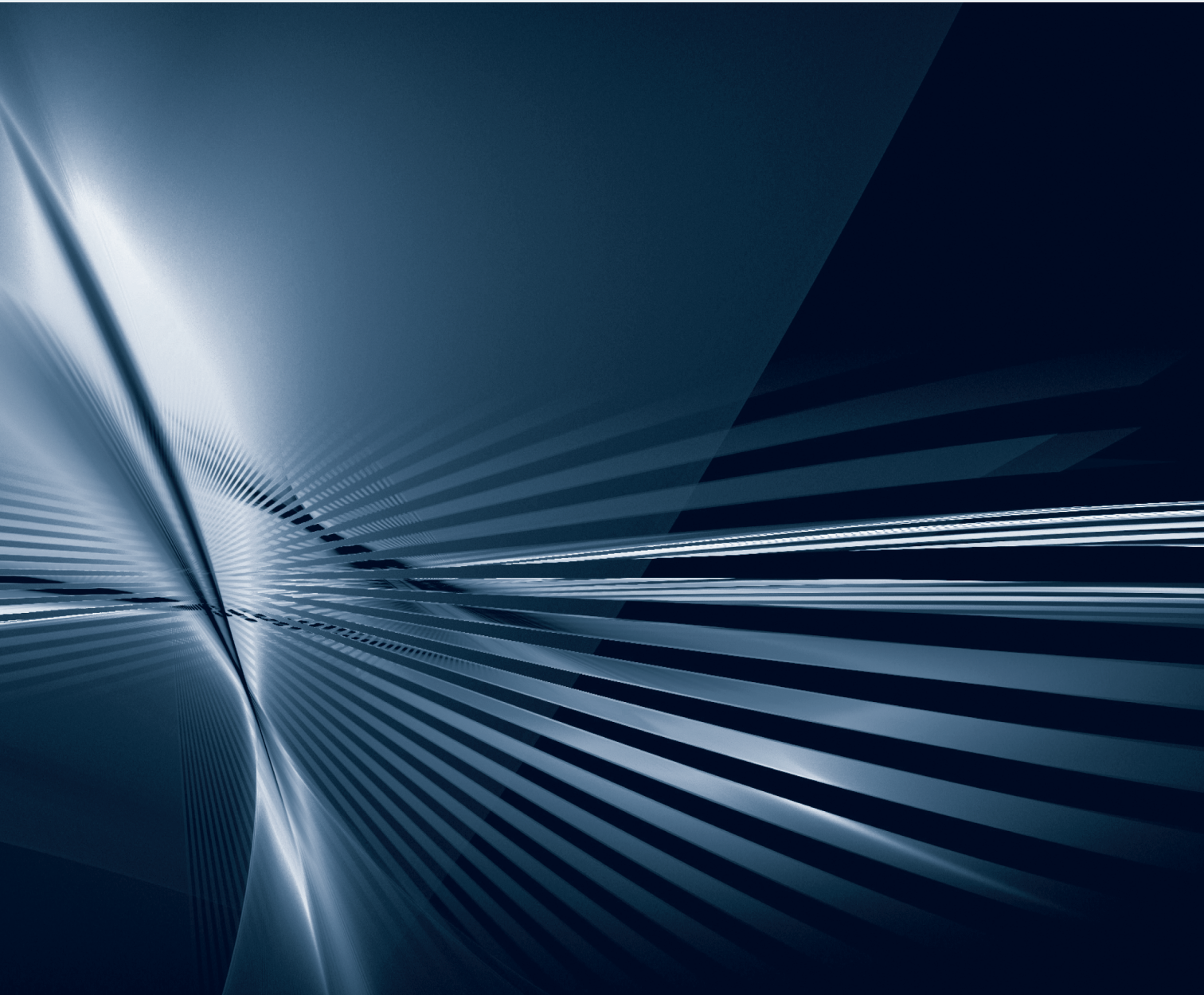


ORGANIZACIJA

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ORGANIZACIJA

Organizacija (Journal of Management, Informatics and Human Resources) is an interdisciplinary peer-reviewed journal which is open to contributions of high quality, from any perspective relevant to the organizational phenomena.

The journal is designed to encourage interest in all matters relating to organizational sciences and is intended to appeal to both the academic and professional community. In particular, journal publishes original articles that advance the empirical, theoretical, and methodological understanding of the theories and concepts of management and organization. The journal welcomes contributions from other scientific disciplines that encourage new conceptualizations in organizational theory and management practice.

We welcome different perspectives of analysis, including the organizations of various sizes and from various branches, units that constitute organizations, and the networks in which organizations are embedded.

Topics are drawn, but not limited to the following areas:

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- human resources management (such as organization & employee development, leadership, value creation through HRM, workplace phenomena etc.);
- managerial and entrepreneurial aspects of education;
- business information systems (such as digital business, decision support systems, business analytics etc.);
- enterprise engineering (e.g., organizational design, business process management, enterprise transformation paradigms etc.);
- papers that analyse and seek to improve organizational performance.

Organizacija (Revija za management, informatiko in človeške vire) je interdisciplinarna recenzirana revija, ki objavlja visoko kakovostne prispevke z vseh vidikov, ki so pomembni za organizacijske procese in strukture.

Revija je zasnovana tako, da spodbuja zanimanje za različne vidike v zvezi z organizacijskimi vedami in je namenjena tako akademski kot strokovni skupnosti. Revija objavlja izvirne članke, ki spodbujajo empirično, teoretično in metodološko razumevanje teorij in konceptov managementa in organizacije. Pozdravljamo tudi prispevke iz drugih znanstvenih disciplin, ki spodbujajo nove koncepte v organizacijski teoriji in praksi. Objavljamo članke, ki analizirajo organiziranost z različnih vidikov, so usmerjeni na organizacije različnih velikosti in iz različnih sektorjev, na enote, ki sestavljajo organizacije, in na mreže, v katere so organizacije vpete.

Teme so pokrivajo predvsem naslednja področja:

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- management človeških virov (kot so organizacija in razvoj zaposlenih, vodenje, ustvarjanje vrednosti s pomočjo človeških virov, organizacijski pojavi na delovnem mestu itd.);
- vodstveni in podjetniški vidiki izobraževanja;
- poslovni informacijski sistemi (kot so digitalno poslovanje, sistemi za podporo odločanju, poslovna analitika itd.);
- podjetniški inženiring (npr. organizacijsko oblikovanje, upravljanje poslovnih procesov, paradigme preoblikovanja podjetij itd.);
- članki, ki analizirajo organizacijsko uspešnost in prizadevanja za izboljšanje le-te.

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Application of the Altman Model for the Prediction of Financial Distress in the Case of Slovenian Companies

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Background/Purpose: The aim of this paper is to verify the applicability and accuracy of the Altman model in the case of Slovenian companies. The use of the Altman model is hugely popular and widespread among financiers, analysts and other stakeholders who want to determine the creditworthiness of a company's operations and the likelihood of it running into financial difficulties in the coming years.

