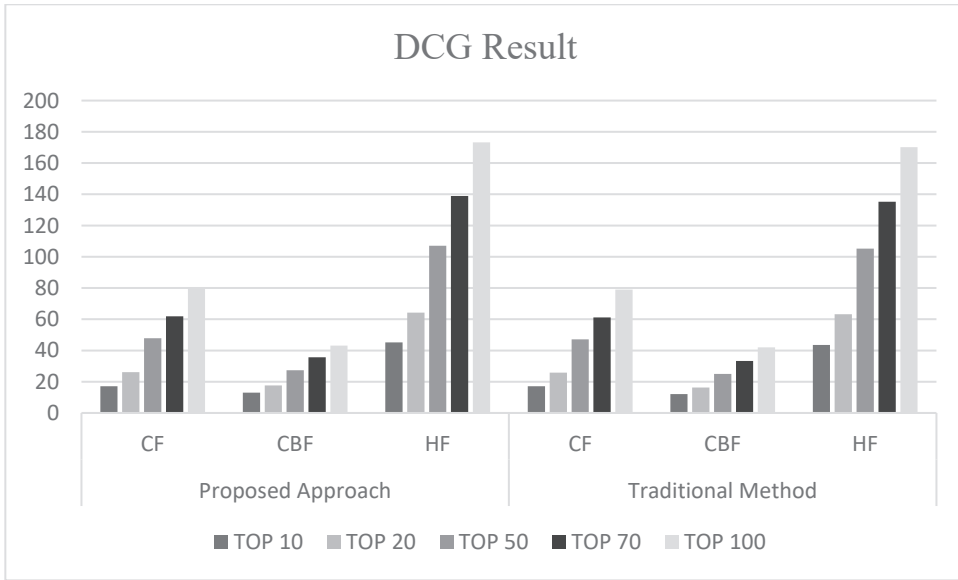


Figure 3. Results of DGC ranking metric

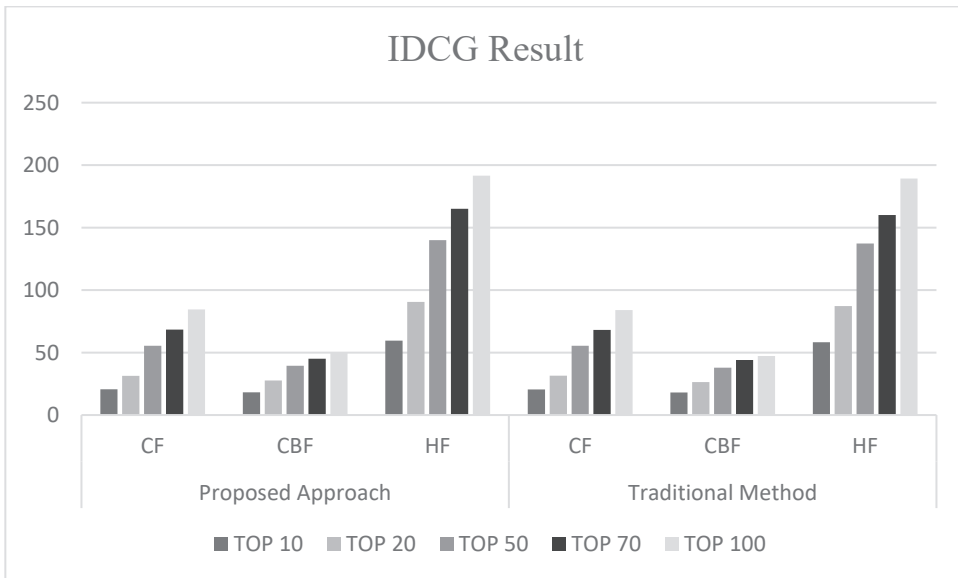


Figure 4. Results of IDGC ranking metric

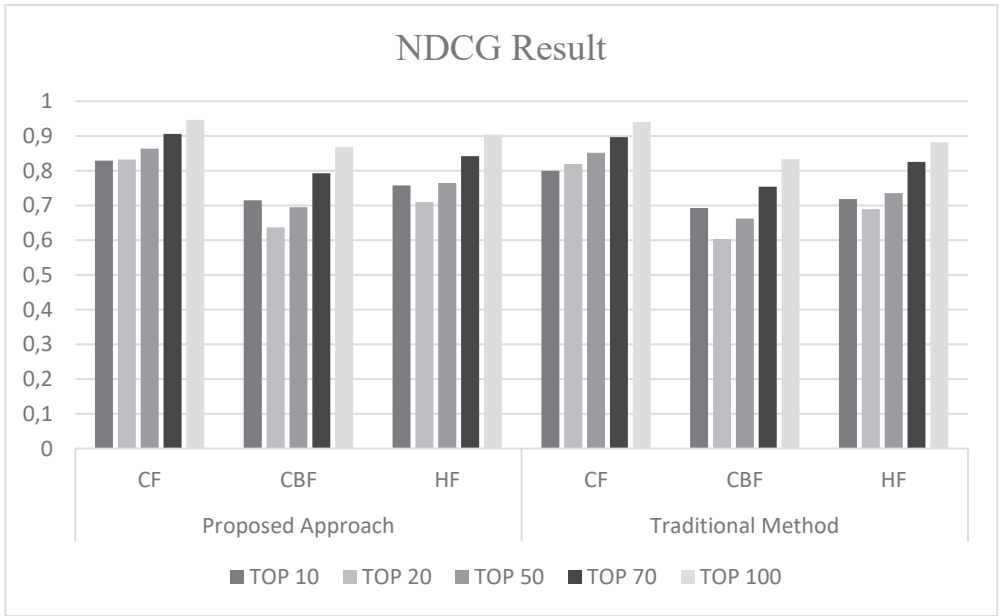


Figure 5. Results of NDGC ranking metric

The results infer that the most of the values satisfies the theory of metrics used. Proposed approach outperforms the traditional approach and HF outperforms CF, CBF and CF outperforms the CBF.

6. Conclusion

Initially, time variant is implemented in traditional collaborative filtering to obtain dynamic item based collaborative filtering. Secondly, machine learning algorithm is implemented in content based filtering. Later, the content based filtering is combined with collaborative filtering to obtain hybrid filtering. When combining the content based and collaborative filtering, the ranks clearly infers that the items rank derived in hybrid filtering by user's ratings computed with person similarity and time variance is either equivalent or higher than the ranks of content based filtering and collaborative filtering. Hence, the proposed algorithm improves the accuracy of item recommendation by combining the collaborative filtering with time variance and content based filtering with winnow algorithm. The accuracy is proved by evaluating the results with the DCG, IDCG and NDCG ranking metrics.

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Differences in Personal Innovativeness in the Domain of Information Technology Among University Students and Teachers

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Abstract

Two online surveys among 1105 university students and 656 employees were conducted with the inclusion of the construct Personal Innovativeness in the domain of Information Technologies (PIIT). After calculating descriptive statistics, statistically significant differences between personal innovativeness of university students and teachers were sought by the application of one-way ANOVA. The first and most important finding was that average perceived PIIT of teachers and students falls around the middle of the seven-point scale, which cannot be regarded as a plausible predictor of upgrading the University as an Innovative Ecosystem. The second was that university teachers scored higher than their students, a situation that could produce an expectancy conflict between those who want to work in an innovative way and those who would prefer study by the book. Teaching assistants, who should belong to the generation of digital natives, are only slightly more innovative than university teachers, who can be regarded as digital immigrants. Assuming that innovativeness can be upgraded by learning, means that efforts should be made by University Management to encourage and support Personal Innovativeness (and other creativities, as well) as a preferred teaching practice.

Keywords: Personal Innovativeness, Information Technologies, University students, University teachers, Online education

1. Introduction

Innovativeness and creativity accompanied by information and digital literacy are recognized by many as paramount factors leading toward solutions to the problems of

modern civilization. Therefore, any society, company and institution that wants to solve problems, create new products, or invent new processes needs a surplus of creative people who think and work creatively and develop a culture of innovation and creativity [1,2,3]. Importance of creativity and innovativeness is well recognized and established as a norm in art, architecture, design, entertainment, and fashion, as examples [4], and new ways of partnership between human and machine creativity are searched [5]. Even if creativity and innovation are named in documents of practically all international organizations oriented toward future [6] operationalization of creativity as an individual and organizational effort is an open-ended challenge [7,8,9].

Nowadays, universities have two major roles. In the first role, universities should be generators of innovations based on creative processes, a demand which calls for highly innovative employees. Their second role is as provider of educated citizens to supplement and replace employees in all sectors, from culture to civil engineering, and be able to infuse innovation into their daily work routines, a role that calls for creative students and employees. Therefore, in an ideal world, universities will be the intellectual playgrounds of communities of teachers and students creating novel ideas, concepts, processes, and products. However, someone cannot just write in a declaration that universities are “Innovative ecosystems” [10]; instead, universities must begin to develop infrastructure, along with the personnel to use it, and develop a culture where it is important to be innovative not only in research but in pedagogy and in the application of innovative pedagogical principles, whether or not through the use of digital technologies.

There exist different views and descriptions of creativity and of innovativeness as a concomitant part. Views from one of the extremes are that creativity is just a manifestation of intelligence [11]. At the other end are opinions about the existence of different kinds of creativity [12,13] and claims that creativity can be taught [14]. For practical reasoning, someone should distinguish between creativity as a personal characteristic or trait and the willingness to adopt an innovative process or tool to be used for solving problems or creating goods [15]. In the words of Ballor and Claar [16] “Creativity can be understood as what human beings do in connection with the fundamental givenness of things. Innovation, on the other hand, can be best understood as a phenomenon related to the historical progress of humankind”.

In recent decades, digital technology has become ubiquitous in such quantity and scope that some authors have tagged those persons born in the digitally rich world as digital natives [17], believing that immersion in digitally rich environments suffices to be able to use it. The concept has been challenged and recognized as an urban myth [18], and on many occasions, it has been shown that intensive use of technology may improve self-efficacy, manipulative skills, and experience, but not, for example, information literacy or the ability to use retrieved information [19]. The connection between general creativity and adoption and adaptation of a specific digital application or program is not well established. On the other hand, studies applying the construct connecting Personal Innovativeness in the domain of Information Technology (PIIT), as defined by [20], are numerous. It is beyond the scope of the

current paper to review these studies, nor the different methods for measuring innovativeness and creativity in all its diversity [21].

2. Theoretical Framework and Hypotheses

The purpose of this paper is to explore differences in PIIT among university students and teachers. The arguments justifying such research are that more innovative students and their educators will apply innovative technology in an earlier adoption phase, which can be regarded as an advance because such pioneers can work as agents of change [15,20].

The researchers [22] continued the effort to explore the nature of influences from personal innovativeness over information systems and technology adoption. They recognized that highly innovative individuals are active seekers of information about new ideas and can cope with high levels of uncertainty and thus develop more positive intentions toward acceptance.

Recent literature regarding the construct PIIT is mainly focused on using it as a construct in the following areas:

- explaining continuance intentions for the usage of Mobile Web 2.0 learning [23];
- readiness for the adoption of Mobile learning [24];
- behavioural intention to use Mobile learning [25];
- behavioural intention, use behaviour and the acceptance of electronic learning systems [15].

However, potential conflicts between teachers and their students regarding the innovative use of information technology could emerge. As described in [26], innovative teachers can encounter innovative students, a situation which can optimally result in fruitful cooperation and high-level intellectual outcomes. In cases where teachers are innovative and expect innovativeness from non-innovative students, such a relation can create stress in both partners. However, students can be forced to learn the use of some cutting-edge technologies. When innovative students meet non-innovative teachers, such teachers can be recognized as boring, a perception which can result in absenteeism and working at the minimum standard with outdated technologies to fulfil the obligations. The situation where non-innovative teachers met non-innovative students is, paradoxically, the situation without conflict; both partners easily negotiate what is necessary for peaceful coexistence because the unexpected as an integral part of innovation is eliminated.

Based on the aims of the study, two research questions were formed:

- Is there a difference between university students and teachers in Personal Innovativeness in adoption of and experimentation with information technology?
- Is there a difference between university teachers and their teaching assistants in Personal Innovativeness in adoption of and experimentation with information technology?

- Differences based on personal and socio-demographic traits and characteristics are without doubt interesting, however, mostly irrelevant for introduction of innovative and creative practices in the educational process based on equality and non-discriminative university standards. Therefore, they were not explored and are not reported.

3. Methodology

3.1. Sampling Procedure

Two different online forms were created for the purpose of the larger studies by the open-source application for web surveys [27] (IKA). The Personal Innovativeness scale formed part of both studies. The link was announced to University teachers through their institutional e-mail. Students were accessed by using a range of access channels, such as social networks and Faculty mailing lists. The instrument was anonymous, and response was considered as consent. An opt-out option was recognized in the fact that no fields were marked as obligatory, and that no participant would be subject to abuse or benefits from responding. After the introductory page giving the reasons for and authorship of the survey, respondents were obliged to tick agreement before entering the survey. According to the University rules, such research does not need the approval of an ethical body, because no sensitive personal data was collected.

3.2. Research Population and Sample

The research population consisted of Slovene-speaking university students and teachers from the University of Maribor, Slovenia (hereinafter students and teachers). The University of Maribor has 19 members (17 faculties, the University Library and the Student Dormitories) and is the second largest and second oldest university in Slovenia. Based on the University of Maribor's annual 2019 program, the total number of students was 13,337 in this year, and the entire population of higher education teachers numbers 598, and higher education associates 316. It is an autonomous, scientific-research and educational institution in the fields of humanities, social sciences, engineering, economics, medicine, natural sciences, law, pedagogical sciences, and the arts.

We received responses about the PIIT construct from 624 employees and 1105 students (Table 1). Out of employee's population 422 (65.7%) declared themselves as university teachers, 152 (24.4) as teaching assistants, and 48 (7.7%) declared as other or data were missing.

	N	Males	Females	Other	Not provided
Teachers	624	332 (49,1%)	298 (45.4%)	4 (0.6%)	4 (0.6%)
Students	1105	197 (17.8%)	773 (66.3%)	2 (0.2%)	173 (15,7%)

Table 1. Gender of the research population.

Given the high response rate, we can accept that the samples are representative for the populations of interest furthermore in all the papers reviewed (see Table 3), the sample population varies from less than 100 to 300. The sample population is limited to the institution or to the users of the service under study. In our study, we included more than 60% of all employed university teachers and teaching assistants and 8% of all students. Therefore, the representativeness of our sample is confirmed.

3.3. Description of the Construct

Agarwal & Prasad [15] define Personal Innovativeness in the domain of information technology (PIIT) as, “the willingness of an individual to try out any new information technology.” The construct was later used in numerous studies, showing appropriate reliability and unidimensionality in different contexts [22,28,29].

Personal innovativeness is recognized by many researchers [30,31,32,33] as an important construct in understanding new information systems and technology diffusion and usage intentions.

The construct in our studies is assembled from three of the four items on the original scale (see Figure 1). The statements can be evaluated on a 7-point format from completely disagree (1) to completely agree (7).

3.4. Statistical Procedures

Statistical analyses follow traditional methods as applied in verifying the differences between groups of persons [34]. Beforehand, all items were checked for missing data and data of them who did not respond to the items of interest were excluded from the calculations. Procedures of descriptive statistics were used for investigating the frequency distribution and calculation of central tendencies (Arithmetic Mean, Standard Deviation, Mode and Median). With the application of Principal Component Analysis, constructs were checked for unidimensionality. Results of KMO and Bartlett's tests show that matrices are appropriate to proceed with PCA. Values of KMO for matrix of student's data is .725 and for teachers .717. Values of Bartlett's test are Chi-square = 1656; $df = 3$; $p < .001$) for matrix of student and Chi-square = 1145; $df = 3$; $p < .001$) for matrix of teachers, respectively. These values are above thresholds as recommended in references [34]. Cronbach's alphas were calculated to assess the reliability of the constructs. As a threshold margin for Cronbach's alphas $> .70$ was set. Statistically significant differences were sought by the application of one-way ANOVA. When two means were compared effect sizes are provided as Cohen's

d for unequal samples interpreted as no effect (< 0.2), small effect (< 0.5), intermediate effect (< 0.8), and large effect (> 0.8) within 95% confidence intervals (CI) [35].

4. Findings

4.1. Figures and Tables

From the results presented in Table 1, it is evident that the means of answers on all items of both groups lie in a range of plus or minus one point around the middle of the scale, which indicates only a mediocre PIIT. However, the tendency is for students to fall below the midpoint, while teachers fall above the midpoint. Being below the midpoint indicates disagreement with a statement showing higher PIIT for teachers, while being above shows agreement with the statement. In terms of effect sizes and according to Cohen's interpretation [35], two effect sizes fall on the border between small and medium, and one in the range of small effect sizes.

	Teachers						Students						Effect sizes	
	N	Mean	SD	Med	Mode	CL	N	Mean	SD	Med	Mode	CL	d	CI
PIIT1 If I heard about new information technology, I would look for ways to experiment with it.	656	4.91	1.72	5	7	.86	1105	4.03	1.79	4	4	.86	0.50	.40 - .60
PIIT2 Among my peers, I am usually the first to try out new information technology.	654	4.26	1.76	4	4	.91	1102	3.44	1.83	3	4	.90	0.51	.41 - .61
PIIT3 I like to experiment with new information technology.	652	4.51	1.86	5	4	.93	1105	3.82	1.91	4	4	.91	0.36	.27 - .45
% of variance	81.2						79.1							
Eigenvalue	2.44						2.37							
Cronbach's alpha	.88						.87							

Note. CI = confidence interval. Confidence Coefficient = 95%. CL = Component loadings. d = Cohen's d

Figure 1. Differences between university teachers and university students in Personal Innovativeness in the Domain of Information Technology.

This allows us to conclude that teachers perceive themselves as more personally innovative in the domain of information technology than students. The differences cannot be taken lightly because many students may perceive tasks and assignments that include innovativeness and creativity as too demanding. On the other hand, one should expect university educators to be recruited among the most innovative part of the population, but it seems that this is generally not the case.

		N	Mean	SD	F	p	Cohen's d
PIIT1	Teachers	424	4.86	1.791	7.905	.005	0.27 CI = 0.08 – 0.46
	Assistants	152	5.32	1.467			
	Total	576	4.98	1.722			
PIIT2	Teachers	422	4.23	1.793	8.897	.003	0.28

	Assistants	152	4.71	1.499			CI = 0.09 – 0.47
	Total	574	4.35	1.732			
PIIT3	Teachers	422	4.43	1.911			
	Assistants	152	5.11	1.488	15.402	> .001	0.38
	Total	574	4.61	1.832			CI = 0.19 – 0.56

Table 2. Differences between teachers and teaching assistants in Personal Innovativeness in the Domain of Information Technology.

Differences between teachers and teaching assistants are statistically significant for all three items (Table 2). It is clear that teaching assistants shows some higher levels of personal innovativeness; however, all effect sizes are in the small range. Based on the test results and calculated effect sizes, we cannot conclude that digital natives, which teaching assistants are supposed to be, are superior in PIIT.

To the best of our knowledge, there is no literature that would allow a comparison between university teachers, teaching assistants and students. There are only a few partial results in studies dealing with a single group (Table 3).

Research	Sample size	Topic	Participants	PIIT 1	PIIT 2	PIIT 3
[22]	388	Adoption of wireless Internet services via mobile technology	MBA students, University of Texas	Mean: 5.11 SD: 1.38	Mean: 4.12 SD: 1.74	Mean: 4.89 SD: 1.67
[36]	66	Acceptance of electronic learning systems	3 rd - and 4 th - year graduate university students Madrid	Mean: 4.81 SD: 1.41	Mean: 5.86 SD: 1.22	/
[37]	292	Mobile learning acceptance	undergraduate students at a Chinese university	Mean: 3.85 SD: 1.32	Mean: 3.57 SD: 1.25	Mean: 3.05 SD: 1.35
[38]	175	Technology acceptance	business professionals enrolled in a part-time MBA program at a comprehensive university.	Mean: 5.46 SD: 1.18	Mean: 4.68 SD: 1.53	Mean: 5.58 SD: 1.27
[39]	121	Resistance to Change and technology acceptance	Students and users of library of a university in northeastern US	Mean: 5.05 SD: 1.30	Mean: 4.09 SD: 1.30	Mean: 4.79 SD: 1.31
[40]	264	Airline passengers' continuance intention towards online check-in services	airline users in China	Mean: 3.55 SD: 0.95	Mean: 3.57 SD: 0.86	Mean: 3.58 SD: 0.87
[41]	301	Intention To Use Wireless Internet Using Mobile Devices	mobile phone users residing in the Klang Valley. Kuala Lumpur	Combined Mean: 3.12 Combined SD: 0.67		

Table 3. Results of studies regarding Personal innovativeness in higher education.

We reviewed 87 papers from the Web of Science containing the keywords Personal Innovativeness and student and 28 papers containing the keywords Personal Innovativeness and higher education. We searched for the construct PIIT and associated data; however, there was a huge lack of information and data in the literature review of results. These are missing either basic statistical data for the constructs or an appendix with the questions used for constructs; therefore, we found only 3 papers where all the data for the construct was accessible (Table 3). The sample population from all reviewed papers comprised university students. If we expand the search outside of higher education, we run into the same problem. It seems that authors usually do not include basic statistical data for the constructs and sometimes do not include an appendix with the questions used for the constructs, however, there are some studies that include both. Comparing our students with the results of other studies, we can see that as a cohort there are higher-positioned postsecondary institutions [22,36,38,39] and some lower-positioned ones [37], however, to obtain definitive answers, an international study with the same inventory should be conducted. We do not have a reference point for university professors and adjunct professors.

5. Conclusion

From the results retrieved, it was possible to draw several conclusions. The first and most important was that the average perceived PIIT for teachers and students falls around the middle of the seven-point scale, which cannot be regarded as a plausible predictor of upgrading the University into an Innovative Ecosystem. The second was that University teachers scored higher than their students, a situation that can produce an expectancy conflict between those who would like to work in an innovative way and those who would prefer studying by the book. There is a difference between university students and teachers in Personal Innovativeness in adoption of and experimentation with information technology, however the effect sizes fall on the border between small and medium.

Teaching assistants, who should logically belong to the generation of digital natives, are only slightly better at PIIT than university teachers, who can be regarded as digital immigrants. The difference between university teachers and their teaching assistants in Personal Innovativeness in adoption of and experimentation with information technology regarding effect size is small.

Based on raw data and lack of reference cut-off points we can only speculate that innovativeness in students and educators follows well known 80/20 Pareto principle [42] as observed in different domains of application of software [43,44,45,46] but not by use of the comparative measurement tools [47], however, we can recognize that innovativeness and creativity are scarce even at the university.

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Declaration of Interest statement

The authors declare that they have no conflict of interest.

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A Complex Adaptive Systems (CAS) Approach to Measuring Organizational Adaptation in Organizations and Investigating its Relationship with R&D Performance

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Abstract

The aim of this paper is to develop a scale for measuring organizational adaptation and investigating its relationship with R&D performance. For this purpose, the items were developed in accordance with the dimensions of organization design, and the scale was tested first in a pilot study, and after making revisions and modifications, it was employed in the main study on two different samples, one for exploratory factor analysis (EFA), and the other for confirmatory factor analysis (CFA). The final scale consists of 17 items categorized under 4 dimensions labeled as contextual factors, tasks and roles, labor and labor division, and rules and regulations. The results indicate that except for rules and regulations, all dimensions of organizational adaptation bear higher values in high R&D performance cluster. The organizations who enforce adaptation in all the other three dimensions yield more innovation which will help them in their decisions regarding their adaptive responses.

Keywords: organizational adaptation, complex adaptive systems perspective, R&D performance

1. Introduction

Today, due to the more dynamic and turbulent environment which is much more demanding than before, the adaptability of the organizations and their people has attracted lots of attention. This adaptation can be viewed from different levels, and accordingly, with appropriate definitions. For instance, the macro level adaptation focuses on socio-economic adaptive responses of a system such as a society, while

¹ This research was part of the author's PhD thesis.

the lowest level is the individual adaptation involving their schemata, the pattern and choice of their actions and behaviors. Despite being at different levels, all the levels are interdependent, and in line with the literature, it can be stated as nested [1]; the macro level is not apart from the individual level, but the accumulation, not necessarily the mathematic accumulation of course.

Adaptive capacity for socio-ecological systems was stated to bear the following components: the first is the capacity to deal with the contingencies in the environment, and the second is the capacity to improve its situation with respect to the environment(s) it is in exchange with [2]. There are few points which are noteworthy here. First of all, a CAS as a kind of open systems can exchange energy and/or information with not just one environment but several, or maybe these environments are nested which in this case the closest one might be called as the immediate environment. Secondly, in the absence of any changes, the system can still makes efforts to improve its situation in the environments, considering it from a CAS standpoint, the improvements occur till the system reaches another equilibrium in the form of a new pattern. This might origin from the activities of various agents found in the system itself, whose decisions and acts influence the decisions and acts of other agents. These improvements are similar to the concept of positive feedbacks in CAS where the signals direct the system towards the continuance of what it has been already doing or to maintain the situation it is currently found in.

Viewing the adaptation in relation with the learning casts light on two important facts associated with learning at individual and organizational levels: first is that what an individual learns in an organization and how he is going to use it for the future purposes is dependent on the position and function he was appointed at in the organization; second, the organizations may become less likely to take high impact risks as the times passes [3]. This highlights the importance of the adaptability of managers namely the managerial adaptability in order for an organization to reach its ideal adaptive capacity. Managerial adaptability was proposed as a multi-dimensional concept consisting of behavioral aspects, cognitive aspects, and socio-economic dimensions [4]. This gains significance whenever a change appears in the system whether it is infused by the environment, or it is originated from the organization, itself, and the response to this change is needed to be decided by the manager. Looking at this issue from a CAS viewpoint can relate the decision maker concept to the notion of agents in systems where an agent can decide on their activities interdependently with other agents, although they are independent, having freedom in the selection of their own actions, the consequences of their decisions change the contexts for the other agents, making them interdependent on each other.

Organizational adaptation was previously modeled in terms of where learning take place in an organization; in individuals, in the organizational structural or in both [3]. To clarify it, the organizational level is related to the organizational design where the organizations seek an optimal design for the environment they are located at [3]. Similarly, adaptability was suggested to rest in the relationship between the organization and its environment or to put it differently, the fit which is formed between the internal structure of the organization and the environment which is external to it [5]. Besides, ambidexterity does not only focus on the acceptance of

different processes in an organization, but also subsumes contradictory structures and cultures [6], [7]. Given all mentioned, it can be concluded that the organizational adaptation is found in its design, or to say it in another way, this is the organizational design which undergoes changes in response to the external and/or internal changes.

Considering the scale developed for organizational innovation intensity [8] implies the two possible options facing the organizations regarding their approaches towards innovation, which was pointed at as the degree of innovation in the original article; one is radical which is reached when the organizational innovation intensity scores high [8], and the other is incremental. To move deeper into the descriptions of these two, in the radical approach, some new technologies or processes have come into existence, and in R&D terminology, some kind of innovation has been occurred. Oppositely, the incremental approach touches on extracting the most from the available technologies or processes currently being employed. These are in the similar vein with the two aspects of organizational learning: exploitation and exploration [9], [10] which were used to explain the adaptive capacity of governance systems [11]. As presented in the literature, there should be a balance between exploration and exploitation activities in a system [11] or between its needs to innovate, and produce respectively [9], [12], [13]. This ability of a firm to concentrate on different degrees of innovation, from incremental to radical, “discontinuous” in that article, was named as organizational ambidexterity which was mentioned to be vital for the organization to survive for a long time [14], [7]. To clarify this, the activities at which the innovation in any of its forms take place can be deemed. Based on one of the categorizations found in the literature, innovation can be seen as managerial, process, marketing and product innovations [15]. The critical point here is that due to the vitality of the radical innovation for the survival of an organization, even a small amount of it in any of the aforementioned activities can make difference. To put it differently, for an organization to survive, radical innovation is expected to happen to any extent in any one of the activities. It might be the result behind the survival or even the great success many organizations achieve, those who have never released innovative products; indeed, their innovative marketing ideas have brought them those successes.

In this paper, first, a measure is developed for measuring organizational adaptation in accordance with organization design, and then, factor analyses are run to check the probable factorial structure of the scale, the number of sub-dimensions and the notions they are representative of. Subsequently, the R&D performance in terms of innovation will be measured in the same organizations where the higher score of R&D performance represents more radical innovation than the incremental innovation, and vice versa. At the final stage, the scores for organizational adaptation on different dimensions are compared between low and high R&D performance clusters to see whether high R&D performance is happening more in the adaptive organizations or not.

2. Methodology

2.1. Scale Items

As stated earlier, the dimensions for organization design is used to develop a scale for organizational adaptation. There are two types of organizational dimensions: structural and contextual; structural dimension subsumes formalization, specialization, hierarchy of authority, centralization, professionalism, and personnel ratios; contextual dimension embraces size, organizational technology, goals and strategy, culture, and environment [16], however, environment is not included for the fact that the perspective employed in this study is CAS, viewing the organization as an open system in exchange with its environment, and therefore, taking the environment as a factor apart from the organization design.

Dimensions of an Organization Design	Related Survey Items
Formalization	1. Change in procedures, job descriptions, regulations, and policy manuals 2. Change in written rules 3. Change in formal or informal rules
Specialization	4. Change in the division of tasks into separate jobs 5. Change in the number of the tasks 6. Change in the division of labor
Hierarchy of Authority	7. Change in the hierarchy of authority 8. Change of the immediate supervisor 9. Change in the number of employees reporting to a supervisor
Centralization	10. Change of the decision makers
Professionalism	11. Change in the level of formal education of the employees 12. Change in the level of training of the employees
Personnel Ratios	13. Change of the personnel at different departments 14. Change of the personnel at different tasks (functions)
Size	15. Change in the number of employees
Organizational Technology	16. Change in the tools used for producing products and/or services 17. Change in the techniques used for producing products and/or services 18. Change in the actions used for producing products and/or services

Goals and Strategy	19. Change of the purpose of an organization 20. Change in the competitive techniques of an organization
Culture	21. Change in the values of an organization 22. Change in the understandings and norms shared by the employees

Table 1. Items for the scale of organizational adaptation

2.2. Data Collection

The questionnaires were distributed among R&D experts and managers of the firms located at four of the technoparks in Ankara, Turkey. The sampling method was snowball sampling; the first respondents were the ones with previous acquaintance who then provided referrals to the rest of the participants. Two different samples of 150 were used in the pilot study, and also at the first step of the main study as it is the recommended minimum sample size for the conduction of EFA [17]. CFA in the main study was conducted on a sample of 233, taking 200 as the suggested minimum sample size for performing CFA [18], [17]. The last analysis of the main study, cluster analysis, was conducted on 81 organizations of the same technoparks.

3. Results

3.1. Pilot Study

This scale was developed for the first time and a high value of the Cronbach's alpha (0.919) was obtained. The Bartlett's test was significant (sig. <0.05), and five factors were extracted explaining 68.115% of the variance. . The factor loadings for all the factors exceed the significant level which is 0.450 for the sample size of 150 [19]. Items 5 and 12 will be excluded from the main study because of the cross-loadings. Item 8 is loaded by the first factor which mainly consists of the items related to context, hence, this item will not be also included in the next analysis. The items loaded by the second factor are all associated with labor and labor division except item 16 which will be taken out from the further analysis. In Table 3, the items are represented along with the factors they are loaded by, and the factors were labeled taking their contents into consideration. In addition, Cronbach's alpha scores were depicted in the same table for each of the dimensions, all above 0.70 which indicate high level of internal consistency [20].

Items	Component				
	1	2	3	4	5
1. Change in procedures, job descriptions, regulations, and policy manuals	-.041	-.095	.109	.896	.132
2. Change in written rules	.086	.072	.032	.807	-.017
3. Change in formal or informal rules	-.207	.011	.070	.844	.325

4. Change in the division of tasks into separate jobs	.026	.114	.492	.357	-.317
5. Change in the number of the tasks	-.203	.493	.476	.021	.079
6. Change in the division of labor	-.030	.303	.720	-.030	.063
7. Change in the hierarchy of authority	.136	-.113	.769	.156	-.109
8. Change of the immediate supervisor	.663	.073	.434	-.158	-.161
9. Change in the number of employees reporting to a supervisor	.027	.574	.436	-.220	.151
10. Change of the decision makers	.309	-.069	.465	.225	.036
11. Change in the level of formal education of the employees	.221	.022	-.016	.242	.771
12. Change in the level of training of the employees	.014	.554	-.165	.090	.582
13. Change of the personnel at different departments	-.078	.880	.083	-.042	-.060
14. Change of the personnel at different tasks (functions)	-.117	.784	.181	.043	.073
15. Change in the number of employees	.079	.603	.145	-.039	.153
16. Change in the tools used for producing products and/or services	.393	.521	-.211	.145	.013
17. Change in the techniques used for producing products and/or services	.538	.434	-.165	.064	-.073
18. Change in the actions used for producing products and/or services	.626	.354	-.208	.130	-.155
19. Change of the purpose of an organization	.796	.009	.082	-.068	-.060
20. Change in the competitive techniques of an organization	.776	-.009	.025	-.263	.341
21. Change in the values of an organization	.828	-.160	.028	.009	.291
22. Change in the understandings and norms shared by the employees	.823	-.255	.136	.096	.178

Table 2. Pattern matrix for the pilot study

Items	Factor Number /Dimensions/ Reliability (Cronbach's Alpha)
1. Change in procedures, job descriptions, regulations, and policy manuals	4. Rules and regulations (0.866)
2. Change in written rules	
3. Change in formal or informal rules	
4. Change in the division of tasks into separate jobs	3. Tasks and roles (0.763)
5. Change in the number of the tasks	Excluded from the main study
6. Change in the division of labor	3. Tasks and roles

7. Change in the hierarchy of authority	3. Tasks and roles
8. Change of the immediate supervisor	Excluded from the main study
9. Change in the number of employees reporting to a supervisor	2. Labor and labor division
10. Change of the decision makers	3. Tasks and roles
11. Change in the level of formal education of the employees	5. Professionalism
12. Change in the level of training of the employees	Excluded from the main study
13. Change of the personnel at different departments	2. Labor and labor division (0.829)
14. Change of the personnel at different tasks (functions)	
15. Change in the number of employees	
16. Change in the tools used for producing products and/or services	Excluded from the main study
17. Change in the techniques used for producing products and/or services	1. Contextual Factors (0.865)
18. Change in the actions used for producing products and/or services	
19. Change of the purpose of an organization	
20. Change in the competitive techniques of an organization	
21. Change in the values of an organization	
22. Change in the understandings and norms shared by the employees	

Table 3. Dimensions of organizational adaptation- Pilot study

3.2. Main Study

4 items were omitted after the pilot study, and the main study was done with 18 items. Promax rotation, as a type of oblique rotation, was preferred for the reason that there might be correlations between the factors. Taking a look at Table 4, it can be seen that item 7 is loaded by two factors, raising a cross-loading problem, therefore, it will not be placed in the model. Subsequently, multi-normality test as an assumption for CFA was run, and after diagnosing the non-normality problem of the data, robust maximum likelihood (ML) estimation was used and the results are illustrated in Table 5. To conclude, an 18-item scale was tested, and four dimensions were found labeled as contextual factors, tasks and roles, labor and labor division, and rules and regulations respectively. Besides, Cronbach's alpha was calculated separately for each of the dimensions along with the scale as a whole. Cronbach's alpha for the whole scale was measured as 0.880. Similarly, for the first factor was 0.857, 0.800 for the second factor, and 0.765 and 0.850 for the third, and forth factors respectively.

R&D performance was measured using previously developed organizational innovation intensity scale [8], though the items representing managerial innovation were not included in this study since they might have interfered with the items seeking information on managerial issues in the organizational adaptation scale. After running both EFA and CFA analyses, a two-factor model was resulted of which the items loaded by the first factor asked the respondents about the extent to which innovation occurs in their companies whereas the the second group of items investigates the forms of innovation whether radical or incremental. Similar to the process taken for organizational adaptation scale, before CFA, multi-normality test was conducted, and the data were found to be non-normal. As a result, the robust ML estimation was used and the data are presented in Table 6.

In the last analysis of this research, cluster analysis was performed on 81 organizations based on their scores on their R&D performance. Two clusters were formed, one including 14, and the other consisting of 67 companies. The large cluster bears low score on R&D performance while the small cluster scored high on both factors of the organizational innovation intensity.