Methods: The study was conducted on a sample of 66 Slovenian companies, which were divided into two equal groups: bankruptcy and non-bankruptcy companies. Based on accounting data for the last five years, the authors of this paper calculated the Z-Score, which is based on the Multiple Discriminant Analysis (MDA). By calculating the statistical error of the estimate (type I and II), the authors verified the extent (in percentage terms) to which the companies had been correctly classified by the model. The Mann-Whitney U test was used to check whether there was a difference in the average Z-Score between the two groups of companies.

Results: The authors determined that the reliability of the Altman model was 71.21% when tested at the upper bound (the threshold value of the Z-Score was 2.6) and 80.30% when tested at the lower bound (the threshold value of the Z-Score was 1.1). This is similar to other countries, where the reliability was found to be over 70% in most cases. Despite the lower reliability of the model, the Z-Score proved to be an important factor in differentiating between the two groups of companies, as bankruptcy companies had a lower value of this indicator than non-bankruptcy companies.

Conclusion: Based on the results of this study, as well as those of other studies, it can be summarized that the Altman model is a fairly good way for companies to determine the success of their business in a relatively simple and quick way and also to predict the potential risk of their operations in the future. However, since the reliability of the model is not 100%, it is important to be careful when making business predictions and carry out additional in-depth analyses or use other methods.

Keywords: *Financial distress, Altman Z''-Score model, Bankruptcy prediction, Multiple Discriminant Analysis, Slovenia*

1 Introduction

Each company has its own lifespan during which various ups and down occur. Some companies have a tradition dating back more than 100 years, while others cease their business activities after only a few years. In the short term the company aims to maximize current profits, while in the long term it aims to increase the value of the company it-

self. Some companies operating within a certain period of time are forced to fail to fulfill their obligations or be liquidated, due to financial difficulties (Martini et al., 2024). Reasons for the termination of a company's activities may vary. One of the most common reasons is financial distress, which manifests itself in insolvency and can subsequently lead to bankruptcy. Bankruptcy is a problem that can occur in a company if the company cannot maintain the stability of the company's performance. Bankruptcy

is a condition when a company suffers from insufficient funds to run its business (Yuna et al., 2020). In this case, it is highly important to be able to predict such an event and take appropriate measures in order to mitigate the consequences. The prediction of business distress and creation of a model that could predict financial distress with a sufficient degree of probability started as early as the end of 1930s, when the first research on the topic was carried out, mainly for banks to assess the creditworthiness (Fitzpatrick, 1932). Charles L. Merwin (1942) published a study on the prediction of financial distress, which held primacy in the field until 1966, when Beaver published a new study that was carried out on a sample of 79 companies that had gone bankrupt in the period between 1954-1964 (Beaver, 1966). The focus of this early studies was on the analysis of financial ratios in order to find financial indicators able to predict business failure (Bogdan et al., 2021). All these studies were based on a univariate statistical analysis, as they merely compared the successful companies with the unsuccessful ones. Nevertheless, they were still important, as they provided a good basis for all the subsequent studies, which were based on multivariate bankruptcy prediction methods. The first such study, which was based on discriminant analysis, was published in 1968 by Edvard I. Altman who developed a five-factor model for predicting bankruptcy of manufacturing companies listed on a stock exchange. The model predicted bankruptcy if the Z-Score value was lower than the critical value. The model was later extended by adding two new versions, namely for non-producing and unlisted companies. The Altman model has thus become one of the most recognized models for predicting a company's financial distress and is used by various companies, credit rating agencies, financial analysts and the like (Altman, 1968).

In the 1950s, predicting problems in the operations of companies and the possibilities of forecasting their bankruptcy also became an increasingly pressing issue in Slovenia, specifically in the banking, business and scientific spheres. Slovenia experienced its first bankruptcy at the end of 1990s, when it was still part of the former Yugoslavia. From then on, assessing the creditworthiness and predicting the bankruptcy of a company has not only become important for creditors, but also for owners, suppliers, customers, employees and other shareholders. The study, which Altman et al., (2014) conducted based on 35 countries, also included a sample of companies from Slovenia (n=41). The analysis in this study shows that while a general international model works reasonably well for most countries, with prediction accuracy levels (AUC - Area Under the Curve) of about 75% (72% for Slovenia), and exceptionally well for some (above 90%), the classification accuracy may be considerably improved with country-specific estimation, especially with the use of additional variables (Altman et al., 2014).

The aim of this paper is to test the usefulness of the

Altman model for the prediction of bankruptcy of Slovenian companies (n=66), in a similar way to the studies that were carried out in other countries, including Slovakia (Vavrek et al., 2021), Sweden (Charraud & Garcia Saez, 2021), Croatia (Galant & Zenzerović, 2023; Bogdan et al., 2019), Romania (Grosu & Macsim, 2019), Italy (Celli, 2015), Indonesia and Singapore (Muzanni & Yuliana, 2021), Turkey (Cindik & Armutlulu, 2021), Greece (Kokkoris & Anagnostopoulou, 2016) and other. Some authors only conducted studies on a specific industry, e.g. banking (Kokkoris & Anagnostopoulou, 2016), agriculture (Vavrek et al., 2021), pharmaceuticals (Panigrahi, 2019) and coal mining (Mulyati & Ilyasa, 2020), while others were not limited solely to a specific industry but included companies from the entire economy. These are just a few examples; in various countries, hundreds of studies can be found using the model. Some resulted in favor of the validity of the Altman Z-Score model, while others revised the model or offered more state-of-the-art technology-added methods (Cindik & Armutlulu, 2021).

2 Theoretical Background

Financial distress is defined as a condition in which a company had negative net income for several consecutive years (Hofer, 1980; Whitaker, 1999). Hopwood, McKeown & Mutchler (1994) stated that financial distress occurs when negative working capital, operating losses and negative retained earnings occur simultaneously. Despite these two definitions, a financial distress signal can also be seen from a company's financial statement. Brigham and Gapenski (1997) split the definition of financial distress into several types, namely economic failure, business failure, technical insolvency, insolvency in bankruptcy, bankruptcy and legal. Financial distress occurs prior to bankruptcy. Bankruptcy itself is usually defined as a situation in which companies fail or are no longer able to meet their obligations to the debtors because they are experiencing a shortage and insufficiency of funds (Ningsih & Filtri Permatasari, 2018). It is important to understand the difference between insolvency and bankruptcy, because the two terms are often confused. A company can be insolvent without being bankrupt, however, a company cannot be bankrupt without being insolvent. First, insolvency can be defined as the inability of a company to pay its debts in time, to counter this problem a company can borrow money from a bank, which will put the company in economic distress (Charraud & Garcia Saez, 2021).