Items	Component			
	1	2	3	4
17. Change in the values of an organization	.789	.025	-.103	.083
13. Change in the techniques used for producing products and/or services	.772	-.021	-.012	-.013
18. Change in the understandings and norms shared by the employees	.759	.259	-.164	-.017
15. Change of the purpose of an organization	.755	-.044	.133	-.091
16. Change in the competitive techniques of an organization	.738	-.094	.007	.085
14. Change in the actions used for producing products and/or services	.738	-.131	.098	.096
5. Change in the division of labor	-.054	.886	-.121	.065
6. Change in the hierarchy of authority	.045	.797	-.113	.132
4. Change in the division of tasks into separate jobs	-.183	.690	.040	.292
8. Change of the decision makers	.141	.622	.212	-.168
7. Change in the number of employees reporting to a supervisor	-.008	.476	.470	-.169
10. Change of the personnel at different departments	.035	-.081	.853	.083
11 Change of the personnel at different tasks (functions)	-.014	.142	.811	.014

9. Change in the level of formal education of the employees	-.081	-.153	.655	.252
12. Change in the number of employees	.045	.377	.479	-.150
1. Change in procedures, job descriptions, regulations, and policy manuals	-.023	.144	.000	.858
2. Change in written rules	.113	.103	-.034	.809
3. Change in formal or informal rules	.062	-.097	.285	.740

Table 4. Pattern matrix for the main study

Model	n	χ^2	df	χ^2/df	CFI	AGFI	NFI	RMSEA
Four- factor (Robust ML)	233	243.690	109	2.235	0.840	-	-	0.073

Table 5. Goodness- of- fit-indices for CFA for organizational adaptation scale

Model	n	χ^2	df	χ^2/df	CFI	AGFI	NFI	RMSEA
Two-factor (Robust ML)	233	13.241	6	2.20	0.974	-	-	0.072

Table 6. Goodness- of- fit-indices for CFA for organizational innovation intensity scale

Table 7 contains the means for each of the dimensions of organizational adaptation in clusters with low and high R&D performance.

Dimensions	Low Performer	High Performer
Contextual factors	24.84	25.16
Tasks and roles	21.06	21.53
Labor and labor division	19.23	19.54
Rules and regulations	15.03	14.86

Table 7. Scores on different dimensions of organizational adaptation in the two clusters

4. Discussion

In order for an organization to respond to changes either external or internal, changes needed to be made to the dimension or dimensions of the organization design. Different dimensions of the organization design were investigated to see whether they are scored differently in organizations with low and high R&D performance. High performers reflect their adaptive responses in the contextual factors, tasks and roles, and labor and labor division. In contrary, the results suggest that changes in rules and regulations are not approached by high performers. Since adaptation is desired from a firm for its long term survival and success which is consistent with CAS perspective, the different result for this dimension needed to be illuminated. This can be due to the bias employees have towards the rules and regulation. The employees might be dissatisfied with any kinds of changes in rules and regulation probably because they

perceive it as something against them, or to put in other words, the changes are perceived to not to be in their favor even if they might not be so. The roots can be traced back to the recruitment process of the companies, and when the employees accept the rules and regulations as they were at that time, reluctant to having them modified and altered. That is why high performers select not to take this risk and continue with their old rules and regulations.

5. Conclusion

In this paper, a multi-dimensional scale was developed for organizational adaptation subsuming contextual factors, tasks and roles, labor and labor division, and rules and regulation dimensions. EFA and CFA analyses were performed on two different samples and the fit of the model with the data was controlled. The scores of each of the dimensions were calculated in the companies categorized after the cluster analysis under two clusters of low and high R&D performance. The companies with high R&D scores were found to adapt in any dimensions except rules and regulations. As for rules and regulations, they go under changes more in low performers than the high performers that might be due to the employees' bias towards the changes to them.

The future research can be directed towards the investigation of the relationship between the employees' adaptation as individuals, and organizational adaptation. It will be a multi-level study with nested levels, and will shed light on how the same concepts at individual and organizational levels vary quantitatively. In this manner, there will be a chance to find the factors which play role in the variance between the individual and organizational adaptation, or to be clearer, the factors who lead to changes in the adaptation of an employee as an individual apart from the organization and him/her when working within the organization. Furthermore, the relationship of the organizational adaptation with the other organizational concepts can also be researched in a quantitative way.

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Attitudes of Croatian Consumers About Mobile Messenger Chatbots

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Abstract

This paper aims to investigate Croatian consumers' attitudes about mobile messenger chatbots (MMC) and their propensity to use them. The proposed conceptual model is based on the Technology Acceptance Model (TAM) and Innovation Diffusion Theory (IDT). The research was conducted through an anonymous survey questionnaire available on the social network Facebook. The empirical research results show that perceived usefulness, perceived ease of use, compatibility, and attitude towards mobile advertisements are statistically significantly related to attitude towards mobile messenger chatbots. No negative correlation was found between internet privacy concern and consumer attitudes about mobile messenger chatbots. A positive correlation was found between attitude towards using mobile messenger chatbots and behavioral intention. In addition to the scientific contribution in better predicting chatbots' acceptance as a communication and promotional tool, the research results will also help marketing experts design advertising campaigns via mobile messenger chatbots.

Keywords: TAM model, IDT, mobile messenger chatbots, attitude toward MMC

1. Introduction

Today we are in a time of intensive digitalization in which new technologies (artificial intelligence, virtual and augmented reality, Big data, blockchain, Internet of things, cloud computing, robotics, process automation ...) that permeate all aspects of human

life have been developed and available. In this regard, companies are initiating the process of the digital transformation of their business. The application of new technologies to marketing enables the development of personalized communication with customers leading to higher marketing productivity and customer satisfaction [1]. Krum [2] points out that mobile marketing, as part of digital marketing, represents the marketing of the future precisely because it allows customers to find the product and all the information about it when they need it. Marr [3] also calls the fourth technological revolution the “smart revolution” whose heart is Big data. A significant portion of data or digital traces people leave using their mobile devices. As Krum [2] states, mobile devices represent the most personal technological thing a person has or will have. The mobile device cares about us, it does not borrow, it remembers all our activities and movements, it contains important data, addresses ..., it provides us with the entertainment we want, etc. As such, it is an ideal medium for targeted direct communication and creating relationships with customers. Tong et al. [4] talk about high hyper-context personalized targeting where based on available data (location, time, environment, etc.) relevant content is delivered to the recipient.

Mobile messenger chatbots are emerging as a newer method for communicating with customers, based on the application of artificial intelligence. Chaffey & Chadwick [5] state that “chatbots mimic human intelligence by being able to interpret consumer’s queries and complete orders for them”. The term occurs in different variants so that the names are found in the literature: chatterbots, virtual assistants, virtual agents, intelligent agents, or web-bots [6]. Such interaction with users can take place in text or voice form and are created for various reasons, whether it is entertainment, providing information, developing dialogue, website guide, frequently asked questions (FAQ), virtual support agent, virtual sales agent, survey taker, quiz host, learning tutor, and chat-room [7]. The American Marketing Association states that chatbots are the future of marketing, according to research which claims that almost 90% of innovation-oriented marketing professionals consider innovation and real-time customer engagement as top priorities. In comparison, 67% of millennials said they like to buy brands that use chatbots [8] [9]. A review of existing research has found that mobile messenger chatbots (MMC) as a new form of communication with customers is still not sufficiently analysed in terms of their acceptability.

This paper aims to investigate Croatian consumers' attitudes about MMC and their propensity to use them. The motivation for the implementation of this research is the lack of similar research, primarily because it is a technology that is just beginning to be used significantly. The empirical research was conducted on a sample of 214 persons who correctly filled out the survey questionnaire. Structural Equation Modeling (SEM) using IBM SAS and AMOS statistical tools was used to test research propositions.

Artificial intelligence is not the future; it is already used and makes life easier. MMC is a relatively new marketing tool that will certainly become an essential part of future marketing strategies. The contribution of this paper is to provide knowledge about its acceptance by users that is currently lacking. Knowledge of attitudes regarding the application of MMC as a form of using artificial intelligence in communication with consumers will also contribute to understanding consumer’s

behaviour related to the widespread use of artificial intelligence in interaction with consumers.

The paper consists of 5 units. After the introductory part, an overview of previous research is given, and a research propositions was proposed in the second part. The third part presents the research methodology and results, while discussion and implications are in the fourth part of the paper. The conclusion is formulated in the last fifth part of the paper.

2. Theory and research model development

According to Statista [10] projections, by 2022, there will be 3 billion users of mobile messenger applications worldwide. The reasons for the great popularity of these applications, especially among the younger population, lie in the fact that “they are free, globally available and very easy to use” [14] as well as to serve for “real-time message transmission” [15]. The most popular global mobile messaging apps 2020 are WhatsApp, Facebook Messenger, WeChat, QQ, Telegram, and Snapchat [11]. Due to high prevalence, a large number of users, and fast exchange of information between users, companies turn to communication via popular mobile messenger applications. This popularity and the development of artificial intelligence lead to creating a new form of commercial communication with customers that excludes human customer support. Using messenger chatbot, customers communicate directly with the machine [17] [18]. The use of mobile messenger chatbots (MMC) in promotional/sales communication has just begun, and research that would deal with their acceptance as a form of communication is still lacking [8]. A review of the research studies found that only a few papers explored the attitude towards chatbot technology applied in mobile commerce.

Based on the literature analysis, a conceptual research framework was formed, and research propositions were proposed. (Figure 1)

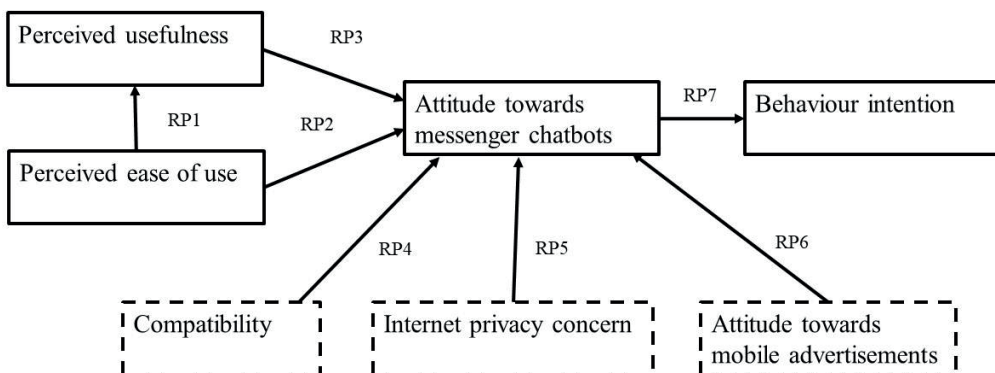


Figure 1. Conceptual model

The proposed conceptual model is based on the Technology Acceptance Model - TAM and Innovation Diffusion Theory DIT. The Technology Acceptance Model is used to determine the intent to use technology by exploring users' attitudes about that technology. The presumption is that the technology will be accepted and used if the attitude about it is more positive. It is the research of attitude that makes this model interesting because it points to the fact that users decide to use an innovation based on making their rational decisions [8]. The model assumes that users' attitudes about technology are influenced by perceived usefulness and perceived ease of use of that technology. A very similar concept of determining the adoption of an innovation is the DIT model, which defines five basic innovation factors that influence the acceptance of an innovation [12]. Subsequent research reduces them to three: relation advantage, compatibility, and complexity [13]. The first two factors are similar to the perceived usefulness and perceived ease of use factors from the TAM model. Complexity is included in the TAM model as a predictor of technology stance bringing the two compatible models together. Within the conceptual model, the impact of internet privacy concern and attitude towards mobile advertising on the attitude about technology is also considered. Research papers that investigate the application of mobile technology in business pay special attention to the risk factor. Within this paper, risk refers to the potential threats to privacy. Mobile messenger chatbots (MMC) are also used in advertising, so it is useful to identify user attitudes about mobile advertising and explore their impact on attitudes about MMC as a new technology/innovation.

2.1. Perceived ease of use (PEOU)

Perceived ease of use as a basic prerequisite for accepting an innovation Davis [14] defines it as “the degree to which a person believes that using a particular system would be free of effort”. According to Al-Hurjan et al. [15], users form a positive attitude about the tools (programs) they use if their use does not require much effort. In the absence of research related to the acceptance of MMC, some studies of the acceptance of mobile advertising and mobile commerce can be useful for this research [16] [17] [18]. The partial justification for this approach lies in the fact that mobile messenger chatbots are part of mobile commerce and mobile advertising. In this regard Mao et al. [19] found the strong impact of perceived ease of use on the acceptance of mobile devices as sales and promotional channels. While Natarajan et al. [20] found the impact of ease of use on the intention to use mobile shopping applications. In the context of MMC Kasilingam [8] especially emphasizes the impact of ease of using MMC on positive attitude and intention to use. Based on a review of previous research, research propositions RP_1 and RP_2 were proposed. The acronym MMC will be used in the continuation of the term mobile messenger chatbots.

RP_1 : Perceived ease of use MMC has a positive influence on the perceived usefulness of MMC.

RP_2 : Perceived ease of use MMC has a positive influence on attitude toward MMC.

2.2. Perceived usefulness (PU)

According to Davis [14], perceived usefulness is “the degree to which a person believes that using a particular system would enhance his or her job performance” [15]. Accordingly, a positive attitude about one of the technologies stems from the perception of its usefulness [21]. If users perceive the technology as useful, they will have a positive attitude about it. Many different studies have proven the direct impact of perceived usefulness on the intention to use some technology or innovation. Several of them also referred to mobile technology and the adoption of various mobile applications [22] [23] [24] [25]. In the context of MMC Kasilingam [8] points out that users attitudes about them will be more positive if they facilitate communication with the company and make the purchase more flexible and pleasant. Based on that observations, the research proposition RP_3 was proposed.

RP_3 : Perceived usefulness of MMC has a positive influence on attitude toward MMC.

2.3. Compatibility (CO)

According to the Innovation Diffusion Theory (DIT) developed by Rogers [12], innovation represents „an idea, practice, or object that is perceived as new by an individual or other unit of adoption“ [26]. According to the same theory, compatibility is one of the essential elements influencing innovation acceptance speed. Rogers defines compatibility as „the degree to which an innovation is perceived as being consistent with the existing values, needs, and past experiences of potential adopters“ [27]. Chen et al. [28] emphasize that greater compatibility contributes to the faster acceptance of innovation. Several studies determine the direct positive impact of compatibility on attitude toward new technology adoption [29] [30] [8]. Mobile messenger chatbots can be viewed as an innovation, i.e., a novelty in the way of buying and selling communication. In this sense, compatibility as an indicator of innovation's response to “potential adopters' values” [29] is viewed as a factor influencing attitudes towards messenger chatbots. According to the determined importance of compatibility in innovation accepting research proposition, RP_4 was proposed.

RP_4 : Compatibility has a positive influence on attitude toward MMC.

2.4. Internet privacy concern (IPC)

Data constitutes and will constitute highly sought-after goods. The high degree of digitization of all human activities allows relatively easy access to data that characterizes an individual, thus raising concerns about their misuse. Studies related to the using of wireless technologies particularly highlights the problem of increased concerns about accessing and using users personal data [31] [32]. The use of mobile devices in shopping (m-commerce) raises the issue of privacy to a higher level as users are „more identifiable, instantly identifiable, and always identifiable“ [33]. The applications that users use on their mobile devices provide several different benefits; however, they also carry high risk [34]. Smartphones contain a range of personal data

and, as such, are a very interesting target for privacy breaches and malicious activities [35]. Mobile messenger chatbots (MMC) are product of artificial intelligence where communication with machine replace human contact and it is to be expected that this kind of communication and data exchange with the machine will negatively affect the acceptance of MMC. Accordingly, research proposition RP_5 was proposed.

RP_5 : Internet privacy concern has a negative influence on attitude toward MMC.

2.5. Attitude towards mobile advertisements (ATMA)

Attitude research is crucial in determining behavior [36] [37] [38]. Farris et al. [39] define the attitude as “a combination of what consumers believe and how strongly they feel about it.” Evaluating something that is the subject of an attitude can range from extremely negative to extremely positive [40]. A few research papers deal with establishing attitudes regarding mobile marketing and mobile advertising [41] [42]. Artificial intelligence enters mobile marketing through chatbots used for the purpose of promotion, sales, and customer services. It is assumed that previous experiences related to mobile advertising will impact the acceptance of MMC as a new form of communication. Accordingly, research proposition RP_6 was proposed.

RP_6 : Attitude towards mobile advertising has a positive influence on attitude toward MMC.

2.6. Attitude towards mobile messenger chatbots (A)

Consistent with the definitions of Davis et al. [20], the attitude about MMC arises from the mental state of the individual, which is manifested through beliefs and emotions towards MMC. In this regard, the attitude can be both positive and negative. According to Rogers [12], the attitude towards innovation is directly related to the prediction of its adoption and use. The TAM model has been integrated into many different studies of the acceptance of different technologies [43]. Authors [10] [44] in their research confirm the importance and influence of the attitude about MMC on predicting their use in the future. Based on the literature analysis for the needs of empirical research, the research proposition RP_7 was proposed.

RP_7 : Attitude toward mobile messenger chatbots has a positive influence on the intention to use.

3. Research methodology

3.1. Research instrument

For empirical research purposes, the measuring instrument used in the Eeuwen [26] research was provided and translated. In accordance with the conceptual framework of the research (Figure 1) and the set variables, the measuring instrument was divided into seven parts, each part containing the corresponding number of questions (Table 1). In addition to the usual variables tested within the TAM model, the influence of

external variables/factors (compatibility, internet privacy concern, and attitude towards mobile advertising) on the attitude towards MMC was also tested. The compatibility factor is taken from the Innovation Diffusion Theory and the other two from previous research related to establishing attitudes regarding mobile and online advertising [45] [46] [47]. A 5-point Likert scale of agreement or disagreement with the proposed statements was used to measure attitudes within the set variables.

3.2. Data

The research was conducted through a survey questionnaire available on the social network Facebook. Two hundred and nineteen (214) correctly filled answers were collected from 148 (69,2%) females and 66 (30,8%) males. Analysing the age of the respondents, it was determined that 129 of them were under the age of 24 (60.3%), 71 were under the age of 27 (33,2%), and 14 were under the age of 36 (6,5%). Based on questions related to mobile devices' use, it was determined that the largest percentage of respondents (33,6%) use a mobile device 2 to 3 hours a day (3 to 4 hours – 27,1%), and 76,6% of them have done at least once in their lives online shopping via mobile devices. Also, the majority of respondents (79,9%) are familiar with the term messenger chatbot, which is a good basis for research.