2.1 Theories Examining Financial Distress

Theories that examine financial distress can be divided into two groups. The first consists of those theories that examine the causes or reasons of financial distress. According to Charraud and Garcia Saez (2021), these are the following: liquidity theory, solvency theory, pecking order theory, profitability theory, cash flow theory and the contagion effect. The second group includes more recent theories on which models that predict a company's bankruptcy are based. According to Aziz and Dar (2004), these are as follows: entropy theory, gambler's ruin theory, cash management theory and credit risk theory. These are discussed in more detail below.

a) Balance Sheet Decomposition Measure (BSDM) / Entropy Theory

One way of identifying a company's financial distress could be a careful look at the changes occurring in its balance sheets. If a company's financial statements reflect significant changes in its balance sheet composition of assets and liabilities over a reasonable period of time, it is more likely that the company is incapable of maintaining a state of equilibrium. Since these changes are likely to become uncontrollable in the future, it is possible to predict financial distress in these companies (Aziz & Dar, 2004).

b) Gambler's Ruin Theory

This probability-based theory, developed by Feller (1968), states that a gambler's capacity to win or lose money depends on chance. The theory assumes that the better commences gambling with a positive amount of cash (In the context of a company's financial distress, the company would take the place of a gambler. Like the gambler, we assume that the firm has a certain amount of cash that is constantly entering and existing the firm as it conducts its operations (Francis, 2022).

c) Cash Management Theory

An imbalance between cash inflows and outflows would mean failure of a company's cash management. Persistence of such an imbalance may cause the company financial distress and, hence, failure (Aziz & Dar, 2004). To avoid financial difficulties and subsequent insolvency, business should place a strong emphasis on proper cash management (Francis, 2022).

d) Credit Risk Theory

The credit risk theory is closely related to the Basel I and Basel II¹ Accords, which mostly refer to financial companies. Credit risk is the risk that a borrower/counterparty will default, i.e. fail to repay an amount owed to a bank. Credit risk includes all of the counterparties and

reasons for which they may default on their obligations to repay (Aziz & Dar, 2004).

2.2 Models for Predicting Company Bankruptcy

Throughout history, a large number of models for predicting bankruptcy have been developed using various quantitative methodologies, from simple regression modeling to very complex methods (Galant & Zenzerović, 2023). In practice, the Altman model (1968) has been the most widely used, and has also been the basis for other models, such as the Springate model (1978), the Ohlson model (1980), and the Zmijewski model (1984). The main difference between them lies in the methodological approach; while Altman used the MDA (Multiple Discriminant Analysis), Ohlson's model is based on logistic regression and Zmijewski's on probit analysis. In 1991, Peter Kralicek developed a model for German-speaking countries called the Kralicek Quick Test (Kralicek, 1991). Unlike the Altman model, which incorporates static indicators, the Kralicek Quick Test includes both dynamic and static indicators and is most commonly used in Germany, Switzerland and Austria (Šverko et al., 2017). The advantage of using all the above-mentioned models is the ability to quickly and simply assess a company's financial position, while the disadvantage is the limited accuracy of the forecasting assessment.

2.2.1 The First Altman Model (Z')

The original Altman model of 1968 included a sample of 66 American companies, of which 33 (half) went bankrupt, while the other half did not. The chosen companies came from the manufacturing industry, they were medium-sized and listed on the stock exchange in the period 1946-1965 (Altman, 1968). For all the companies, Edward I. Altman obtained financial statements and calculated 22 financial indicators relating to profitability, indebtedness, liquidity, activity and solvency (Alcalde et al., 2022). By using the MDA, he modelled these 22 indicators into five variables and developed a Z-Score model to predict whether or not a company would go bankrupt. The Z-Score model is a linear analysis, which uses five measures that are objectively weighted and summed up to arrive at an overall score that then becomes the basis for classification of companies into one of the a priori groupings: bankruptcy and non-bankruptcy (Altman, 2013). The model has the following form:

¹ Basel is a set of international banking regulations established by the Basel Committee on Banking Supervision (BCBS). It prescribes minimum capital requirements for financial institutions, with the goal of minimizing credit risk (https://www.investopedia.com/terms/b/basel_i.asp).

$$Z = 1.2 x_1 + 1.4 x_2 + 3.3 x_3 + 0.6 x_4 + 0.999 x_5 \quad (1)$$

where:

X1 = Working capital/Total assets

X2 = Retained Earnings/Total assets

X3 = EBIT (Operating income)/Total assets

X4 = Market value of equity/Book value of total liabilities

X5 = Sales/Total assets

Z' = Overall Index

The higher the Z-Score, the lower the risk of a company going bankrupt. Altman developed three zones: the safe zone, the grey zone and the distress zone. The safe zone ($Z > 2.99$) means that the company is in a good financial position and that it is not likely to go bankrupt in the next two years. The grey zone ($1.81 < Z < 2.99$) means that the company has financial difficulties, but the possibility of being saved and going bankrupt is just as great depending on the company's policy decisions. The distress zone ($Z < 1.81$) means that the company is in serious financial difficulties and that there may be a solvency issue or the possibility of bankruptcy of the company in the following two years (Altman, 2013).

2.2.2 The Second Altman Model (Z')

Since this original Altman model was only intended for the manufacturing companies listed on the stock exchange, it was later revised. In 1983, Altman developed a new model (Z'), which was designed for companies not listed on the stock exchange. In light of this, he replaced the market value of the capital with the book value in the numerator of the x4. variable. The other variables remained the same as in the original model. In this revised model, Altman also changed the constants in individual variables and slightly lowered the values of the intervals according to the bankruptcy prediction. This model has the following form (Altman, 1983):

$$Z' = 0.717 x_1 + 0.847 x_2 + 3.107 x_3 + 0.420 x_4 + 0.998 x_5 \quad (2)$$

Due to the change in the discriminant of the function, the intervals for the classification of companies into a relevant zone have also been changed: a value of $Z' > 2.9$ represents the safe zone, values in the range $1.23 < Z' < 2.99$ mean the grey zone and the values of $Z' < 1.23$ fall into the distress zone (Altman, 1983).

2.2.3 The Third Altman Model (Z'')

The third modification of the Altman model originates from 1995 and is called the Emerging Market System (EMS) or the Z'' and can be applied to both manufacturing and non-manufacturing companies (Altman, 2005). Unlike the revised model above (Z'), this model only includes the first four variables. Altman omitted the fifth variable (x5)

$$Z'' = 6.56x_1 + 3.26x_2 + 6.72x_3 + 1.05 x_4 \quad (3)$$

due to the possible influence of the activity on the value of the dependent variable. He also changed the constants of the variables, which are higher than in the previous two models. The advantage of this model is it is also suitable for companies not listed on the stock exchange and for the companies engaged in non-manufacturing activities. This model was also used in our study and takes the following form:

where:

X1 = Working capital/Total assets

X2 = Retained Earnings/Total assets

X3 = Operating income/Total assets

X4 = Book value of equity/Total liabilities

Z' = Overall Index

In this case, too, the values of the intervals for the classification of companies into zones have lowered because of the changed discriminant function: a $Z'' > 2.6$ value means the safe zone, values in the $1.10 < Z'' < 2.60$ range represent grey zone and values of $Z'' < 1.10$ mean the distress zone (Altman, 2005).

3 Methodology

The study was carried out in three steps. First, the authors created a study sample, which was then stratified into two groups – the first stratum included companies that had gone bankrupt or into liquidation in the past (hereinafter referred to as 'bankruptcy companies'), and the second stratum consisted of companies that were still in business (hereinafter referred to as 'non-bankruptcy companies'). A random sampling was carried out within the stratum, whereby each of the two stratums included 33 companies, thus resulting in a total sample of 66 companies. The data were obtained from AJPES².

The second step involved obtaining data for every company from its financial statements (balance sheet and profit and loss account) for the last five years of its operations (the five years preceding insolvency proceedings

² AJPES manages the Slovenian Business Register as a central public database for all business entities, their subsidiaries and other organization segments located in Slovenia that are engaged in profitable or non-profitable activities (<https://www.ajpes.si/?language=english>).

for the unsuccessful companies and the last five years of operation for the successful companies), i.e. from 2017 to 2022. The source of the data was the Slovenian credit rating agency BIZL.si, which provides access to financial statements (balance sheet and profit and loss account) for each company for previous periods.

In the third step, the third Altman Z-Score model (Z'') was applied, which is based on MDA. The MDA is a statistical technique used to classify an observation into one of several a priori groupings dependent upon the observation's individual characteristics (Altman, 2013). It is used primarily to classify and/or make predictions for problems where the dependent variable appears in qualitative form, for example, male or female, bankrupt or non-bankrupt. In its most simple form, MDA attempts to derive a linear combination of the characteristics that 'best' discriminate between the groups. If a particular object, for instance, a corporation, has characteristics (financial ratios) that can be quantified for all of the companies in the analysis, the MDA determines a set of discriminant coefficients (Altman, 2013).

The aim of this study was to build a model that best distinguishes between bankruptcy and non-bankruptcy companies on the basis of four independent variables (calculated on the basis of data from financial statements). Using financial statement data for the last five years, the authors first calculated the average value for all four independent variables (x_1, x_2, x_3 in x_4), which we then weighted with the suitable factors and calculated the value of the dependent variable Z'' on the basis of equation 3. Based on the value of Z'', the companies were divided into three zones, which show the likelihood that a company would go bankrupt in the future. Figure 1 shows the conceptual model of the research.

The main purpose of the study was to test the usability of the Altman model in the case of Slovenian companies. In doing so, the authors formed the following two hypoth-

eses:

H1: There is a significant difference in the value of the Z''-Score between bankruptcy and non-bankruptcy companies.

The authors predict that bankruptcy companies will have a lower Z''-Score value than non-bankruptcy companies. Our hypothesis is established on the theoretical starting points, which explain the reasons for the bankruptcy and represent the basis for the creation of independent variables in the Altman model. These refer to profitability, indebtedness, liquidity, activity and solvency. Higher values of the independent variables are also associated with a higher Z''-Score value, which could thus distinguish between bankruptcy and non-bankruptcy companies.

H2: The Altman model will correctly classify at least 75% of companies.

The Altman model is relatively simple and allows for a quick assessment of the performance of companies. However, it also has a limitation, which is reflected in the limited reliability of the assessment. This has also been discovered by other authors in the case of other countries: for example, the model proved to be 72% reliable for Croatian companies (Bogdan et al., 2019), 78% for Italian companies (Celli, 2015) and 76% for Turkish companies (Cindik & Armutlulu, 2021).

4 Results

4.1 Sample Description

The sample of companies (n=66) was stratified into two equally sized groups: bankruptcy companies (n=33) and non-bankruptcy companies (n=33). The sample was balanced in terms of both the industry (manufacturing, service and trading companies) and the legal form (public limited companies and private limited companies) of

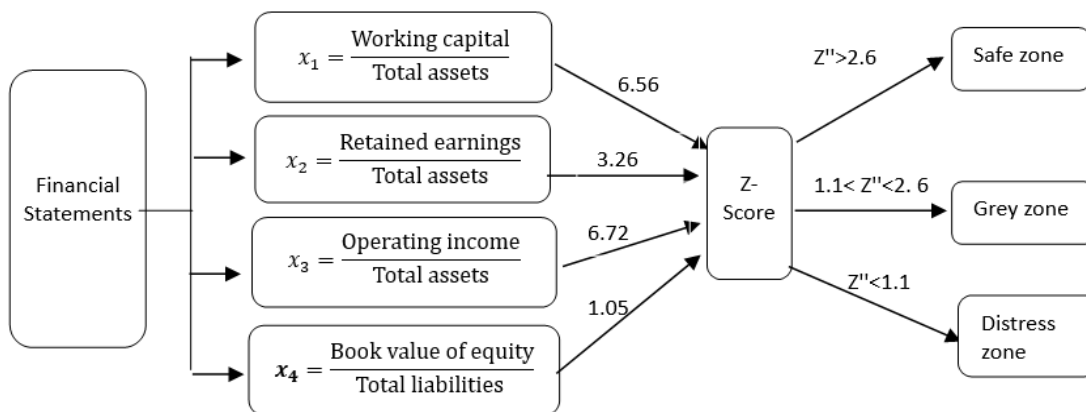


Figure 1: Graphical Representation of the Research Model

both groups of companies, as can be seen in Table 1. Both groups are dominated by service companies (69.7% or 66.7% respectively) and private limited companies (75.8% or 78.8% respectively). There is only a slight difference in the sample structure in terms of the size of companies, with the share of small companies being 63.6% for non-bankruptcy companies and 42.4% for bankruptcy companies.

4.2 Descriptive Statistics of Variables in the Altman Model

Based on the data obtained, the authors of this paper calculated all four variables of the Altman Z'' model and weighted them accordingly. The table below shows the descriptive statistics for the variables (x1 do x4), separately for bankruptcy and non-bankruptcy companies. As can be seen in the table below, the mean value of all four variables is positive for non-bankruptcy companies and negative for bankruptcy companies (with the exception

of the x4 variable). This means that the indicators for the successful companies are on average significantly higher and, consequently, reach values higher than 0 compared to the unsuccessful companies, where the average values are lower than 0.

Below, a more detailed commentary has been provided for each variable separately:

a) X1: Working capital/Total assets

This ratio (x1) is the measure of liquidity by comparing net liquid assets with total assets. Working capital is defined as the difference between current assets and current liabilities (Altman, 2013). Its average value is -0.215 (SD = 0.441) for bankruptcy companies and 0.214 (SD = 0.231) for non-bankruptcy companies. The reason behind the negative values is the negative working capital, which means that for bankruptcy companies the current liabilities are higher than the current assets. In contrast, working capital is positive in the case of non-bankruptcy companies, which means that short-term assets are higher than short-term liabilities and this has a positive impact on

Table 1: Discriminant validity

	Companies				
	Bankruptcy (n=33)		Non-bankruptcy (n=33)		
	N	%	N	%	
Industry	Manufacturing	3	9.1%	3	9.1%
	Services	23	69.7%	22	66.7%
	Trade	7	21.2%	8	24.2%
Size	Small	21	63.6%	14	42.4%
	Medium-sized	5	15.2%	12	36.4%
	Large	7	21.2%	7	21.2%
Legal form	Public limited company	8	24.2%	7	21.2%
	Private limited company	25	75.8%	26	78.8%

Table 2: Descriptive Statistics of Independent Variables

Companies		x1	x2	x3	x4
Bankruptcy	Mean	-0.215	-0.216	-0.111	0.119
	Std. deviation	0.441	0.326	0.219	0.285
	Minimum	-1.243	-0.784	-0.792	-0.322
	Maximum	0.590	0.450	0.160	1.058
Non-bankruptcy	Mean	0.124	0.192	0.059	1.176
	Std. deviation	0.231	0.299	0.051	0.771
	Minimum	-0.275	-1.010	-0.012	-0.043
	Maximum	0.648	0.581	0.179	3.826

a company's liquidity. A company with negative working capital is likely to experience problems meeting its short-term obligations because there are simply not enough current assets to cover those obligations (Mcclure, 2022). A Mann-Whitney U test was performed to evaluate whether x_1 differed by companies. The results indicated that bankruptcy companies had a significantly lower x_1 value of than non-bankruptcy companies ($Z = -3.610$; $p = 0.000$).

b) x_2 : Retained earnings/Total assets

Retained earnings is the account which reports a company's total amount of reinvested earnings and/or losses over its entire life. This ratio measures the amount of reinvested earnings or losses, which reflects the extent of the company's leverage. Companies with low ratios are financing capital expenditure through borrowings rather than through retained earnings. Companies with high ratios suggest a history of profitability and the ability to stand up to a bad year of losses (Mcclure, 2022).