3.3. Statistical methods

The collected data were analysed using different statistical methods. In order to determine the correctness of the measuring instrument, its validity and reliability were tested. Determining validity looks at the extent to which an instrument measures what it was originally designed for. Construct validity of the research instrument was ensured through the application in theory of a well-known and widely used model of measuring the acceptance of innovation, while content validity is ensured by using literature-defined and research-tested questions (items).

To determine the degree of convergence of items within an individual construct, convergent validity was examined by calculating average variance extracted (AVE) and composite (construct) reliability (CR).

In order to check the uniqueness of the constructs, i.e., to determine their differences in terms of the absence of a large correlation between them, discriminant validity was tested.

The reliability of the measuring instrument was assessed using Cronbach's alpha coefficients, which indicates the items' internal consistency in the measured scale. As the Cronbach's alpha coefficient is considered a conservative measure that underestimates true reliability, it is often used and composite reliability (CR) in measuring internal reliability [37].

The suitability of the proposed research model from the aspect of its matching with empirical data was assessed using fit indices: Chi-square index, Goodness of fit (GIF), Adjusted goodness of fit (AGFI), Incremental fit index (IFI), Normed fit index (NFI), Comparative fit index (CFI) and Root Mean Square Error (RMSEA).

Structural equation modelling was used to examine the relationships between variables and the strength of those relationships, i.e., to verify proposed research propositions.

3.4. Validity analysis

Before running a structural equation modelling measure, the instrument validity and reliability were tested. Convergent validity was examined by calculating average variance extracted (AVE) and composite reliability (CR). Composite reliability was calculated based on factor loadings determined through the implementation of confirmatory factor analysis. The cut off value for AVE is > 0.5 and $CR > 0.6$ [48]. All obtained AVE and CR measurement results are within the cut-off values (Table 1).

Construct	Item	Internal reliability			Convergent validity		Mean	SD
		Cronbach's alpha	Item-total correlation	Factor loading	Composite reliability (CR)	AVE		
Perceived usefulness (PU)	PU1	,855	,869	,793	,894	,576	3,939	0,757
	PU2		,874	,729			4,042	0,752
	PU3		,855	,699			3,393	0,772
	PU4		,853	,695			3,467	0,766
	PU5		,850	,866			3,575	0,851
Perceived ease of use (PEOU)	PEOU1	,890	,788	,859	,823	,746	4,416	0,671
	PEOU2		,741	,779			4,140	0,786
	PEOU3		,843	,945			4,444	0,660
Compatibility (CO)	CO1	,931	,795	,821	,790	,829	3,528	0,932
	CO2		,896	,945			3,042	1,018
	CO3		,893	,959			3,062	1,032
Internet privacy concern (IPC)	IPC1	,944	,874	,906	,819	,850	3,215	1,048
	IPC2		,907	,957			3,084	1,106
	IPC3		,871	,902			3,009	1,096
Attitude towards mobile advertisements (ATMA)	ATMA1	,907	,710	,683	,868	,632	3,654	0,889
	ATMA2		,795	,739			3,294	1,031
	ATMA3		,808	,838			2,850	1,068
	ATMA4		,743	,835			2,505	1,006
	ATMA5		,782	,866			3,280	0,922
Attitude towards messenger chatbots (A)	A1	,861	,639	,762	,865	,576	3,780	0,752
	A2		,730	,702			3,668	0,843
	A3		,721	,737			4,126	0,882
	A4		,747	,830			3,682	0,894
	A5							
Behavioral intention (BI)	BI1	,903	,867	,853	,820	,760	3,463	0,972
	BI2		,877	,834			3,182	1,087
	BI3		,843	,927			3,271	0,940

Table 1. Validity and reliability of the measuring instrument

Discriminate validity was checked, and it was found that there is no large correlation between the constructs, i.e., the constructs show a satisfactory degree of uniqueness [49]. The discriminant validity of the research instrument is shown in Table 2.

Cronbach's alpha coefficient was calculated to determine the research instrument's reliability. The results shown in Table 1 show that all obtained values are above the limit of 0.7, which represents the lower limit of acceptability [50]. The obtained values for composite reliability also show the research instrument's high reliability, which is above the cut-off values. This confirmed the satisfactory internal consistency within each construct (variable).

	PU	PEOU	CO	IPC	ATMA	A	BI
PU	,795						
PEOU	,602	,864					
CO	,699	,475	,909				
IPC	0,08	-0,02	0,08	,921			
ATMA	,458	,283	,563	,255	,795		
A	,749	,623	,664	-0,02	,376	,759	
BI	,751	,517	,731	,164	,692	,741	,872

PU-perceived usefulness, PEOU-perceived ease of use, CO-compatibility, IPC-internet privacy concern, ATMA- consumer's attitude towards mobile advertisement, BI- behavioral intention

Table 2. Discriminant validity

3.5. Estimation of model fit

In order to estimate the adequacy of the research model, i.e., its coincidence with the actual data, confirmatory factor analysis was performed using the statistical tool IBM AMOS 26. Fit indices were used to present the model fit in terms of matching empirical data with the theoretical model. Fit indices with corresponding values and cut-off values are shown in Table 3. Based on the obtained values, a good model fit was determined.

Fit indices	Research Model	Recommended value	Source
Chi-square	616,414; 275, p< 0,001		
χ^2/df	2,242	< 5	[51]
GFI	0,827	>0,8	[52]
AGFI	0,780	>0,8	[52]
IFI	0,925	>0,9	[51]
TLI	0,910	>0,9	[53]
NFI	0,872*	>0,9	[51]
CFI	0,924	>0,9	[54]
RMSEA	0,076	0,03 to 0,08	[55]

* Value of 0.8 <NFI <0.9 is considered acceptable [56], [57]

Table 3. Model fit indices

3.6. Research propositions testing

In the research propositions check, the analysis focused on presenting standard regression weights related to the strength of the influence of independents on the dependent variables (path coefficient) and the determination of the critical ratio with his significant level. The critical ratio cut-off value is >1.96 , while value $p < 0.05$ represents a significant level. Table 4 shows the results of research propositions testing. Perceived ease of use MMC is significantly related to perceived usefulness of MMC ($\beta = 0.609$, $CR = 8,130$, $p < 0.001$). Perceived ease of use is significantly positive related to attitude toward MMC ($\beta = 0.185$, $CR = 2,393$, $p < 0,05$). Perceived usefulness of MMC is significantly related to attitude toward MMC ($\beta = 0.523$, $CR = 5,206$, $p < 0.001$). Compatibility is significantly related to attitude towards MMC ($\beta = 0.376$, $CR = 4,998$ $p < 0.001$). Internet privacy concern is not significantly negatively related to attitude towards MMC ($\beta = -0,004$, $CR = -0,082$, $p > 0,05$). Attitude towards mobile advertising is significantly related to attitude towards MMC ($\beta = 0,301$, $CR = 3,845$, $p < 0.001$). Attitude towards MMC is significantly related to behavioural intention regarding use of MMC ($\beta = 0,864$, $CR = 8,452$, $p < 0.001$). Additionally, the result of the path analysis is shown in Figure 2. The figure shows a low value for the path coefficient $IPC \rightarrow A$ (0.00), which caused rejected the research proposition (RP_5), “Internet privacy concern has a negative influence on attitude towards MMC.”

Research proposition	Independent variable	Dependent variable	β value	CR	P-value	
RP1 (+)	PEOU	PU	0,609	8,130	***	Accept
RP2 (+)	PEOU	A	0,185	2,393	0,017	Accept
RP3 (+)	PU	A	0,523	5,206	***	Accept
RP4 (+)	CO	A	0,376	4,998	***	Accept
RP5 (-)	IPC	A	-0,004	-0,082	0,935	Reject
RP6 (+)	ATMA	A	0,301	3,845	***	Accept
RP7 (+)	A	BI	0,864	8,452	***	Accept

*** $P < 0,001$, PU - Perceived usefulness, PEOU- Perceived ease of use, CO- Compatibility, IPC- Internet privacy concern, ATMA-Attitude towards mobile advertisement, A-Attitude towards messenger chatbots, BI- Behavioral intention, CR-Critical ratio, β - Standardised coefficient

Table 4. Regression weights structural equation model

Squared multiple correlation coefficient (R^2) „indicates the percentage of the variance in the dependent variable that the independent variables explain collectively” [58]. The coefficient is used in practice to measure the goodness-of-fit of the models. The coefficient from Table 5 shows that 37,1% of the variance of the dependent variable „perceived usefulness” was explained by the independent variable “perceived ease of use.”

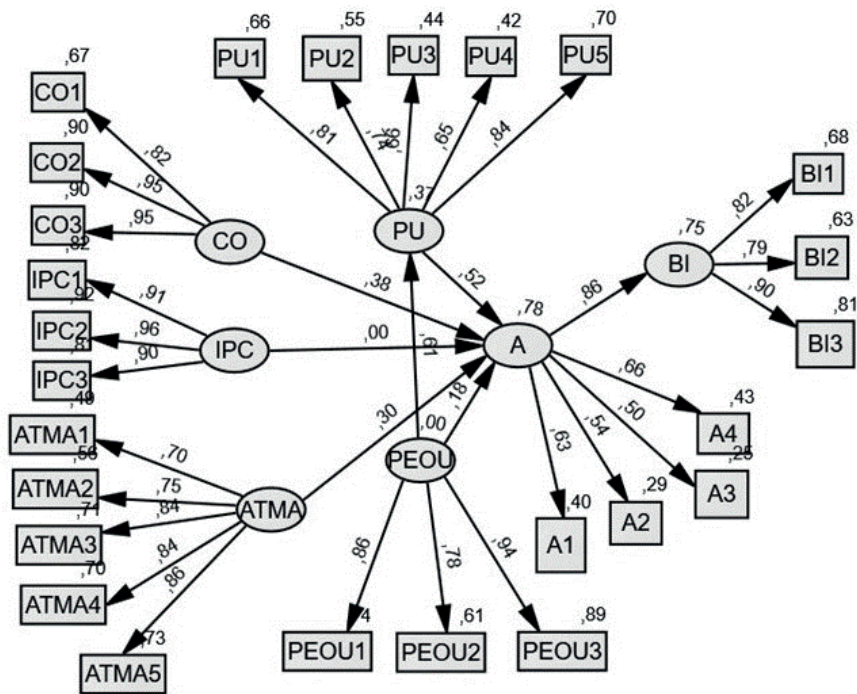


Figure 2. Path diagram

Furthermore, 78,3% of the variance of the second dependent variable, “attitude towards MMC,” was explained by independent variables from the tested model (PEOU, PZ, CO, IPC, and ATMA). Finally, 74,6% of the variance dependent variable “Behavioural intension” was explained by independent variable (A). The obtained values indicate a good fit for the model.

Dependent Variables	Percentage of variance explained (R – squared)
Perceived usefulness	37,1
Attitude towards MMC	78,3
Behavioural intension	74,6

Table 5. Squared multiple correlation coefficient (R²)

4. Discussion and implications

4.1. Comparison with previous research

The increasing use of artificial intelligence leads to the appearance of new innovative solutions in marketing communication. Chatbots represent a good example of using AI in building, maintaining, and developing customer relationships. The creation and

use of chatbots within mobile applications is a recent innovation, and there is still a lack of relevant knowledge about their acceptance by mobile device users. With an intention to explore this area, research was conducted in the Republic of Croatia using the well-known TAM model and Theory of Diffusion of Innovations (DIT). The literature analysis shows that there is a lack of research on the topic of MMC acceptance by mobile device users, which is understandable given that this is a relatively new technological solution. For this reason, the other studies related to the acceptance of different technological solutions (mobile applications) related to using smartphones will also be examined.

The research's conceptual framework is based on the basic TAM model [14], which determines the intention to use through the user's attitude towards MMC based on the perception of their ease of use and their usefulness. Empirical research has found that perceived ease of use of MMC positively affects the perception of their usefulness (RP₁). Two recent papers [8] [44] on the subject have not considered this relationship, while papers related to the acceptance of m-commerce [16], m-payments [17], using mobile apps [18], and m-library [59] confirm the impact of ease of use perception on usefulness perception. The same studies determine the positive effect of these factors on the attitude about new technology (innovation) in accordance with the result of this research in testing research propositions RP₂ and RP₃. Kasilingham, in its research about attitudes towards MMC in mobile shopping, finds the same positive effect with a significance of 0.05 [8]. The mean score in this research for PU ranges from 3.3 to 4.0 and for PEOU from 4.1 to 4.4. The higher percentage of agreement with the claims regarding the chatbot's usefulness can be explained through the rapid development of technology and the great connection between the mobile device and its owner who wants to be connected and make purchases regardless of their physical location and time. The high percentage of agreement with the proposed claims regarding the POEU might be directly related to the age of the respondents (15 to 27 - 99.5%) who, as a rule, do not separate from their smartphones and very easily adopt all technological innovations. As the results show, a high degree of influence of PU ($\beta = 0.523$) on the attitude about MMC is evident.

Compatibility indicates how compatible some technology or innovation is with the activities, attitudes, thoughts, or lifestyle of an individual or future user. In this regard, compatibility was expected to positively affect millennials' attitude about MMC, which the research confirmed. Research proposition RP₄ is accepted. The result is conducted with multiple papers that also determines a strong relationship between credibility and the intention to embrace innovation related to smartphone using [60] [61] [62]. The mean score for compatibility ranges from 3.04 to 3.52; respondents' neutrality can be explained by the relative unknowing or lack of experience in using MMC that are just beginning to be used more significantly. The negative influence of internet privacy concern on the attitude toward MMC has not been determined, and research proposition RP₅ was rejected. The result is inconsistent with researches conducted by Kasilingam [8] and Sony & Tyagi [44] regarding the acceptance of MMC. Kasilingam additionally observes the influence of mediator variables gender, age, and experience and finds no negative effect of IPC on attitude when age is included. The author finds that perceived risk among older users

(> 35) does not have a negative impact on the intention to use a chatbots for shopping. The author deals with the term risk, which, in a broader sense, includes and concerns about privacy. In this context, several studies point to the negative impact of risk on the adoption of new technologies [60] [62]. Respondents are neutral in terms of concerns about data privacy regarding using MMC (mean range up 3.01 to 3.21). The reason for less privacy concern can be found in the fact that using different mobile applications that make life easier and more enjoyable asks for some compensation in the form of sharing of certain personal data. So, despite some concerns, mobile app users agree to share the data with some benefit. Such behavior is presented as the so-called “privacy paradox” [63] [64] [65]. Lee et al. [66] emphasize that such irrational behavior stems from the expected benefit of sharing. According to Multiple research [67], the benefits of communicating with chatbots are 24-hour availability, instant answers, consistent answers, recorded answers, instant transactions, and personalization. Furthermore, research proposition RP_6 was accepted, a positive effect of attitude toward mobile advertising on attitude toward MMC was established. Respondents are generally neutral (mean range up 2.50 to 3.65) regarding their attitude towards mobile advertising. However, they believe that mobile advertising is useful and important for promoting new products.

Research proposition RP_7 was also accepted. A strong positive effect ($\beta = 0.864$) of attitudes about mobile messenger chatbots on behavioural intention was established. Respondents find mobile messenger chatbots interesting and fun and express the intention of their further use and recommendations (mean range up 3.55 to 4.07). The result is consistent with previous research about adoption and intention to using MMC [8] [44].

4.2. Contribution to theory

This research is based on testing a very well-known and exploited TAM model extended by a single predictor from Innovation Diffusion Theory and two predictors from recent research. The research results provide very useful information to scientists and professionals regarding the acceptance of MMC as an innovation in consumer communication based on artificial intelligence. With empirical research, all research propositions were accepted except one (RP_5), thus supporting the proposed model to a large extent. The influence of PU, PEOU, CO, and ATMA on the attitude towards MMC was confirmed. All variables together explain the high 78.3% of the variance in A.

PU has the greatest impact on the attitude towards MMC, which indicates that their practical usefulness significantly contributes to forming a positive attitude. A strong CO to A effect was also found, making respondents feel that MMC is compatible with their lifestyles. The impact of ATMA on A is somewhat smaller but strong enough to indicate how the attitudes about mobile advertising affect the attitude towards MMC. As MMC is also used in promotion, determining that relationship is very useful.

The model also tested the impact of concern (fear) of misuse of data exchanged in communication with the machine (MMC). No significant negative impact of IPC on A was found. Research to date shows that generation Z and generation Millennials generally show some concern about the misuse of private data they share over the internet, but they believe that companies will not misuse that data for the purpose of harming them. The use of various mobile applications is conditioned by providing certain information or consent to use by accepting the installation of so-called cookies. Such everyday communication with companies and the desire to use certain (new) applications or content certainly has the effect of reducing concerns.

Finally, a significant positive effect of the attitude towards MMC on the intention to use MMC has been determined. Attitude towards MMC explain the high 74.6% of variance in BI. The result indicates the presence of a high level of intention to accept and use MMC as a communication and sales tool.

4.3. Research implications

In addition to new knowledge, the research results can be used by marketing and sales professionals in the application and design of a new communication and sales channel. It was found that the attitude about MMC is an important predictor of the use of MMC, and it is significantly influenced by the perception of ease of use and the perception of usefulness. It means that when applying MMC, the focus should be on values that will contribute to satisfaction and the perception of utility. Primarily their availability 24/7, non-stop customer services, providing accurate information, ease of use, saving time for contacting retailers and the purchase itself, giving quick responses, using the nearest store locators, personalized communication, customized offer, customer engagement, and others. Millennials are a generation that has grown with the development of the internet and new technologies, and they cannot imagine their daily lives without using the benefits that these technologies provide. The adoption of MMC also depends on how much they support consumers' current patterns of behaviour (lifestyle) in online communication and shopping. Big data enables collecting and analyzing large amounts of data that reveal patterns of customer behaviour in communication and shopping. These findings are the basis for creating values that will support and build on existing consumer behavior patterns.