Table 2 shows that the mean value of this indicator for bankruptcy companies is negative ($M = -0.216$; $SD = 0.326$), indicating that these companies were loss-making in the past and that this loss exceeded profits made in the previous years. In the case of non-bankruptcy companies, the mean value is positive ($M = 0.192$; $SD = 0.299$), which suggests that this group of companies generated profit that exceeded any loss. Profits were not shared by the owners, but were instead retained in the company. A Mann-Whitney U test was performed to evaluate whether x_2 differed by companies. The results indicated that bankruptcy companies had a significantly lower x_2 value than non-bankruptcy companies ($Z = -4.931$; $p = 0.000$).

c) x_3 : EBIT/Total assets

This ratio is a measure of the true productivity of a company's assets, independent of any tax or leverage factors. Since a company's ultimate existence is based on the earning power of its assets, this ratio appears to be particularly appropriate for studies dealing with corporate failure. Furthermore, insolvency, in the sense of bankruptcy occurs when the total liabilities exceed a fair valuation of the company's assets with value determined by the earning power of the assets (Altman, 2013). The ratio is a version of return on assets (ROA), an effective way of assessing a company's ability to squeeze profits from its assets before deducting factors such as interest and tax (Mcclure, 2022). Ratio x_3 made the highest contribution to discrimination power in this version of model.

Table 2 shows that the interpretation of this indicator is similar to the previous two. For bankruptcy companies, the mean value is negative ($M = -0.111$; $SD = 0.219$), indicating that they are generating negative EBIT (Earnings Before Interests and Taxes) or operating losses. For non-bankruptcy companies, the mean value is positive ($M = 0.059$; $SD = 0.051$), which suggests that the company generated a positive EBIT or operating profit. A Mann-Whitney U test was performed to evaluate whether x_3 differed by companies.

The results indicated that bankruptcy companies had a significantly lower x_3 value than non-bankruptcy companies ($Z = -5.444$; $p = 0.000$).

d) x_4 : Market value of equity/Book value of total liabilities

This ratio shows how much the company's market value would decline before liabilities exceed assets on the financial statements if a company were to become insolvent. This ratio adds a market value dimension to the model that is not based on pure fundamentals. In other words, a durable market capitalization can be interpreted as the market's confidence in the company's solid financial position (Mcclure, 2022).

Table 2 clearly shows that the mean value of this indicator for bankruptcy companies is 0.119 ($SD = 0.285$) and 1.176 ($SD = 0.771$) for non-bankruptcy companies. By using the Mann-Whitney U test, the authors determined that bankruptcy companies had a significantly lower x_4 value than non-bankruptcy companies ($Z = -6.137$; $p = 0.000$).

4.3 Z''-Score Value

Based on the third Altman model (equation 3), the authors of this paper calculated the Z''-Score separately for both groups of companies, noting that the mean value of the Z''-Score for bankruptcy companies is -2.66 ($SD = 4.72$) and 3.07 ($SD = 2.80$) for non-bankruptcy companies. The value of the Z''-Score indicator in half of the bankruptcy companies was less than or equal to -1.95, while the median for non-bankruptcy companies equated to 2.61. The distribution for bankruptcy companies is asymmetric to the left and slightly conical, while it is slightly asymmetric to the right and slightly flattened for non-bankruptcy companies.

Verifying the first hypothesis:

The authors of this paper also wanted to determine whether, when using the first hypothesis, there was a statistically significant difference in the Z''-score value between both groups of companies. First, the Kolmogorov-Smirnov test was used to check how the variable was distributed. It was determined that it was not distributed normally ($p = 0.07$), hence the non-parametric Mann-Whitney U-test was used to verify the hypothesis. The results indicated that bankruptcy companies had a significantly lower Z''-Score value than non-bankruptcy companies ($Z = -4.982$; $p = 0.000$). This allows the hypothesis to be confirmed with a 5% risk.

4.4 Classification of Companies into the Corresponding Zones

Based on the discriminant analysis, Altman divided the companies into three groups (zones), as described in the previous chapter:

- Safe Zone $Z'' > 2.60$
- Grey Zone $1.10 < Z'' < 2.60$
- Distress Zone $Z'' < 1.10$

Similarly, for the purposes of this study, the authors also re-coded the value of the Z-Score into three groups. The data can be seen in the table below. For bankruptcy companies, the share of companies in the distress zone is

81.8%, while it is 9.1% in both the grey and safe zones. In the case of non-bankruptcy companies, the largest share of companies can be found in the safe zone (i.e. 51.5%), followed by those companies in the grey zone (i.e. 27.3%) and the distress zone (i.e. 21.2%).

Table 3: Descriptive Statistics of the Z''-Score Value

	Companies	
	Bankruptcy	Non-bankruptcy
Mean	-2.66	3.07
Median	-1.95	2.62
Std. deviation	4.72	2.80
Variance	22.27	7.85
Minimum	-15.39	-3.68
Maximum	5.49	8.36
Range	20.88	12.04
Kurtosis	0.24	-0.18
Skewness	-0.65	0.09

Table 4: Mann Whitney U Test

Companies	N	Mean Rank	Sum of Ranks
Bankruptcy	33	21.73	717.00
Non-bankruptcy	33	45.27	1,494.00
Total	66		
Mann-Whitney U	156.000		
Wilcoxon W	717.000		
Z	-4.982		
Asymp. sig. (2-tailed)	0,000		

Table 5: Classification of Companies into Zones

	Companies				
	Bankruptcy (n=33)		Non-bankruptcy (n=33)		
	N	%	N	%	
Altman model	Distress Zone	27	81.8%	7	21.2%
	Grey Zone	3	9.1%	9	27.3%
	Safe Zone	3	9.1%	17	51.5%

4.5 Reliability of the Assessment

The explanatory ability of the Altman model is verified by the calculation of the type I error (α) and type II error (β). The primary error types associated with the Altman’s Z-Score model are:

1. Type I Error (False Positive): This occurs when the Z-Score predicts financial distress or bankruptcy for a company that does not actually go bankrupt. The formula for the calculation of a type I error is as follows (Bogdan et al., 2019, pp.38):

$$\text{Type I Error} = 1 - \frac{CCF_{BF}}{n_{BF}} \tag{4}$$

Where:

- CCF BF – Correctly classified companies (bankruptcy companies)
- nBF- Sample size for bankruptcy companies

As is apparent from Table 6, the Altman model was used to classify a total of 33 bankruptcy companies, of which 30 (90.91%) were classified according to the upper bound of the interval ($Z'' < 2.6$) and 27 (81.81%) according to the lower bound ($Z'' < 1.1$).