Furthermore, the results of the research support the privacy paradox phenomenon, which requires further development of the values offered by mobile messenger chatbots and their harmonization with user expectations. Research shows that millennials' attitude about mobile advertising is neutral (average mean 3.1 on a scale of 1-5). Several different studies about the attitude toward mobile advertising find that millennials perceive mobile ads as irritating and that they want ads to be fun, credible, and informative [68] [69]. Applying Big data makes it possible to provide them with the ads they want and reduce their unwontedness. Some previous studies particularly emphasize mobile ads' personalizations as the most important factor in their effectiveness [70].

5. Conclusion

By applying the TAM model, this paper aimed to predict the acceptance and use of MMC by consumers. The empirical research was conducted on a sample of 214 respondents who belong to the generation of Millennials according to their age. The obtained results confirm the research propositions; the younger population perceives MMC as a useful innovation that will facilitate and speed up their communication with companies and the brand as well as help them make purchases. As such, they are ready to accept and use it in the future. A positive attitude towards MMC has been established, which is significantly influenced by the compatibility of MMC with the previous habits and patterns of behaviour of that generation in the online ecosystem. Given the significant role of MMC as a promotional tool, impact of the attitude towards mobile advertising on attitude towards MMC also explored. The results confirm that this positive relationship exists. Furthermore, it was found that privacy concern is not a factor influencing attitude about MMC and the intention to use them.

A review of previous research found only two studies on the topic of this paper. Both studies confirm that millennials have a positive attitude towards MMC and intend to use them [8] [44]. The authors of these papers identify the negative impact of privacy concern (IPC) on the attitude towards MMC that this paper does not establish. By involving age mediators, Kasilingam finds that there is also no negative impact of IPC on attitude towards MMC. [8] The daily use of mobile applications and internet contents is conditioned by exchanging data, so less concern and greater trust in companies could be predicted.

A chatbot is a child of artificial intelligence that is constantly evolving and getting smarter, thus becoming a very effective tool in personalized communication. As such, they are slowly replacing existing direct marketing channels such as e-mail or e-mail marketing. For this reason, this research can be useful in preparing and conducting direct marketing campaigns and more broadly, in achieving and maintaining a competitive advantage in the market.

This research also has certain limitations. In research, the original TAM model is often extended by certain variables in accordance with the specifics of the considered technologies. This research focused on only three external factors influencing the acceptance of innovation. Although they, together with PU and PEOU, explain 78.3% of the variance of the attitude towards MMC by introducing other influencing factors (for example, perceived enjoyment, trust, price consciousness), the percentage of explanation of variance might be higher. Respondents in the study belong to the millennial generation that is technologically much more educated and experienced than the older population, so the results cannot be generalized. Accordingly, recommendations for further research go in the direction of including an older population who find it more difficult to adopt new technologies and prefer to talk to a live salesperson and a company representative. As MMC and the application of artificial intelligence are in the early stages of implementation, there will be new impacts on their use that need to be recognized and explored over time.

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Digital Divide and E-Inclusion as Challenges of the Information Society – Research Review

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Abstract

The issue of e-Inclusion has become an important topic and increasingly gains significance if one takes into account the global trend of digital transformation in the development of the information society and that the digital divide is still present. The reason more for taking the e-Inclusion of all social groups as a challenge has recently been the Covid-19 pandemic and natural disasters (earthquakes, floods) that change the norms of social behavior, require adaptation and create new rules. Users' ability to use digital services and goods as well as open data provided by public and private organizations which ultimately results in greater access to relevant information as well as improved quality of life and are a key factor for the effectiveness of digital transformation and the economic justification of investing in advanced digital technologies, goods and services. The digital divide manifests itself on certain social groups, which is a social problem. However, despite these initiatives, there are still limitations that prevent certain population groups from becoming e-inclusive members of the information society. This paper presents an overview of the analysis results of the research perspective in which scientific and professional papers consider the concepts of e-Inclusion and digital divide as a challenge. The multiperspectiveness and multidimensionality of the concept of e-Inclusion indicates its significant role in the development of the information society.

Keywords: e-Inclusion, digital divide, digital inequality, information society, open data, empowerment, impact on quality of life

1. Introduction

Development of a global digital society is a common vision shared by all countries, especially in today's pandemic situation caused by the COVID-19 virus, as well as the natural disasters like earthquakes and floods. However, it should be noted that the individual's ability to use digital technology and services, which are the products of digital transformation, whether for personal or business purposes, is critical for creation of information society. Throughout history, societies have been divided into

various social groups or strata that distinguish people's rights and benefits based on a variety of factors such as ethnicity, race, gender, age, and disability. These distinctions are still important in today's digital-based era. Inequality in access to and use of digital technology and the Internet may play a significant role in the emergence of social inequalities.

The "digital divide" is a term used in literature to describe this phenomenon [1], [2], [3], [4], [5], [6], [7]. We may classify digital divide as a special form of social exclusion. Digital divide and social exclusion are complicated concepts, and most scholars in the field do not agree that this divide can be bridged simply by providing computers or connecting people to the Internet. The term "digital divide" was coined in the mid-1990s and was seen as an indicator of inequality in access to ICT and the Internet, as well as an appeal to society to address the problem of inequality [8]. National Telecommunications and Information Administration (NTIA) [9] of the US Department of Commerce in its second study, *Falling Through The Net II: New Data on the Digital Divide*, published in 1998, mention this concept among the first. Telephone and computer penetration rates of low-income groups, minorities, women, and the elderly and other vulnerable groups in society were examined in the survey [9]. Early studies were first to identify digital divide as a result of observed inequalities in accessing technology in the general population [9], [10] and majority of research was focused on technical aspect of access to a computer and the Internet, but also other technological devices such as mobile phones and digital television have been studied [11], [12].

A variety of academic studies have been conducted at the macro and micro level related to the "digital divide" [7], [3], [13], [14]. At the macro level, the key causes of the digital divide, according to Bindé [12], include a country's income, availability of technology and costs of ICT and the Internet, digital literacy education in school systems, etc. At the micro level, research shows that socio-cultural and economic factors such as gender, age, ethnicity, place of residence, income levels, social support, educational background, and others have an impact on "digital divide" [13], [15], [16], [17], [18]. Afterwards, researchers clarified that it refers not only to differences in access, but also to disparities among Internet users in terms of their ability to benefit from their use of technology [6].

Various scholars have established different forms and levels of digital divide over time. According to Molnar [19] (2003), there are three different forms of digital divide:

The access divide, also known as the early digital divide, refers to the disparity between those with and those without access to ICT and the Internet.

2) The usage gap, also known as the main digital divide, focuses on those who have access but do not use it, as well as the distinction between users and non-users.

3) The quality of usage, also known as the secondary digital divide, focuses on the disparities in participation rates among those who have access to and use the internet, as well as the distinctions between various types of users. Dewan and Riggins [11] further characterized the digital divide into three levels. The first level of the digital divide encompasses both hardware and software use. The second level is the disparity in IT capacity, or the ability to use technology. One of the most important

aspects of disparity of use, according to their study, is disparities in computer skill levels. The digital outcome divide is the third level of digital divide, which is caused by the second level digital divide as well as other contextual factors. Van Dijk [4] distinguishes four forms of digital divide:

1) Physical access to ICT and the Internet (have/don't have); 2) Motivational access (want/don't want); 3) Skills access (are able/are not able); 4) Usage access (enough/not enough). Given the numerous studies conducted, it is clear that the digital divide is influenced by a population's socioeconomic status and geographic location and many other factors. This is a complex issue, and some scholars are advocating for solutions focused on new paradigms and multi-dimensional approaches that foster digital opportunity, such as e-Inclusion, as means of bringing people into the digital world [20]. Proponents of e-Inclusion claim that by implementing this approach, which allows development of democracy, mutual understanding, training and education of the economically most disadvantaged groups such as low-income people, the disabled and the unemployed, this gap can close completely or be reduced to a minimum [21]. There are several ways to improve e-Inclusion by ensuring infrastructure, providing skill-building courses, and ensuring social support for those who are not e-included. The motivational access appears to be the most difficult for achieving these goals because it is solely dependent on the will of the individuals.

The pandemic of Covid-19 has pushed society to change its practices and habits by being even more e-included and adopt e-service [22], [23], [24], [25], [26], [27].

Since digital divide and e-Inclusion have been research topics of many authors in the last two decades, they still represent a space for research because the aforementioned problems are multidisciplinary and multidimensional.

2. Background

The terms digital divide and e-Inclusion are mentioned in numerous papers listed in relevant scientific citation databases (Scopus and Web of Science). The authors have selected those that assure the multidisciplinary point of view about causes of digital divide and effects on raising e-Inclusion rate.

According to the Eurostat Glossary [28]:

- **“Digital divide** refers to the distinction between those who have Internet access and are able to make use of new services offered on the World Wide Web, and those who are excluded from these services. At a basic level, the participation of citizens and enterprises in the information society depends on access to information and communication technology (ICT), i.e. the presence of electronic devices, such as computers, and Internet connections...” (https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Digital_divide)
- **“E-inclusion** refers to the situation where everyone in society can participate in the information society. This requires affordable access to technologies, the accessibility and usability of ICT tools and services, and the ability and skills of all individuals to use these tools.” (<https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:E-Inclusion>).

The European Commission confirmed in 2016 in Digital Competence Framework that about 40% of EU population do not have enough digital skills, and 22% do not have it at all. This category includes vulnerable groups such as the elderly population, lower-educated young people, lower-income families and migrants. In addition, around 32% of the workforce lacks sufficiently developed digital skills. As a response to the problems related to ageing of population, the Active Ageing policy has been developed by UN and supported by other relevant world institutions.

At the start of research process, the author considered numerous researches, projects and programs on e-Inclusion of adults, the elderly population, vulnerable social groups (migrants, disabled people, people at risk of poverty), lifelong education of which [39]-[43], [45] are more significant. Components of micro causes represent an integrated measurement model of digital inequality from [32] and are the common denominator for all these researches.

The articles are focused in general to possible aspects of solving reasons of digital divide to increase the degree of e-Inclusion of vulnerable population groups. Mendonc [29] regarded digital divide as a social issue and suggested to measure the inequality by composite index (access, skills, intensity of use and material status). Public policy is a mechanism that has to be used for solving recognized social issues, as well as solving digital divide by building digital skills as a key to combating poverty as Huesing and Selhofer [30] suggest. The communication infrastructure has become necessary to assure solving digital divide so the public administration and corporations whose activities are ICT are responsible to assure the Internet access and, while solving personal skills issues is aimed at the individual and educational institutions as Epstein et al. [31] presented. Yu et al. [32] emphasized that continuity in usage of digital staff and services leads to the desired effects of permanent e-Inclusion and collective awareness of importance of the digital economy and society.

The skills are one of the most needed preconditions for being e-included so the United Nations program and policies focused to lifelong learning and human rights to get the same chances are the base for building the personal capacities [33], [34], [35].

Demographic changes across the world mentioned in research conducted by European Central Bank show that 75% of workforce is 55 to 74 age old [36].

The European Commission confirmed in 2016 in Digital Competence Framework that about 40% of EU population do not have enough digital skills, and 22% do not have it at all. This category includes vulnerable groups such as the elderly population, lower-educated young people, lower-income families and migrants. In addition, around 32% of the workforce lacks sufficiently developed digital skills. As a response to the problems related to ageing of population, the Active Ageing policy has been developed by UN and supported by other relevant world institutions. The authors Walker and Zaidi specified the domains and the index indicators of active ageing. They consist of a few topics: of being able to get the employment, social engagement, independency, healthy and safe life, capacities and environment assured for active ageing [37]. The importance of including the elderly, not only because of economic activities since they can earn incomes, but in general of being e-Included in social activities by specialized clubs for empowerment and building DS was presented by Naumanen and Tukiainen [38]. Fox [39], Padilla-Góngora, López-Liria, et al [40] and

Hernández-Encuentra, Pousada, Gómez-Zúñiga [41], have researched the lack of motivation for building digital skills and communication about benefits of digital skills as the main reason of being “offline”. According the research concluded that new technologies have to be included in everyday life at the time when users feel that they serve for the personal development, and not when they will be used as a substitution of some lost possibilities (mobility, senses, speed, cognitive ability). The similar conclusion has been found by González, Paz Ramírez, Viadel [42]. Active users of tele-services were active during the education process to keep up the mental condition, being socially included and for lifelong learning. During the educational process it is important to avoid barriers that are caused by a lack of technical social support in acquiring digital skills Xie [43]. Additionally, the barriers can be caused by ages, language, physical ability to use ICT. For those adults who decided to take challenge to build their digital skills it is important who is the trainer. Čurin [44] has concluded according the research that young lecturers often do not understand the special needs and advantages of the elderly. The study found that the elderly finds it easier to work with instructors who are generationally closer to them, and who have one level of more developed digital literacy and skills. It is also important what kind of tools are used during the educational process. Public policies are aimed at reducing the overall digital divide through a number of media literacy projects and e-learning projects, but to no avail due to insufficient systematic methodological access L. Abad-Alcalá [45]. Silva, Matos and Martinez-Pecino [46] presented the results of a regression analysis which showed that general stability and public policies have an impact on the will to use the Internet, reinforcing the importance of public policies to encourage e-Inclusion of older people.

R.S. Sharma, et al. “Digital Literacy and Knowledge Societies: A Grounded Theory Investigation of Sustainable Development” [47] have dealt with following issues: a) what are the important policies implemented with a view to promoting digital literacy, digital inclusion and participation in the company known as Sharma Ja; b) how digital literacy policy affects sustainable development (education, health and e-public administration) [48] in 2016. The survey was conducted in Finland, Singapore, New Zealand, Hong Kong and Qatar, also taking into account their socioeconomic parameters (population, GDP, annual GDP growth, country area, net income). Following this research, in 2018 Sharma presented a model of digital literacy maturity [48] which has four pillars (governance, infrastructure, education and human capital, and innovation) and the maturity dimension (the lowest level is access, followed by: use, participation and human values). The conclusion of that research is that public policies by promoting workshops to strengthen digital skills are key to developing an information-based economy.

In order to strengthen digital skills in general, but also with focus on the needs of the elderly, strategies have been planned in this decade, projects have been implemented at national level (albeit in a limited area, such as provinces, large cities, etc.), and countries that have implemented such projects/programs should definitely highlight Spain [45], Finland [49], United Kingdom [50], [51], Czech Republic [52], Lithuania [53], [54], Australia [55], Mexico [56], Canada [57], and United States [58]. For the most part, physical infrastructure projects are the subject of most of the

countries' strategies in the EU. The European Commission has also supported projects to raise the digital skills of the elderly, including a view to raising their competitiveness in the labor market [59], mainly with a view to reducing poverty rates, which is certainly linked to the results of the European Central Bank survey [59]. The economic impact of digital technology was measured by a composite index that, according to R. Evangelista, P. Guerrieri, V. Meliciani [60] includes three sets of aggregated economic variables: a) labor productivity and GDP growth per capita, b) employment growth, c) employment rates of special groups (women, the elderly and long unemployed), which are rising. During the research, it was concluded that there is an impact of several transmission mechanisms from ICT approach, use and digital empowerment on macroeconomic variables (labor productivity, GDP/population, employability growth and employability rates).

Digital literacy not only represents the ability to use programs or digital devices, but includes cognitive abilities, driving abilities, sociological and emotional skills that users need to be able to operate in a digital environment, so in the Digital Era it is recognized as a survival skill [61].

In 2014, the Commission conducted research concerning the inclusion of the elderly population in society through volunteer work in five EU countries (Denmark, Germany, Italy, the Netherlands and Portugal) [62]. The research focused on volunteering as a tool to prevent social exclusion of the elderly population. The authors cited recommendations for public policy makers in the domain of social policy, but also for municipalities and cities, based on knowledge gathered by the research.

On the other hand, just as Siren and Grønberg Knudsen conclude in their research [63], the key problem of the implementation of e-public administration and e-health projects is precisely the inability of users to use such services.

Although it has been almost twenty years since the problem of the digital divide became a topic for discussion and research, it should be said that the problem remains unresolved in the middle of this decade. Namely, technological progress is made at a higher rate than society is ready to monitor and the gap widens, especially in the area of the use of governmental and non-governmental electronic services as well as the increasing opportunities offered related to the use of open data. The European Commission has adopted the Digital Agenda 2020 and the Digital Single Market Strategy, the implementation of which is annually reported by the European Commission via official websites and written reports. The European Parliamentary Research Service said in December 2015 report [64] that digital (il)literacy is a characteristic of four socio-economic categories: "low-educated", "unemployed", "retired" and "aged 55-74". In 2014, according to Eurostat data, about 50% of the population aged 55-74 use the Internet. Since open issues persist, the authors decided to make a cross-section of the area by identifying the status according to referenced models, on the one hand digital inequality and on the other e-Inclusion.

3. Methodology

The goal of this research is to present the crosscut of the causes of the digital divide and effects of e-Inclusion by using two groups of key words, first specified by authors of the paper and second by content search made by authors of this paper.

The research questions we ask are:

- 1) What are the observable themes in published studies on digital divide and e-Inclusion?
- 2) What are the observable trends in published studies on digital divide and e-Inclusion?

Based on the research goal and defined research questions, the research procedure is divided into several steps.

In the first step authors have determined what kind of documents will include in the research. The documents that have been considered in this research are articles, survey reports, project reports, and books which are divided in two groups: scientific and professional papers. For documents questionable regarding classification, the authors were contacted to provide additional information about the classification of the paper.

In the second step, the research concept was defined. This step considered multidisciplinary approach by using components and attributes of multidimensional and multiperspective theoretical model of e-Inclusion made by Žajdela Hrustek [65] and integrated model of digital inequality [32] (in following text: referenced models). The theoretical model of e-Inclusion that was taken as theoretical foundation consists of four components: access, use, empowerment and the impact on quality of life. Another side is theoretical model of digital inequalities that consists of: a) deterrents of digital inequalities divided into macro cause, meso cause and micro cause, and b) measurements of digital inequality: behavioral measurement and effect measurement. This research connects the aforementioned two models by observing the cause-and-effect role of detected key words to e-Inclusion and to digital divide and is presented as theoretical relations.

The third step was related to the decision on which sources will be used for searching papers that have to be analyzed. Authors have used library databases from network sources to find scientific papers, regarding multidisciplinary approach, using keywords such as: accessibility, active ageing, ageing society policy (social policy), competence, digital literacy (ICT literacy, computer literacy), elderly citizens (older people, elders, older age), ICT including mobile telephony and all-inclusive infrastructure, e-Inclusion (digital inclusion, info inclusion), rural areas, learning strategy, later life learning (lifelong learning, lifelong education, adult learning), vulnerable groups (people with disabilities, marginalized groups), empowerment, social support, public community policy, e-readiness, digital divide (digital exclusion), user experience ((UX), individual experience). These keywords are related to inclusion issues and mostly present the cause of digital inequalities. Additionally, authors have checked the references of already identified papers. The next condition is that article had to be published in scientific journals, indexed in Scopus, Web of

Science (WoS) or other referred sources specified on network sources on Faculty's library webpage.

Authors have researched the respectable sources of relevant institutions official webpages to find professional papers indexed in other sources (official web pages of institutions, official project web pages, etc.).

The point of including both kinds of papers, scientific and professional, is to get the view of which issues are emphasized by scientific research and which by professional.

In the fourth step authors specify keywords that were used for search of databases. There have been specified two groups of key words: a) specified by authors of the paper and b) by content search made by authors of this paper. The documents that do not specify keywords by authors (older scientific articles, professional articles, reports) were excluded from that part of research. For both groups of classification have been created tuple for further comparison.

Other sources indexed databases are: Index Copernicus International and EBSCOhost, Cabell Publishing, Inc., CrossRef, EBSCO, Google Scholar. Books are published by Springer. Conferences: IFIP Advances in Information and Communication Technology, IFIP International Federation for Information Processing, ESA Research Network Sociology of Culture Midterm Conference: Culture and the Making of Worlds, European, Mediterranean & Middle Eastern Conference on Information Systems.

The key words that researchers and authors of this paper have emphasized are: ageing society (policy), active ageing, elderly citizens/older people, other vulnerable groups, digital literacy, competences/e-readiness, inclusion/e-Inclusion, digital divide, ICT, mobile telephony, learning/informal education/empowerment.

The fifth step involved determining the analysis criteria, and they are grouped in three groups. The first group of research criteria focus on year of publishing, specifying source of the document and indexed database, key words - defined by authors of document, key words - content of the document, county of research, clusters of countries by number of matching in analyzed research.

Second group of research criteria is focused on topics and issues of investigation, data collection method/technique, paper by research population groups. The list of data collection method/techniques is created according to findings. In some researches have been used the mixed method/technique, so the authors have decided to present founded combination. The population groups are presented as they have been found during the research in analyzed documents. There are overlaps between the groups authors decided at the end to few groups: under 20 years, between 25 and 65, over 50 years old, whole population; in some cases the population was not mentioned and in some cases it was not applicable.

The third group of research criteria is defined by multidisciplinary approach for solving problem of digital divide and raising e-Inclusion rate. As the reference models describe, papers are grouped by components and attributes in chronologic array from 2003 to 2020. As it has been mentioned, the papers are divided into two groups: scientific and professional, and are compared with the related components of two reference models (digital inequality and e-Inclusion).

The collected data were analyzed using descriptive statistical analysis and presented through the tables in the following chapters.

4. Results

Summarization and categorization of reviewed papers are grouped by research focus, research approach and by theoretical foundation on referenced models (e-Inclusion model and digital inequality model).

4.1. Research focus

Using described criteria, 58 documents have been included in the research, spanning the years 2003 through 2020 (Table 1). Regarding the data shown in Table 1, 51,8% of papers were published in the last five years. It is interesting to note that after 2014 the number of scientific papers by year is rising. According to the categorization into professional and scientific document, it can be noticed that scientific papers predominate (86.2%).

Year	Total	%	Category of the document	
			Professional	Scientific
2003	1	1,72		1
2007	2	3,45		2
2008	3	5,17	1	2
2009	1	1,72		1
2010	5	8,62	2	3
2011	2	3,45		2
2012	2	3,45		2
2013	3	5,17		3
2014	7	12,07	1	6
2015	2	3,45		2
2016	4	6,91		4
2017	6	10,34	1	5
2018	6	10,34	2	4
2019	7	12,07		7
2020	7	12,07	1	6
Total	58	100	8	50

Table 1. Papers by year and category of the document

Journal, Document	Scopus	WoS	Other	Total	%
Ageing and society		1		1	1,724
BMC public health		1		1	1,724
Book			3	3	5,172
Computer		1		1	1,724
Comunicar Media Education Research Journal			1	1	1,724
Conference paper	3		1	4	6,897

Educational Gerontology		1		1	1,724
Employee Relations		1		1	1,724
European Journal of Ageing		1		1	1,724
Government Information Quarterly		2		2	3,448
IEEE Consumer Electronics Magazine		1		1	1,724
Information Systems Frontiers		1		1	1,724
Information Systems Management		1		1	1,724
International Journal of Business and Social Science			1	1	1,724
International Journal of Computer Science and Information Security		1		1	1,724
International Journal of Electronic Governance	1			1	1,724
IOSR Journal of Humanities And Social Science			1	1	1,724
ISG International Society for Gerontechnology		1		1	1,724
Journal of Aging & Social Policy		1		1	1,724
Journal of Medical Internet Research		1		1	1,724
Lecture Notes in Computer Science		6		6	10,351
New media & society		1		1	1,724
New Zealand Computer Society			1	1	1,724
PLoS ONE	1			1	1,724
Procedia-Social and Behavioral Sciences			2	2	3,448
Profesional de la Información		1		1	1,724
Project report			3	3	5,172
Research publication			3	3	5,172
Revista Latina de Comunicación Social		1		1	1,724
Rural Society		1		1	1,724
Science and Engineering Ethics			1	1	1,724
Sensors		1		1	1,724
Smart Learning Environments	1			1	1,724
Statistika-Statistics and Economy Journal		1		1	1,724
Telecommunications Policy		2		2	3,448
The Information Society		1		1	1,724
Topics in Geriatric Rehabilitation		1		1	1,724
Universal access in the information society		1		1	1,724
Viešoji Politika Ir adMINISTRAVIMS		1		1	1,724
ZDM Mathematics Education		1		1	1,724
Zeitschrift für Weiterbildungsforschung			1	1	1,724
Total		40	18	58	100

Table 2. Papers by source and citation database.

Table 2 shows the selected papers by source (journals) and the citation database that they are indexed in. The 69% of papers are published in journals that are indexed in Scopus or WoS. 30% of other sources are books and project reports. By examination of the list of sources (journals and other types of documents), the previously mentioned can be confirmed - the concepts of digital divide and e-Inclusion are

multidisciplinary (social science, computer science, information science, medical science and geriatric, etc.), and issues related to these concepts are multidimensional.

The analyzed set of documents are mostly related with concept e-Inclusion, the spatial social group of citizens – elderly, ICT. Ageing and specific vulnerable citizen groups, as well as informal education similarly participate in the sample of analyzed documents.

Key words - defined by authors of document	Count	% of documents include the key word
Inclusion/e-Inclusion/	19	32,76
Elderly citizens/Older people	18	31,03
ICT	16	27,59
Digital divide	12	20,69
Digital literacy	7	12,07
Ageing society (policy)	6	10,34
Other vulnerable groups	6	10,34
Learning/Informal education/Empowerment	6	10,34
Active ageing	4	6,9
Competences / E-Readiness	4	6,9
Mobile telephony	2	3,45

Table 3. Key words - defined by authors of documents.

Key words in content of the document	Scientific	Professional	Total	% of all documents	Rank
Elderly citizens/ Older people/ Elders/ Older age	42	8	50	86,2	1
e-Inclusion / eInclusion / Digital inclusion / Info-inclusion	29	6	35	60,3	2
Vulnerable groups / People with disabilities / Marginalized groups	28	7	35	60,3	2
Digital divide / Digital exclusion	28	5	33	56,9	4
Digital literacy / ICT literacy / Computer literacy	29	3	32	55,2	5
User experience (UX) / Individual experience	27	5	32	55,2	5
ICT including mobile telephony and all-inclusive infrastructure	28	2	30	51,7	7
Accessibility	24	5	29	50,0	8
Public / Community policy	22	7	29	50,0	8
Competences	24	4	28	48,3	10
Empowerment (Social support)	21	7	28	48,3	10
Later life learning / Lifelong learning / Lifelong education / Adult learning	22	4	26	44,8	12

Rural areas	16	3	19	32,8	13
Active ageing	14	4	18	31,0	14
Ageing society policy / Social policy	12	3	15	25,9	15
Learning strategy	7	1	8	13,8	16
E-readiness	3	0	3	5,2	17

Table 4. Key words - content of the document.

As it can be seen in Table 4, the content of analyzed documents give a different perspective on keywords than the keywords highlighted by authors. When the digital divide and e-Inclusion are discussed, the interest of scientific and professional community is focused on the elderly citizens and vulnerable societal groups, as well as user experience and digital literacy. That is the landscape of the multidisciplinary and multidimensional researches.

In Table 5 the counties and geographic areas are presented where the researches were conducted. The data are divided national or international research. The 79% of research papers is related with some specific geographic area. The rest of papers, like reviews and general theory research is classified in the category "Not exactly defined". In absolute value in the UK has been conducted 6 research during the observed period. It is very indicative if we take into the consideration that the rate of e-Inclusion of vulnerable group population by Eurostat is on the top level. Which leads to the conclusion that these groups in the population are most affected by the problem of exclusion from the information society.

Geographic area in which the research was conducted	National	International	Total	%	Rank
Not exactly defined	12		12	13,04	1
EU		6	6	6,52	2
United Kingdom	6		6	6,52	2
Italy	3	2	5	5,43	4
Netherland	1	4	5	5,43	4
Spain	3	2	5	5,43	4
Denmark	2	2	4	4,35	7
Finland	2	2	4	4,35	7
Germany		3	3	3,26	9
Portugal	1	2	3	3,26	9
Romania	1	2	3	3,26	9
Australia	2		2	2,17	12
Belgium		2	2	2,17	12
Bulgaria	1	1	2	2,17	12
France		2	2	2,17	12
New Zealand	1	1	2	2,17	12
Norway		2	2	2,17	12
Slovenia	2		2	2,17	12
Switzerland	1	1	2	2,17	12
United States of America	1	1	2	2,17	12

China (Heilongjiang Province)	1		1	1,09	21
Cyprus		1	1	1,09	21
Estonia		1	1	1,09	21
Greece		1	1	1,09	21
Great Britain		1	1	1,09	21
Hong Kong SAR		1	1	1,09	21
Hungary		1	1	1,09	21
Japan	1		1	1,09	21
Kenia		1	1	1,09	21
Lithuania	1		1	1,09	21
Poland	1		1	1,09	21
Qatar		1	1	1,09	21
Russia	1		1	1,09	21
Singapore		1	1	1,09	21
Scotland		1	1	1,09	21
Slovakia		1	1	1,09	21
Sweden		1	1	1,09	21
Zimbabwe		1	1	1,09	21
Total	44	48	92	100	

Table 5. Papers by country.

The importance of the digital divide and the e-Inclusion issues is seen also according to the fact that the researches have been conducted on the wide area (Table 6), everywhere in the world. Sharing the standards, achieved projects, goals and impacts, good and bad practice is noticed during the analysis.

Count of paper	Country
1	Belgium; Bulgaria; China; Cyprus; Estonia; France; Greece; Hong Kong; Hungary; Japan; Kenia; Lithuania; Norway; Poland; Qatar; Russia; Scotland; Singapore; Sweden; the Slovak Republic; Zimbabwe;
2	Australia; Germany; New Zealand; Slovenia; Switzerland; USA;
3	Denmark; Portugal; Romania;
4	Finland; Netherland
5	Italy; Spain
6	EU; UK

Table 6. Clusters of countries by number of matching in analyzed researches.

Table 7 presents the list of papers by authors and issues of investigation expressed in terms of referenced models. It is evident from the results that according to the causes (macro, meso, micro), most studies have focused on macro causes with emphasis on ideological and personal force. To a much lesser extent, research was focused on behavioral measurement - e-acceptance and effect measurement - situational e-Inclusion if one looks at it from aspect of causes of digital divide (left side of the Table

7). While it is interesting to notice this ultimately results in the fact that effects on e-Inclusion are achieved mostly on the side of access and use and less in terms of empowerment and impact on quality of life (right side of the Table 7).

Researched paper can be divided in 5 groups by research focus of digital inequality and 4 groups by research of e-Inclusion, as it is presented in Table 7.

Causes of Digital Divide					Reference of the document	Effects on e-Inclusion			
E-Inclusion or digital divide: an integrated model of digital inequality						Proposed General Theoretical Conceptual Model of e-Inclusion			
MACRO CAUSE - Forces	MESO CAUSE - Resources	MICRO CAUSE - Access	BEHAVIORAL MEASUREMENT - REMENT - E-ACCEPTANCE	EFFECT MEASUREMENT - SITUATIONAL E-INCLUSION		ACCESS	USAGE	EMPOWERMENT	IMPACT ON QoL
Personal force			Continuous use		Selwyn, N., Gorard, S., Furlong, J., & Madden, L. (2003).	Material access, Affordability;	Intensity; Social support		
Personal force	Educational resource				Morris, A., Goodman, J., & Brading, H. (2007).	Material access	Skills		all atributes
Personal force		Cognitive access			Boulton-Lewis, G. M., Buys, L., Lovie-Kitchin, J., Barnett, K., & David, L. N. (2007).		Skills; Motivation ; Social support		
Community force					Petrauskas, R-A, Bilevičienė, T.,Kiškienė, A. (2008)		Social support		
Personal force					European Social Survey (ESS). (2008).		Attitudes		
		Material access; Motivational access			Repetto, M. and Trentin, G., (2008).		Motivation ; Skills		
		Motivational access			Siren, A., & Hakamies-Blomqvist, L. (2009).		Motivation		
			Initial adoption		van Deursen A., van Dijk J. (2010).		Skills		
		Material access; Motivational access			Leahy D., Dolan D. (2010).		Motivation ; Skills		
Ideological force					Maier-Rabler, U., (2010).		Social support		
Ideological force					Bunker, B. (2010).		Social support		
Ideological force					European Commission, (2010).		Social support		
	Educational resource; Material resource; Psych resource				Epstein, D., Nisbet, E. C., & Gillespie, T. (2011).	Affordability	Skills		
Ideological force; Personal force	Material resource; Intellectual resource	Cognitive access	Continuous use		Almuwil, A., Weerakkody, V., & El-Haddadeh, R. (2011).	Material access	Skills; Attitudes; Intensity	Content creation	

			Initial adoption		Vishanth Weerakkody, Yogesh K. Dwivedi, Ramzi El-Haddadeh, Ahlam Almuwil & Ahmad Ghoneim (2012).				E-governm ent
				Impact personal life	Näsi, M., Räsänen, P., & Sarpila, O. (2012).		Intensity		E-entertain ment
	Education al resource				Lima Oliveira, A. et.al. (2013).		Skills		
Community force; Industrial force; Personal force	Material resource; Education al resource; Psych resource				Rerup Schlichter, B., Danylchenko, L. (2014).	Material access; Affordab ility; Network			
Public admin force; Community force					Bannier S., Glott R., Meijs V. (2013).		Social support		
Personal force		Motivati onal access			Ayako, H., Masaaki, K. (2013).		Motivation		
		Cognitiv e access			Loureiro A., Barbas M. (2014).		Skills		
Personal force					Billestrup J., Stage J. (2014).			E-participation	
Ideological force					Watkins, I., & Xie, B. (2014).		Skills		
Ideological force		Motivati onal access			Haasjes, M., (2014).	Affordab ility	Social support; Attitudes; Motivation		
	Education al resource				Nistor, G. (2014).		Skills		
	Education al resource				Alcalá, L. A. (2014).		Skills		
Community force					Comunello F., Mulargia S., Belotti F., Fernández-Ardévol M. (2015).		Skills		
Ideological force					Chalkia E., Bekiaris E., Madrid R.I. (2015).	Network; Point of access			
Personal force					Sergeyeva, O., & Makarova, L. (2016).		Motivation		
Public admin force; Community force					Sharma, R., Fantin, A. R., Prabhu, N., Guan, C., & Dattakumar, A. (2016).	Network	Skills		
Community force; Industrial force; Personal force	Material resource; Education al resource; Psych resource				Berenguer, A., Goncalves, J., Hosio, S., Ferreira, D., Anagnostopoulos, T., & Kostakos, V. (2016).	Affordab ility; Material access	Motivation ; Skills		
		Material access; Motivati onal access			Friemel, T. N. (2016).		Motivation ; Skills		
		Motivati onal access			M Viñarás-Abad, L Abad-Alcalá, C Llorente-Barroso, M		Motivation		

					Sánchez-Valle, M Pretel-Jiménez (2017).				
				Impact personal life	Dudek, H., & Szczesny, W. (2017).		Attitudes		All attributes
		Motivati onal access			Siren, A., & Knudsen, S. G. (2017).		Motivation		
Public admin force; Community force					Silva P, Matos AD, Martinez-Pecino R (2017).		Social support		
Personal force					Padilla-Góngora, D., López-Liria, R., del Pilar Díaz-López, M., Aguilar-Parra, J. M., Vargas-Muñoz, M. E., & Rocamora-Pérez, P. (2017).		Skills		
Ideological force	Material resource	Material access	Initial adoption		Dolničar, V., Setinc, M. (2017).		Social support		
Community force					Galdon Clavell G., Zamorano M.M., Zavala Pérez J.M. (2018).		Social support		
Industrial force					Ruiz-Rodríguez, F., Lucendo-Monedero, A.L., González-Relaño, R. (2018).		Motivation	Content creation; Networking	
Personal force					Chipeva, P., Cruz-Jesus, F., Oliveira, T., & Irani, Z. (2018).		Attitudes		
			Continu ous use		Trilar, J., Kos, A., Jazbinšek, S., Jensterle, L., & Stojmenova Duh, E. (2018).		Intensity		
Ideological force; Personal force		Motivati onal access			Centre for Economics and Business Research (Cebr) (2018)			E-participation ; E-democracy; Networking; Content creation	
Ideological force; Personal force	Interperso nal resource	Motivati onal access			Davidson, S., (2018).		Attitudes; Social support		
	Education al resource				Kirongo, A.C., Huka, G. S., Bundi, D. G., Muketha G. M., (2019).		Skills		
			Initial adoption		Brenna, E. (2019).	Point of access	Intensity		all attributes
Public admin force; Community force					Al-Muwil, A., Weerakkody, V., El-haddadeh, R. et al. (2019).		Social support		
Public admin force; Community force					Atarodi, S., Berardi, A.M., Toniolo, A-M. (2019).		Social support		
Ideological force	Material resource				Moreno, L., & Martinez, P. (2019).	Accessib ility	Network and Quality		
Ideological force	Education al resource	Cognitiv e access			Richards, C. (2019).		Attitudes; Social support		
Ideological force; Public admin force					Arrieta F. (2019).	Affordab ility	Social support		

	Education al resource				Zhang, X., Tlili, A., Nascimbeni, F. et al. (2020).		Skills		
Ideological force	Education al resource				Gal, I., Grotlüschen, A., Tout, D., Kaiser, G., (2020).		Skills		
				Impact personal life	Bejaković, P., & Mrnjavac, Ž. (2020).		Digital engagem nt	Content creation; Networking	E-work
Public admin force; Community force					Guenther, J., Smede, B., & Young, M. (2020).		Social support		
Ideological force					Martínez-Bravo, M. C., Sádaba- Chalezquer, C., & Serrano- Puche, J. (2020).		Social support		
Community force					Sun, X., Yan, W., Zhou, H., Wang, Z., Zhang, X., Huang, S., & Li, L. (2020).		Motivation , Social support		
				Impact personal life	Burr, C., Taddeo, M. & Floridi, L. (2020)		Social support; Motivation ;		

Table 7. Papers by issue of investigation, referenced in Appendix 1.