2. Type II Error (False Negative): This occurs when the Z-Score fails to predict financial distress or bankruptcy for a company that does go bankrupt or experiences financial difficulties. In this case, the model incorrectly identifies a company with financial troubles as safe. The formula for the calculation of a type I error is as follows (Bogdan et al., 2019):

Where:

$$\text{Type II Error} = 1 - \frac{CCF_{NBF}}{n_{NBF}} \tag{5}$$

- CCF NBF - Correctly classified companies (non-bankruptcy companies)
- nNBF - Sample size for non-bankruptcy companies

As can be seen in Table 7, out of all 33 non-bankruptcy companies, the Altman model correctly classified 17 companies (51.51%) according to the upper bound of the interval ($Z'' > 2.6$) and 26 companies (78.78%) according to the lower bound of the interval ($Z'' > 1.1$).

By combining the data from Tables 6 and 7, it can be observed that, in relation to the threshold of 2.6, 47 companies (71.21%) were correctly classified, while 53 companies (80.31%) were correctly classified in relation to the threshold of 1.1, as shown in Table 8.

Table 6: Classification of Bankruptcy Companies According to the Upper and Lower Bound of the Z''-Score Model

		Correctly classified companies - ($Z'' < 2.6$)	Type I Error ($Z'' > 2.6$)	Correctly classified companies ($Z'' < 1.1$)	Type I Error ($Z'' > 1.1$)	Total
Bankruptcy companies	n	30	3	27	6	33
	%	90.91%	9.09%	81.81%	18.19%	100.00%

Table 7: Classification of Non-bankruptcy Companies According to the Upper and Lower Bound of the Z''-Score Model

		Correctly classified companies ($Z'' < 2.6$)	Type II Error ($Z'' > 2.6$)	Correctly classified companies ($Z'' < 1.1$)	Type II Error ($Z'' > 1.1$)	Total
Non-bankruptcy companies	n	17	16	26	7	33
	%	51.51%	48.49%	78.78%	21.22%	100.00%

Table 8: Classification of the Entire Sample According to the Upper and Lower Bound of the Z''-Score Model

		Correctly classified companies	Incorrectly classified companies	Correctly classified companies	Incorrectly classified companies	Total
		Limit value=2.6	Limit value=1.1			
All companies	n	47	19	53	13	66
	%	71.21%	28.79%	80.31%	19.69%	100.00%

Verifying the second hypothesis:

When testing the upper bound (the Z''-Score limit value was 2.6) using the Altman model, it was possible to correctly classify 47 companies (71.21%), while 53 companies (80.30%) were correctly classified when testing the lower bound (the Z''-Score limit value was 1.1). If this estimate were to be generalized according to the population with the estimate of the percentage, it can be estimated with a 5% risk that the model would correctly classify between 60.29% and 82.14% of the companies in the entire population (when estimating the upper limit value of 2.6), or between 70.71% and 89.99% (when estimating the lower limit value of 1.1). As hypothesis H2 assumed that the model would correctly classify at least 75% of companies, the authors can confirm the hypothesis, as the value of 75% falls within both the first and the second interval.

5 Discussion

The Altman model is still one of the most widely used predictive models in the 21st century, and it aims to highlight the differences between bankrupt and healthy companies. This model has been modified several times; its most well-known forms are from 1968, 1983 and 1995 (Vavrek et al., 2021). By November 2023, the study of Altman's model had accumulated 24,836 citations (Google Scholar, October 11, 2023), showing that this pioneering work in the field of corporate failure prediction has spread worldwide. As demonstrated by the results of various studies, the Altman model represents a fairly good way for companies to identify the performance of their business in a relatively simple and quick way, and also to predict the potential risk of that business in the future. Due to the fact that insolvency is a problem that concerns different social actors, such as shareholders, suppliers, financial institutions and workers, it is important to know the predictive capacity of the Altman model in order to make adequate decisions (Fito et al., 2018). This model can provide any owner, investor or lender with an indicative assessment of a company's financial stability. This is all the more important in times of financial crisis or potential recession. Companies need to be vigilant and detect problems in time in their own company or with their business partners.

Using a sample of Slovenian companies (n=66), which included both bankruptcy and non-bankruptcy companies, the aim of this study was to discover whether the Altman model is also applicable to Slovenian companies. To this end, the authors set two hypotheses, both of which were confirmed. The first hypothesis was intended to determine how good the model is at estimating the mean value of the Z''-Score between the two groups of companies. It was determined that the Z-Score value was higher in bankruptcy companies than in non-bankruptcy companies. In this respect, the Altman model is useful for a first, more general assessment of a company's performance and could also be

used to assess a company's creditworthiness. By using the second hypothesis, the authors wanted to see how reliable the model is at estimating the probability of a company going bankrupt in the future. In order to verify the hypothesis, interval estimation of the type I and II errors were used. This study has shown that the reliability of the model turned out to be 71.21% in the case of the upper bound estimation, and 80.30% in the case of the lower bound estimation. The reliability of the model has also been shown to be between 70% and 80% in studies carried out in other countries (Bogdan et al., 2019; Celli, 2015; Cindik, & Armutlulu, 2021), however, there are also some studies in which the reliability of the model is lower. In this regard, the authors confirmed the second hypothesis, which predicted that the model would have a reliability of more than 70%. However, no foreign studies have confirmed the 100% reliability of the Altman model, which means that it is necessary to be cautious when making predictions about business performance.

As a result of the above, it can be concluded that the Altman model is not the most reliable method for predicting a company's bankruptcy, however, it is certainly very useful and suitable for the first assessment of a company's performance. Therefore, it is preferable to use another method (e.g. the logit model) or a more in-depth analysis in addition to the Altman model in order to complement this assessment. The Altman model is also not suitable for newly-formed businesses, as financial statements from previous periods are required in order to carry out a successful analysis. Hence, this topic has become one of the main concerns of the analysts and they are still having difficulties finding a reliable tool for the risks and threats of failure of the companies (Cindik & Armutlulu, 2021).

This study offers a basic overview of the applicability of the Altman model. However, there are certainly numerous possibilities for further studies, e.g. a study could be done for just one industry (construction, hospitality, tourism, etc.) or the Z-Score could be calculated separately for each year, which would determine whether the Z''-Score is higher in the years running up to bankruptcy than in the previous years. It would also be sensible to revise the Altman model and calculate a separate MDA function in the case of Slovenian companies, or to compare the calculations under this model with other methods (logit) or models, such as the Springate, Ohlson or Zmijewski models. Due to the ever-increasing use of artificial intelligence and machine learning, it would also make sense to verify the methods of determining a company's creditworthiness.