According to the data in Table 7. it could be concluded that 63,79% of analyzed documents are related with macro cause issues (37 of 58 documents), and it follows by meso and micro cause of digital divide 15 of 58 documents, or 25,86%). During the research it was revealed that ideological forces was the topic in 11 documents, and it is followed by personal force that was found in 9 documents. Considering the meso cause the educational resources it was found that it has been mentioned in 8 documents. On micro cause motivation has been the topic of research in 7 documents. Considering e-acceptance the initial adoption has been researched in four documents and continuous use in three documents. Impact on personal life, as the effect of measurement situation e-Inclusion property has been analyzed four times.

Regarding the e-Inclusion referent model, it could be concluded that usage has been the research topic in 53 documents (of 58) or 91,38%, access in 11 documents or 18,97%, empowerment in five (8,62%) and impact on quality of life in 4 documents (6,9%).

The focus of researchers of access issues was directed to skills (14 documents) and social support (13 documents), while on other e-Inclusion components have been noted lower number of occurrence (access: affordability and material access in two documents; empowerment: content creation and networking in two documents; impact on quality of life all attributes have been found in only once).

4.2. Research approach

One of the focuses of the research was to determine the method/methodology or technique of collecting data used by the authors in the research they conducted. Results are presented in the Table 8. At the start it is said that 25 of 58 papers focus on analyses of existing documents (for making reviews; using secondary data), so there are no specific methods or techniques for data collection. The usually used

methods or techniques for collecting data from individuals are: questionnaire (11 of 58, including semi-structured), interview (9 of 58) followed by survey (4) and focus groups (3).

Data collecting method/technique	Count	%
Review	20	34,49
Questionnaire	8	13,80
Interview	6	10,34
Secondary data	5	8,63
Survey	4	6,90
Project	3	5,17
Focus group	3	5,17
Grounded theory method	2	3,46
Experiment	1	1,72
User centred design (UCD)	1	1,72
Secondary data, interview	1	1,72
Grounded theory method, interview, questionnaire	1	1,72
Experiment, questionnaire, semi-structured questionnaire	1	1,72
Experiment, questionnaire	1	1,72
Experiment, interview	1	1,72
Total	58	100

Table 8. Papers by data collecting method/technique.

Unit of analysis is not explicitly mentioned because the papers analyze the documents and second source data (22 of 58), which makes about 38% of all papers. Other 36 papers are based on collected data from individuals of specific age groups, as it stands in Table 9. The data tell the researchers of 11 papers included general population in the research process. Other most occurred population groups included in the research were 60+ and 65+. In general, 31% of papers are focused especially on 50+ population. The reason is certainly because the population of 50+ is vulnerable group from the digital inequality point of view, mostly because of lack of required skills (in correlation with Eurostat data).

Population groups	Count	%	
16+	1	1,72	10,34
up to 18	1	1,72	
18+	2	3,46	
18-74	1	1,72	
19+	1	1,72	
25 - 65	1	1,72	1,72
50 - 74	1	1,72	31,04
50+	2	3,45	
55+	1	1,72	
58+	1	1,72	
60+	5	8,63	

60 -79	1	1,72	
65 - 81	1	1,72	
65+	6	10,35	
General population	11	18,98	18,97
Not Applicable	4	6,90	6,90
Not specified	18	31,03	31,03
Total	58	100	100

Table 9. Paper by population groups.

As many other social issues, the heterogeneity of population characteristics (especially age) has an impact on the phenomenon that is being analyzed. If we exclude the researches where the population hasn't been the source of data, the e-Inclusion issues and digital divide issues have been analyzed mostly as an issue related with population 50+. This is very indicative, and it could be said that researchers consider the vulnerable population group defined by ages.

4.3. Theoretical foundation on e-Inclusion model and digital inequality model

Following part of data presented in Table 10 to Table 14 are the results of documents analyzes according to two referenced models: a) digital inequality and b) e-Inclusion model. The aforementioned present the third part of research – the analysis of multidisciplinary approach for solving problem of digital divide and raise e-Inclusion rate. As the reference models describe, papers are grouped by components and attributes in chronologic array from 2003 to 2020. Following part of research displays selected papers divided into two groups: scientific and professional. The papers were analyzed by key words which were found in the content of the paper and paired with the related components of two reference models (digital inequality and e-Inclusion model).

Theoretical foundation of causes and effects on referenced models is presented in Table 10 that presents the connection of causes of digital inequalities from the left side of keywords in content, and the effects they have on e-Inclusion described by components on the right side of keywords. The yellow-colored cells present the connections between terms from specific points of view. It can be concluded that, except from terms “e-Inclusion” and “digital divide”, the term “public/community policy” has been related with all components of e-Inclusion model, but it is related only to macro cause of digital inequality model. Most key words are related with usage in e-Inclusion model, but on the left side of Table 10 it can be seen that all parts of the model by key words are equally represented. In other words, it could be said that most of keywords are related with or are cause of only one component of the digital inequality model.

Causes of Digital Inequalities						Effects on e-Inclusion			
E-Inclusion or digital divide: an integrated model of digital inequality					Multidisciplinary view of causes and effect	Proposed General Theoretical Conceptual Model of e-Inclusion			
Macro cause - Forces	Meso cause - Resources	Micro cause - Access	Behavioral measurement - e-acceptance	Effect measurement - Situational e-Inclusion	Keywords	Access	Usage	Empowerment	Impact on QoL
					Accessibility				
					Active ageing				
					Ageing society policy / Social policy				
					Competences				
					Digital literacy / ICT literacy / Computer literacy				
					Elderly citizens/ Older people/ Elders/ Older age				
					ICT including mobile telephony and all-inclusive infrastructure				
					e-Inclusion / eInclusion Digital inclusion/ Info-inclusion				
					Rural areas				
					Learning strategy				
					Later life learning / lifelong learning / lifelong education / adult learning				
					Vulnerable groups/ People with disabilities/ Marginalized groups				
					Empowerment (Social support)				
					Public / Community policy				
					E-readiness				
					Digital divide / Digital exclusion				
					User experience (UX) / Individual experience				

Table 10. Multidisciplinary approach for solving problem of digital divide and raise e-Inclusion rate.

Table 11 visualizes the dispersion of papers according to components and attributes of referenced models by the year of research. The digital inequality is mostly analyzed according to ideological attribute (16 of 58) and personal force (14 of 58), both on macro cause. Personal force is continually analyzed according to referenced years, but ideological force started to be analyzed from 2010 until 2020, continually. The educational resource as meso causes and motivational access as micro causes of digital inequalities are the topics of research the most mentioned not specifically at one point of time.

Model	Component	Attributes	Total	% (of total number of analyzed 58 articles)	2003	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
E-INEQUALITY	MACRO CAUSE - FORCES	Public admin force; Community force	6	10,34								1			1	1		2	1
		Personal force	9	15,52	1	2	1					1	1		1	1	1		
		Industrial force	1	1,72													1		
		Ideological force; Public admin force	1	1,72														1	
		Ideological force; Personal force	3	5,17						1							2		
		Ideological force	11	18,97					3				2	1		1		2	2
		Community force; Industrial force; Personal force	2	3,45								1			1				
		Community force	4	6,90			1							1			1		1
	MESO CAUSE - RESOURCES	Educational resource	8	13,79		1						1	2					2	2
		Educational resource; Material resource; Psych resource	1	1,72						1									
		Interpersonal resource	1	1,72													1		
		Material resource	2	3,45												1		1	
		Material resource; Educational resource; Psych resource	2	3,45								1			1				
		Material resource; Intellectual resource	1	1,72						1									
	MICRO CAUSE - ACCESS	Cognitive access	4	6,90		1				1			1					1	
		Material access	1	1,72												1			
		Material access; Motivational access	3	5,17			1		1						1				
		Motivational access	7	12,07				1				1	1			2	2		

	BEHAVIORAL MEASUREMENT - E-ACCEPTANCE	Continuous use	2	3,45					1						1		
		Initial adoption	4	6,90				1	1						1	1	
	EFFECT MEASUREMENT - SITUATIONAL E-INCLUSION	Impact personal life	4	6,90					1						1		2
E-INCLUSION COMPONENTS AND ATTRIBUTES	ACCESS	Accessibility	1	1,72												1	
		Affordability	1	1,72					1								
		Affordability; Material access	1	1,72								1					
		Material access	2	3,45		1			1								
		Material access; Affordability;	1	1,72	1												
		Material access; Affordability; Network	1	1,72						1							
		Network	1	1,72								1					
		Network; Point of access	1	1,72								1					
		Point of access	1	1,72												1	
		Attitudes	3	5,17			1								1	1	
	USAGE	Attitudes; Social support	2	3,45												1	1
		Digital engagement	1	1,72													1
		Intensity	2	3,45												1	1
		Intensity	1	1,72						1							
		Intensity; Social support	1	1,72	1												
		Motivation	6	10,34				1			1			1	2	1	
		Motivation; Social support	1	1,72													1
		Motivation; Skills	4	6,90			1		1				2				
		Network and Quality	1	1,72													1
		Skills	14	24,14		1			1	1		1	4	1	1	1	2
		Skills; Attitudes; Intensity	1	1,72						1							
		Skills; Motivation; Social support	1	1,72		1											
		Social support	13	22,41			1		3		1				2	1	3

		Social support; Attitudes; Motivation	1	1,72								1						
		Social support; Motivation;	1	1,72														1
	EMPOWERMENT	Content creation	1	1,72					1									
		Content creation; Networking	2	3,45												1		1
		E-participation	1	1,72								1						
		E-participation; E-democracy; Networking; Content creation	1	1,72												1		
	IMPACT ON THE QUALITY OF LIFE	All attributes	3	5,17		1									1		1	
		E-government	1	1,72						1								
		E-entertainment	1	1,72						1								

Table 11. Paper by components and attributes in period 2003 – 2020.

The skills (20 of 58) and social support (20 of 58) are the most represented attributes of e-Inclusion model. The social support has often been researched in recent years, but skills are continually in the focus of research during observed period. As both are the attributes of usage component, it is clear the usage is the most analyzed component of the e-Inclusion model. Access and empowerment, as well as the impact on the quality of life are rarely being present in sample of analyzed articles.

The analysis showed, among other things, that some papers are related with more than one component of the referenced models (digital inequality or e-Inclusion), which also confirms the multidisciplinary approach of researches. The component macro cause is relatively the most researched component of the digital inequality models in both of papers type (scientific and professional). As it can be concluded from Table 12, the scientific type of papers follows decreasing trend in the meso cause (13), micro cause (11) components. According to selected papers, the focus of scientific papers on behavioral and effect measurement is relatively low. The point is that scientific type of research focuses much more on general macro causes of the inequalities than on the individual adoption and continual use or impact on people's quality of life, which ultimately leads to a successful e-Inclusion process. The professional papers are focused rarely on resources and measurement (behavioral or effect). Thus, it can be said that all components of the model must be equally represented, in order to achieve progressive results of e-Inclusion.

By viewing data in Table 13 it can be seen that scientific papers are focused on usage (46 of 50) and access (11 of 50). In professional papers the focus on the impact on QoL is not observed, but therefore greater focus is given to the component usage. The component impact on QoL is also rarely represented in scientific research (6 of 50). The component empowerment is represented only in 4 scientific papers and 1 professional one. It is relatively negative that these two components are in such a small extent represented in research, because they are the core point of the whole process of

being e-included for individuals, as well as for other stakeholders (public authorities, business community and other stakeholders).

Type of document	MACRO CAUSE - Forces	MESO CAUSE - Resources	MICRO CAUSE - Access	BEHAVIORAL MEASUREMENT - E-ACCEPTANCE	EFFECT MEASUREMENT - SITUATIONAL E-INCLUSION
Professional	7	2	4	1	1
Scientific	30	13	11	6	3
Total	37	15	15	7	4
%	63,79	25,86	25,86	12,07	6,9

Table 12. Paper by type and digital inequality model component.

Type of document	ACCESS	USAGE	EMPOWERMENT	IMPACT ON QoL
Professional	1	7	1	0
Scientific	11	46	4	6
Total	12	53	5	6
%	20,69	91,38	8,62	10,34

Table 13. Paper by type and e-Inclusion model component.

Most of analyzed papers consider the digital divide and e-Inclusion as a multidimensional and multiperspective issues as it is presented in Table 14. The total number of keywords defined at the start of content research is 17. The analysis of papers has resulted in following conclusions:

- 14% of scientific papers are related with 9, 6 and 5 keywords; in the group of professional papers, 38% of them are related with 11 and 8 keywords in the content of papers.
- The professional papers have a wider spectrum of view than the scientific ones and are focused only on specific issues related with a reduced number of referenced keywords in the content.

Number of related referenced key words in the papers' content	14	13	12	11	10	9	8	7	6	5	4	3	2	Total
Scientific	1	2	3	1	5	7	5	5	7	7	4	2	1	50
% of scientific total	2	4	6	2	10	14	10	10	14	14	8	4	2	100
Professional	0	1	0	3	0	0	3	0	0	0	1	0	0	8
% of professional total	0	12,5	0	38	0	0	38	0	0	0	12,5	0	0	100

Table 14. Papers by number of related referenced key words in the papers' content.

The authors have also analyzed potential future research suggestions from selected scientific papers indexed in Scopus or in WoS (40 of 58). Seven of 40 papers contain the exact recommendations and future work ideas, as it stands in Table as follows.

Reference of the document	Recommendations and future work ideas
Zhang, X., Tlili, A., Nascimbeni, F. et al. Accessibility within open educational resources and practices for disabled learners: a systematic literature review. Smart Learn. Environ. 7, 1 (2020)	This study opens new research perspectives for researchers and practitioners on the use of open educational resources and practices for accessibility and functional diversity in educational contexts by uncovering gaps in this field that should be investigated.
Morris, A., Goodman, J., & Brading, H. (2007)	There is much to be done to change the perceptions of older people and to provide facilities more suited to their use.
Boulton-Lewis, G. M., Buys, L., Lovie-Kitchin, J., Barnett, K., & David, L. N. (2007)	The need for access to computers for people with lower incomes also needs to be addressed.
van Deursen A., van Dijk J. (2010)	Administrators are responsible for the institution of the public information supply, both internally and externally. They have to decide on the acquisition and implementation of infrastructures, architectures and applications and assess whether these fit within the existing organization or whether they need to be adapted. It is therefore recommended that administrators possess more Internet skills. Policy advisors should support administrators in decision-making and have to be aware of all possibilities that the Internet offers to the government. It is highly recommended to improve the levels of Internet skills among civil servants, especially the levels of information and strategic Internet skills; It is recommended that the Internet skill levels are tested when hiring new employers, preferably using tests or surveys.
Bejaković, P., & Mrnjavac, Ž. (2020)	The government, educational institutions and employers should design new forms to assess digital skills, change standards to reflect the value of 21st century literacy, design and implement intervention programs for workforce digital skills development. For all these demanding tasks, there is a need for a strong partnership on the national and European level, where stakeholders work together to reduce the digital skills gap.
Martínez-Bravo, M. C., Sádaba-Chalezquer, C., & Serrano-Puche, J. (2020)	It is also important to point out that throughout the research process and data processing we identified other terms of interest that have been left out of the analysis such as: computer literacy, e-literacy, internet literacy, among others, which should be considered in future studies.

Table 15. Recommendations from selected scientific researches.

Ten of 40 selected papers have specified the limitations related to those researches. The limitations of scientific researches like reduced number of criteria parameters such as keywords, sample size, population groups, specific factors important for research issues, variables and geographic territory were included in the research.

Future work was specified in eleven of 40 papers, and is mostly related with previously mentioned limitations of the research by providing research on a bigger sample, on wider geographic territory by using more variables or factors important for research topics, including wider population, etc.

Regarding the criteria that was used in this research and two referenced models that presents the backbone of the research methodology it is reviled that e-Inclusion and digital divide attributes of the models did not attracted attention of the researches by the same intensity. The impact on quality of life is not enough emphasized as the motivational factor for raising e-Inclusion of vulnerable population groups. The developed countries have much more research related with key issues and the most important is that they recognized the importance much earlier of that and take practical measures according the public policies to make thing better. So the results of that are visible according the results of e-society research conducted by EUROSTAT.

5. Conclusion

The main contribution of this paper is that it connects two referenced models – the multidimensional and multiperspective theoretical model of e-Inclusion [65] and integrated model of digital inequality [32] by focusing on keywords of analyzed documents. The main idea was to make the landscape of research during the period of 2003-2020 and find out which components of actual referenced models are emphasized. The problem of digital divide is still present, which means the focus of researchers and practitioners must be moved to those components of referenced models that can assure the potential raise of e-Inclusion regarding the attitudes of all kind of e-Inclusion vulnerable social groups. It means that practitioners have to use the scientific results more in the process of making programs for e-Inclusion of vulnerable social groups. According the goal of this research the article presents the crosscut of the causes of the digital divide and effects of e-Inclusion.

The paper presents the bridge between digital divide and e-Inclusion, and keywords are bottleneck for raising e-Inclusion.

According to the results presented in this study, several concluding remarks could be specified:

- The authors of analyzed papers in their research have been mostly focused on components usage and access, and less on components empowerment and impact on QoL. Empowerment and impact on QoL are more associated with motivational issues and both have a significant impact on raising the e-Inclusion rate. It could be concluded that the impacts of e-Inclusion on quality of life are not presented enough as motivational mechanisms to raise the e-inclusion rate of vulnerable population groups.
- The causes of digital inequalities are relatively analyzed much more than the behavioral measurement of e-acceptance and effect measurement of

situational e-Inclusion. This is a similar situation to the previous note, but from the point of practice that follows the scientific conclusions, it could be said that the effect measurement of situational e-Inclusion or the behavioral measurement of e-acceptance should be seen as motivational factor for raising e-Inclusion rate in global.

6. Limitations and future work

Regarding the results of presented research, especially those related with bridging two referenced models by keywords from selected papers, the authors of this research can specify few limitations. The limitation of this paper is that the documents considered are in English language. Also, it has to be mentioned that multidimensional and multiperspective theoretical model of e-Inclusion has much more attributes than the analyzed keywords which are taken into consideration during research – like the attributes which together form the component impact of quality of life (e-government, e-health, e-learning...). These attributes are key components of digital society developing processes – and in nature they are a kind of digital services that are the objects of usage and - in authors' opinion - must be separately analyzed from that aspect, which also represents the idea for the future research.

Future work will focus more on components empowerment and raising quality of life by e-Inclusion of vulnerable social groups. Until now, that was recognized by public administration and politicians for distribution of public information of their work. Citizens have to use much more among all e-services that have positive impact on quality of life, so the future research will be oriented to those attributes referenced in e-Inclusion model [65].

Appendix 1. Analyzed scientific and professional papers

Order No.	List of analyzed scientific and professional papers
1.	A. Lima Oliveira, et.al., "Promoting conscious and active learning and aging - How to face current and future challenges?", available on https://www.uc.pt/imprensa_uc/catalogo/ebook/E-book_Promoting , 2013.
2.	G. Galdon Clavell, M.M. Zamorano, J.M. Zavala Pérez, "ICTs and Community Policing: An Ethical Framework. In: Leventakis G., Haberfeld M. (eds)", <i>Societal Implications of Community-Oriented Policing and Technology</i> ", pp 63-76. SpringerBriefs in Criminology. Springer, Cham, https://doi.org/10.1007/978-3-319-89297-9_8 , 2018.
3.	A.C. Kirongo, G.S. Huka, D.G. Bundi, G.M. Muketha, "Competence Network for e-Inclusion and Assistive Technologies", available on http://www.iosrjournals.org/iosr-jhss/papers/Vol.%2024%20Issue6/Series-7/H2406076670.pdf , 2019.
4.	E. Brenna, "Adult Education, the Use of Information and Communication Technologies and Their Impact on Elderly's Quality of Life: A Case Study", <i>International Journal of Business and Social Science</i> , 10(8), 2019.

5.	O. Sergeyeva & L. Makarova, "E-Inclusion and perception of time among elderly: Russian regional perspective", <i>International Journal of Electronic Governance</i> , 8(3), 303-313, 2016.
6.	X. Zhang, A. Tlili, F. Nascimbeni, et al., "Accessibility within open educational resources and practices for disabled learners: a systematic literature review", <i>Smart Learn. Environ.</i> 7, 1, https://doi.org/10.1186/s40561-019-0113-2 , 2020.
7.	N. Selwyn, S. Gorard, J. Furlong & L. Madden, "Older adults' use of information and communications technology in everyday life", <i>Ageing and society</i> , 23, 561, 2003.
8.	A. Morris, J. Goodman & H. Brading, "Internet use and non-use: views of older users", <i>Universal access in the information society</i> , 6(1), 43-57, 2007.
9.	G. M. Boulton-Lewis, L. Buys, J. Lovie-Kitchin, K. Barnett & L.N. David, "Ageing, learning, and computer technology in Australia", <i>Educational Gerontology</i> , 33(3), 253-270, 2007.
10.	R-A. Petrauskas, T. Bilevičienė, A. Kiškienė, "E-Inclusion as a Part of E-Government Developemnt in Lithuania", ISSN 1648-260, Viešoji Politika Ir administrAVIMS, 2008 Nr. 23 https://www3.mruni.eu/ojs/public-policy-and-administration/article/view/2011/1821 , 2008.
11.	A. Siren & L. Hakamies-Blomqvist, "Mobility and well-being in old age.", <i>Topics in Geriatric Rehabilitation</i> , 25(1), 3-11, 2009.
12.	A. van Deursen, J. van Dijk, "Civil Servants' Internet Skills: Are They Ready for E-Government?. In: Wimmer M.A., Chappelet J.L., Janssen M., Scholl H.J. (eds)", <i>Electronic Government</i> pp 132-143. EGOV 2010. Lecture Notes in Computer Science, vol 6228. Springer, Berlin, Heidelberg, https://doi.org/10.1007/978-3-642-14799-9_12 , 2010.
13.	D. Epstein, E.C. Nisbet & T. Gillespie, "Who's responsible for the digital divide? Public perceptions and policy implications.", <i>The Information Society</i> , 27(2), 92-104, 2011.
14.	W. Vishanth, Y.K. Dwivedi, R. El-Haddadeh, A. Almuwil & A. Ghoneim, "Conceptualizing E-Inclusion in Europe: An Explanatory Study", <i>Information Systems Management</i> , 29:4, 305-320, DOI: 10.1080/10580530.2012.716992, 2012
15.	M. Näsi, P. Räsänen & O. Sarpila, "ICT activity in later life: Internet use and leisure activities amongst senior citizens in Finland", <i>European Journal of Ageing</i> , 9(2), 169-176., 2012.
16.	B. Rerup Schlichter, L. Danylchenko, "Measuring ICT usage quality for information society building", <i>Government Information Quarterly</i> Volume 31, Issue 1, January 2014, Pages 170-184, https://doi.org/10.1016/j.giq.2013.09.003 , 2014.
17.	S. Bannier, R. Glott., V. Meijs, "How E-Inclusion and Innovation Policy Affect Digital Access and Use for Senior Citizens in Europe. In: Stephanidis C., Antona M. (eds) Universal Access in Human-Computer Interaction. User and Context Diversity. UAHCI 2013", <i>Lecture Notes in Computer Science</i> , vol 8010. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-39191-0_1 , 2013.
18.	H. Ayako, K. Masaaki, "Active Use of ICTs among the Elderly by Positive User Experience", <i>International Journal of Computer Science and Information Security</i> , Vol. 11, No. 3, 2013. http://sites.google.com/site/ijcsis , ISSN 1947-5500, 2013.

19.	A. Loureiro, M. Barbas, "Active Ageing – Enhancing Digital Literacies in Elderly Citizens. In: Zaphiris P., Ioannou A. (eds) Learning and Collaboration Technologies. Technology-Rich Environments for Learning and Collaboration pp 450-459. LCT 2014.", <i>Lecture Notes in Computer Science</i> , vol 8524. Springer, Cham, https://doi.org/10.1007/978-3-319-07485-6_44 , 2014.
20.	J. Billestrup, J. Stage, "E-government and the Digital Agenda for Europe. In: Marcus A. (eds) Design, User Experience, and Usability. User Experience Design for Diverse Interaction Platforms and Environments, pp 71-80. DUXU 2014.", <i>Lecture Notes in Computer Science</i> , vol 8518. Springer, Cham, https://doi.org/10.1007/978-3-319-07626-3_7 , 2014.
21.	I. Watkins, B. Xie, "eHealth literacy interventions for older adults: a systematic review of the literature", <i>Journal of medical Internet research</i> , 16(11), e225, 2014.
22.	F. Comunello, S. Mulargia, F. Belotti, M. Fernández-Ardèvol, "Older People's Attitude Towards Mobile Communication in Everyday Life: Digital Literacy and Domestication Processes. In: Zhou J., Salvendy G. (eds) Human Aspects of IT for the Aged Population. Design for Aging, pp 439-450. ITAP 2015.", <i>Lecture Notes in Computer Science</i> , vol 9193. Springer, Cham, https://doi.org/10.1007/978-3-319-20892-3_43 , 2015.
23.	E. Chalkia, E. Bekiaris, R.I. Madrid, "Evaluating All-Inclusive ICT with Developers, End Users and Stakeholders. In: Zhou J., Salvendy G. (eds) Human Aspects of IT for the Aged Population. Design for Aging, pp 157-165. ITAP 2015.", <i>Lecture Notes in Computer Science</i> , vol 9193. Springer, Cham, https://doi.org/10.1007/978-3-319-20892-3_16 , 2015.
24.	R. Sharma, A.R. Fantin, N. Prabhu, C. Guan, A. Dattakumar, "Digital literacy and knowledge societies: A grounded theory investigation of sustainable development", <i>Telecommunications Policy</i> , 40(7), 628-643, 2016.
25.	A. Berenguer, J. Goncalves, S. Hosio, D. Ferreira, T. Anagnostopoulos, V. Kostakos, "Are smartphones ubiquitous?: An in-depth survey of smartphone adoption by seniors", <i>IEEE Consumer Electronics Magazine</i> , 6(1), 104-110, 2016.
26.	T.N. Friemel, "The digital divide has grown old: Determinants of a digital divide among seniors", <i>New media & society</i> , 18(2), 313-331, 2016.
27.	M. Viñarás-Abad, L. Abad-Alcalá, C. Llorente-Barroso, M. Sánchez-Valle, M. Pretel-Jiménez, "e-Administration and the e-Inclusion of the elderly". <i>Revista Latina de Comunicación Social</i> , 72, pp. 197 to 219., http://www.revistalatinacs.org/072paper/1161/11en.html , DOI: 10.4185/RLCS-2017-1161en, 2017
28.	H. Dudek, W. Szczesny, "Correlates of Multidimensional Indicator of Quality of Life-Fractional Outcome Model Approach", <i>STATISTIKA-STATISTICS AND ECONOMY JOURNAL</i> , 97(4), 45-60, 2017.
29.	A. Siren, S.G. Knudsen, "Older adults and emerging digital service delivery: A mixed methods study on information and communications technology use, skills, and attitudes", <i>Journal of aging & social policy</i> , 29(1), 35-50, 2017.
30.	F. Ruiz-Rodríguez, A.L. Lucendo-Monedero, R. González-Relaño, "Measurement and characterisation of the Digital Divide of Spanish regions at enterprise level. A comparative analysis with the European context", <i>Telecommunications Policy</i> ,

	Volume 42, Issue 3, Pages 187-211, ISSN 0308-5961, https://doi.org/10.1016/j.telpol.2017.11.007 , 2018.
31.	P. Chipeva, F. Cruz-Jesus, T. Oliveira, Z. Irani, "Digital divide at individual level: Evidence for Eastern and Western European countries", <i>Government Information Quarterly</i> , 35(3), 460-479., DOI: 10.1016/j.giq.2018.06.003, 2018.
32.	J. Trilar, A. Kos, S. Jazbinšek, L. Jensterle, E. Stojmenova Duh, "ICT to Promote Well-Being within Families", <i>Sensors</i> , 18(9), 2760, 2018.
33.	A. Al-Muwil, V. Weerakkody, R. El-haddadeh, et al. "Balancing Digital-By-Default with Inclusion: A Study of the Factors Influencing E-Inclusion in the UK", <i>Inf Syst Front</i> 21, 635–659, https://doi.org/10.1007/s10796-019-09914-0 , 2019.
34.	S. Atarodi, A.M. Berardi, A-M. Toniolo, "Comparing local policy practices to implement ICT-based home care services for aging-in-place in Finland, France, Italy, Spain & Sweden", <i>Gerontechnology</i> , ISG International Society for Gerontechnology, 2019, 18 (2), 10.4017/gt.2019.18.2.005.00 . hal-02315164, 2019.
35.	L. Moreno, P. Martinez, "The harmonization of accessibility standards for public policies", <i>Computer</i> , 52(7), 57-66, 2019.
36.	I. Gal, A. Grotlüschen, D. Tout, G. Kaiser, "Numeracy, adult education, and vulnerable adults: a critical view of a neglected field", <i>ZDM Mathematics Education</i> , https://doi.org/10.1007/s11858-020-01155-9 , 2020.
37.	P. Bejaković, Ž. Mrnjavac, "The importance of digital literacy on the labour market", <i>Employee Relations: The International Journal</i> , 2020.
38.	J. Guenther, B. Smede, M. Young, "Digital inclusion in central Australia: what is it and what makes it different?", <i>Rural Society</i> , 1-17, 2020.
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3. Instructions for Formatting JIOS Articles

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Abstract

This document describes the required formatting of JIOS papers, including margins, fonts, citation styles, and figure placement. While the format requirements are only compulsory for final submissions, we strongly encourage authors to adopt this template, as well as its recommendations throughout the submission process. Abstract must not exceed 150 words. The abstract appears at the beginning of the paper, indented 0,5 cm from the left and right margins. The title "Abstract" should appear in bold face 11 pt, centered above the body of the abstract. The abstract body should be in 10 pt. Spacing between Abstract and author(s) affiliations is 36 pt, and spacing between "Abstract" title and abstract text is 6pt.

Keywords: formatting instructions, Microsoft word template, JIOS

3. Introduction

To ensure that all articles published in the journal have a uniform appearance, authors must produce a PDF document that meets the formatting specifications outlined in this document. The same document will be used for digital and hard copy version of the journal. Paper submission must be made in one ZIP archive which must include source document (ie. MS Word file) and PDF. When crating PDF make sure all fonts are embedded.

This document briefly describes and illustrates format used by JIOS journal. Your article should look as similar as possible to this document. This template can be obtained form journal web site at the address <http://www.jios.foi.hr>. Below the basic specifications, including font sizes, margins, etc. will be outlined. We encourage you to use this sample in case of any dilemma. For any questions you cannot decide, feel free to contact JIOS.

JIOS is published twice a year. 1st volume is published 30th of June, and 2nd volume 31st of December. All papers that enter copyediting process at least one month

before publishing date will be included in current volume. All papers that enter copyediting process less than one month from the publishing date will be included in the next volume.

4. Format and Margins

Papers must be in the single column format as shown in the enclosed sample. The page format should be set to B5. Left, right and top margin should be set to 2,2 cm while bottom margin should be set to 2,5 cm. Headers should be 1,27 cm from top and footer should be 2,18 cm from bottom of page. Title should be 36 pt below the header.

4.1. Fonts

You should use Times Roman style fonts. Please, do not use any non-standard fonts in your paper. They could make problems in formatting of the paper, as well as in printing.

4.2. Authors

Authors' names should appear in designated areas below the title of the paper in 12 pt bold type. Authors' affiliations and complete addresses should be in italics 11 pt, and their email addresses in 10 pt italic. If author is part of institution, organization or company, information should include full author name, full institution/organization/company name, town/city and country. If author is publishing as a private person, information should include full author name, full address (street address and number), town/city and country. Authors' affiliations and email address must be aligned according to the left and right paper margin.

4.3. Title, Headings and Sections

The title of the paper should be in 14 pt bold. When necessary, headings should be used to separate major sections of your paper. First headings should be in 12 pt bold and second headings should be in 11 pt bold. The text and body of the paper should be in 11 pt. Third-level headings should also be in 11 pt italic. Each heading should have 18 pt spacing above and 6 pt spacing below it. Do not skip a line between paragraphs. After a heading, the first sentence should not be indented.

Paper title and all headings should be capitalized. Please refer to Rules for Capitalization in Titles regarding capitalization of paper title and section headings.

References to sections (as well as figures, tables, theorems and so on), should be capitalized, as in "In Section 4, we show that...".

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Figures and tables should be inserted in proper places throughout the text. Do not group them together at the beginning of a page, nor at the bottom of the paper. Number figures sequentially, e.g., Figure 1, and so on.

The figure or table number and the caption should appear under the illustration. Spacing around caption should be 6 pt above and 11 pt below. Captions, labels, and other text in illustrations must be at least 9 pt.

	CPU Speed	Wage
A		
B		
C		

Table 1. Note well that JIOS expects table captions below the table. $\geq$ 9pt font.

We strongly suggest not to use color figures and pictures. Authors are responsible for providing grayscale figures and pictures without any loss of information.

When placing figures and tables in the paper please keep in mind possible blank spaces which might appear at the bottom of some pages. Please relocate paper elements (tables, figures and text) to fill existing blanks. While doing so pay attention not to create new ones.

4.5. Headers and Footers

Headers and Footers should be in 9 pt. All information in headers should be in small caps, respecting capital first letters. The first page of your article should include the short journal name, volume, number and year in the upper left corner, and the submission date and acceptance date in the upper right corner. The editor will let you know the volume, number, year, submission date and acceptance date.

On the even numbered pages, the header of the page should be the authors' names in the upper left corner and short title of the paper in the upper right corner. If paper title is too long to fit in the header (maximum 40 characters), please shorten the title and add three dots (...) at the end. Please do not abbreviate any title words. On the odd pages, starting with page 3, the header should be the full name of the journal, aligned right.

4.5.1. Page Numbering

Please do not add any page numbers in the article. They will be assigned by the publishing board at the bottom of the page in the center, as well as added in the footer of the article.

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We encourage authors to use footnotes sparingly, especially since they may be difficult to read online. Footnotes should be numbered sequentially and should appear at the bottom of the page, as shown below.¹

4.6. **References**

The reference section should be labeled "References" and should appear at the end of the paper. References must be ordered according to their appearance in the paper. Please prepare complete and accurate citations. References should be formatted according to the IEEE Citation reference. Do not include references that are not cited in the text of the paper.

Citations within the text should include the number of the reference in the reference section in the brackets, for example [1]. Multiple citations should be separated by a colon, as in [1], [2].

Acknowledgements

The acknowledgments section, if included, appears after the main body of the text and is headed "Acknowledgments." The section should not be numbered. This section includes acknowledgments of help from associates and colleagues, financial support, and permission to publish..

Appendix A: Title of the Appendix

Appendices, if included, follow the acknowledgments. Each appendix should be lettered, e.g., "Appendix A".

References

- [1] IEEEDataPort, "How to Cite References: IEEE Documentation Style" [Online]. Available: http://jios.foi.hr/guidelines/IEEE_Documentation_Style.pdf [Accessed: Jun. 5, 2018].
- [2] References should be indented on the left side by 0,63 cm and hanging must be set to 0,83 cm.
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¹ A footnote should appear like this. Please ensure that your footnotes are complete, fully punctuated sentences.

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