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Uporaba Altmanovega modela za napoved finančnega neuspeha na primeru slovenskih podjetij

Izhodišče/Namen: Namen članka je verificirati uporabnost in zanesljivost Altmanovega modela na primeru slovenskih podjetij. Uporaba Altmanovega modela je zelo priljubljena in razširjena tako med finančniki, analitiki in ostalimi interesnimi skupinami, ki želijo ugotoviti boniteto poslovanja podjetja in verjetnost, da bi podjetje v prihodnjih letih zašlo v finančne težave.

Metode: Raziskavo smo naredili na vzorcu 66-ih slovenskih podjetij, ki smo jih razdelili v dve enako veliki skupini: podjetja v stečaju in uspešna podjetja. Na podlagi računovodskih podatkov za obdobje zadnjih petih let smo izračunali s pomočjo Altmanovega modela izračunali vrednost Z'' , ki temelji na multipli diskriminanti analizi. Z izračunom napake ocene (tipa I in II) smo preverili v kolikšnem % je model pravilno razvrstil podjetja. Z izračunom Mann-Whitney U testa pa smo preverjali ali obstaja razlika v povprečni višini vrednosti Z'' med obema skupinama podjetij.

Rezultati: Ugotovili smo, da je zanesljivost Altmanovega modela 71,21 % pri testiranju na zgornjo mejo (mejna vrednost Z'' je 2,6) pri testiranju na spodnjo mejo pa 80,30 % (mejna vrednost Z'' je 1,1), kar je podobno kot v ostalih državah, kjer se je ta zanesljivost v večini primerov izkazala za več kot 70 %. Kljub slabši zanesljivosti modela, pa se je izkazalo, da je vrednost Z'' pomemben dejavnik pri razlikovanju med obema skupinama podjetji, saj so podjetja v stečaju dosegla nižjo vrednost tega kazalnika kot uspešna podjetja.

Zaključek: Na podlagi rezultatov naše raziskave in tudi ostalih raziskav lahko povzamemo, da je je Altmanov model dokaj dober način, da lahko podjetja na razmeroma enostaven in hiter način ugotovijo uspešnost poslovanja podjetja in napovejo tudi morebitno tveganje tega poslovanja v prihodnost. Ker pa njegova zanesljivost ni 100 % moramo biti pri napovedi poslovanja tudi previdni in izvesti še kakšno drugo poglobljeno analizo ali uporabiti kakšno drugo metodo.

Ključne besede: Finančni neuspeh, Altmanov model, Napoved stečaja, Multipla diskriminanta analiza

Workplace Flexibility: Identifying New Trends and Directions from the Grey Literature Sources

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Background and purpose: This literature review examines labour market trends, focusing on workplace flexibility. It analyses grey literature and statistical reports to understand the impact of policies promoting sustainable digitisation. The analysis seeks to understand how these strategies have influenced labour market dynamics.

Methodology: The research utilised descriptive and compilation techniques to analyse grey literature, focusing on theoretical frameworks and temporal trends. It analysed non-traditional publications, reports, and statistical data to understand emerging labour market trends, particularly workplace flexibility and sustainable digitisation policies. This approach provided unique insights beyond traditional academic publications.

Results: Three major themes were identified by the review of grey literature sources. First is the impact of digitalisation on the labour market, the second is flexible working arrangements, and the third is working time flexibility.

Conclusion: The digital revolution transforms lifestyles and practices, leading to novel work forms. The pandemic has accelerated this trend, focusing on digitisation for work optimisation and flexibility. These new work forms increase productivity efficiency and reduce operational costs. Technological integration affects work quality and employee competencies, influencing the workforce's needs.

Keywords: Flexible forms of work, Flexible working hours, Digital workplaces, Digital skills, Grey literature sources

1 Introduction

Flexible employment encompasses a wide range of non-standard work arrangements, including part-time, temporary, and self-employment, as well as freelancing, subcontracting, and teleworking (Felstead & Jewson, 1999). It can introduce insecurity and upskilling opportunities, depending on the type of flexibility (Barbieri, 2009). However, it has hidden costs, such as low-productivity jobs and increased inequality (Rubery et al., 2016). Legislative reforms and measures are needed to balance flexibility, stability, and worker protection (Shibata, 2022).

As defined by Hill et al. (2008), work flexibility re-

fers to workers' ability to choose when, where, and how long they engage in work-related tasks. This concept is crucial in operations management, where it is used to manage labour capacities and capabilities to mitigate system imbalances caused by uncertainties and changes (Qin et al., 2015). In the workplace, flexibility can be a coping mechanism for workers, allowing them to create short-term opportunities for flexibility within a structured environment (Root & Young, 2011). It is also associated with better self-reported health, although it may not necessarily reduce organisational healthcare costs (Butler et al., 2009).

New forms of work are global expansion and include platform work, employee sharing, job sharing, i.e. part-

time work, casual work, mobile work based on ICT, i.e. digital nomads, internal management, i.e. hiring workers, portfolio work. All this follows the development of talents as a human resources development model that offers opportunities for retraining and continuous improvement. Digitisation (Tretter & Burns, 2023) makes the boundaries of business extraction more and more flexible. However, Kossek and Michel's (2011) research on work flexibility describes the significant benefits for women of family planning, opportunities for work and education, and longer absences from work to recover from serious illnesses or during military service. Expectations about where and when someone should work can change as work moves into non-working hours, and employees struggle to live a predictable life outside of work, as Kossek et al. (2021) concluded.

A range of studies have explored the concept of flexible employment, with Bessa and Tomlinson (2017) identifying key themes and debates in this area. Morley et al. (1995) and Rodgers (2007) both caution against oversimplifying the relationship between labour market flexibility and employment, with Morley et al. (1995) noting a trend towards greater flexibilisation in the Irish labour market and Rodgers (2007) emphasising the need to consider flexibility within a wider framework of policies and institutions. Bal and Jansen (2016) emphasise the need for a joint approach to negotiating workplace flexibility, particularly for older workers. Collectively, these studies underscore the need for a nuanced understanding of the challenges and opportunities associated with flexible employment. These are just a few examples of the literature reviews on flexible employment (e.g. Omondi & K'obonyo, 2018). However, these literature reviews were based on academic papers. Conversely, grey literature, particularly commercial white papers, can be a valuable source of information for business practitioners and can be accessed through online databases and search engines (Juricek, 2009).

Grey literature, which includes research reports and government publications, is a valuable resource for studying business issues (Paez, 2017). It can provide data not found in commercially published literature, reducing publication bias and increasing the comprehensiveness of reviews (Paez, 2017). However, there are challenges in accessing and preserving this type of literature, particularly regarding diversity and digital preservation (Marsolek et al., 2021). Despite these challenges, grey literature can be useful in validating research-based literature search results (Benzies et al., 2006).

The main aim of this article is to identify and analyse trends pertaining to the sustainable implementation of digitisation policies and initiatives based on the grey literature review. This analysis is based on grey literature sources, encompassing past research and data studies published by consulting companies, government bodies and international organisations. The research is specifically centred on

comprehending the impact of digital technologies on the labour market, particularly in improving workplace flexibility.

The study aims to present a comprehensive perspective on the current dynamics of the labour market, emphasising digital technology's crucial influence on future work practices and regulations. This comprehensive analysis seeks to provide significant insights for both academic and practical applications in labour market studies and the adoption of digital technology.

A methodical and thorough examination of relevant worldwide grey literature sources supports this work. The sources have been carefully chosen for their pertinence to the domains of innovation and the impact of digital technologies in business, specifically in their contribution to advancing progress through practical research.

The article is organised across multiple pivotal sections, each focusing on separate facets of labour market changes and digital technologies. After the introduction, the methodology is elaborated in the second chapter. The third chapter segment explores the phenomenon of digital technology and its complicated interconnection with society and the economy. Following that, the research examines the notion of flexibility in working hours, especially utilising a reduced work week, in the fourth section. This is accomplished by analysing diverse experimental models adopted in various countries. The purpose of the analysis in this section is to offer a thorough comprehension of the use and efficacy of these models in improving work-life balance and productivity. The concluding chapter centres on the adaptability of the workplace in response to the increasing demand for inventive work arrangements.

2 Methodology

Conducting a grey literature review on work flexibility began with defining the research question or topic, where the aim was to gain a deeper understanding of various aspects and trends in work flexibility. Following this, a search strategy was developed, following the approach of Adams et al. (2017), which involved identifying relevant keywords and phrases related to work flexibility. This strategy guided the search across various databases and sources rich in grey literature, such as government websites, institutional repositories, and conference proceedings.

The next phase involved thoroughly searching for grey literature using pre-determined keywords and sources. This process was meticulously documented, capturing details like search dates, sources searched, and specific terms used, saved in multiple databases (Piotrowski, 2007). After accumulating a range of materials, the screening and selection process commenced. Titles and abstracts were reviewed to assess their relevance, applying specific inclusion and exclusion criteria to refine the selection.

Critical appraisal was an essential step in evaluating the selected grey literature’s quality and relevance. This assessment looked at the credibility of the sources, the methodologies employed, and the validity of the findings presented, particularly concerning work flexibility. Data extraction and synthesis followed, extracting key information and data pertinent to work flexibility from each source. This step involved organising and synthesising the findings that addressed the research question or topic centred on work flexibility.

The final step in this narrative approach involved managing potential biases (Mahood et al., 2014). To counteract this, a broad range of sources was included to provide a balanced and comprehensive view of work flexibility.

The process of a grey literature review is outlined in Figure 1.

The review of grey literature sources revealed three major themes, each pivotal in understanding the current dynamics of the labour market in the context of digitalisation (Figure 2).

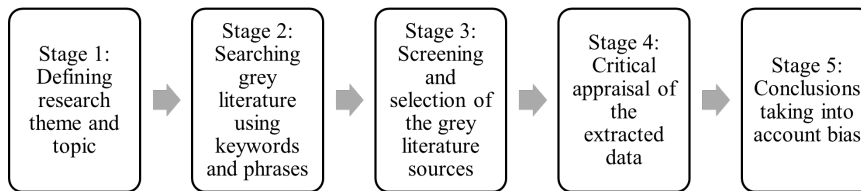
The first theme centres on the impact of digitalisation on the labour market. This encompasses how technological advancements reshape job structures, employment

opportunities, and skill requirements in various industries.

The second theme delves into flexible working arrangements. This aspect explores the evolving nature of work environments and practices, considering how flexibility in location, job roles, and collaborative models are integrated into modern workplaces. This theme is particularly relevant in understanding how businesses and employees adapt to the increasing work-life balance demand and the opportunities presented by remote and hybrid work models.

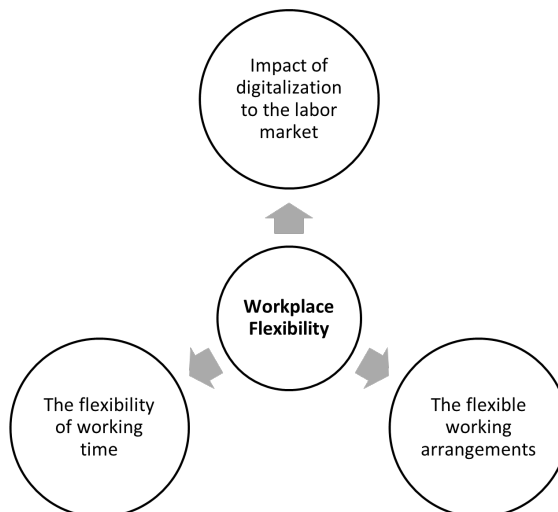
Lastly, the third theme focuses on the flexibility of working time. This involves an examination of how traditional working hours are being redefined. It covers aspects such as part-time work, compressed workweeks, job-sharing, and other innovative time management strategies employed to accommodate the diverse needs and preferences of the workforce.

In the following chapters, each of these themes will be discussed in detail, offering insights into how they individually and collectively influence the contemporary labour market, shape future trends, and address the challenges posed by the rapid pace of digital transformation.



Source: Authors’ work

Figure 1: The process of a grey literature review



Source: Authors’ work

Figure 2: Major themes of workplace flexibility generated by the review of grey literature

3 Impact of digitalisation on the labour market

Since the late 1980s, the digital revolution has transformed the economy and society (Mandl, 2020). The first phase was the introduction of the Internet and the broadband network, and the increasing use of digital platforms marked the second phase as business models to offer goods and services. Eurofound mapped all new trends in the inclusion of digital technology in all economic, social and environmental dimensions through the integration of advanced digital technologies (mobile networks of the fifth generation (5G), Internet of things (IoT), cloud computing, artificial intelligence, big data analysis, robotics, etc. (Mandl, 2020).

Digitisation in the economy means meeting the needs of consumers with new innovative solutions, the so-called

smart products. Data and digitised knowledge are becoming a strategic success factor in business (Economic Commission for Latin America and the Caribbean, 2021). It follows the increased flexibility in work and the re-configuration of digital skills needed for more advanced digital use, thus shaping a new workforce. The traditional economy, with its organisational, production and management systems, overlaps or merges with the development of digitisation. Continuous development in a synergistic process changes the structure and dynamics of business while adopting digital technologies and artificial intelligence marks the entry into a new phase of the digitised economy. The digital transformation process is dynamic and complex, requiring constant adaptation and a systematic approach.

Table 1 shows the dimension of digital development and its active effects on society, the economy and the state.

Table 1: Dimensions of digital development and effects on society, economy and state

Digital development	Society	Economy	State
Risks: Increasing inequality; reduced competitiveness for those lagging in the process; concentration of intellectual capital	New models of communication and interaction; new consumption models	New management models (e.g. SmartCity), new business models, new production models, industrial restructuring	Digital government: active participation of citizens through platforms for comments (public e-debates)
Telecommunications and information technology: digital infrastructure; telecommunication services; software and digital service systems	Broadband internet coverage; high data transfer speeds; easy use of services; accessibility of devices and services		
Digital economy: digital products and services; applications and digital platforms; digital content and media; the sharing economy	Information and knowledge of online products and services; electronic access to public services; threat to privacy and data security; new jobs, development of new digital skills	Innovation and entrepreneurship; access to the market; efficiency in management, marketing and distribution; data management; intellectual capital as a security asset; cyber security and data privacy protection	Digital government; digital innovations in the country; digital tax efficiency; digital citizenship and citizen participation (e-Citizens); publicly available data and transparency; cyber security and data privacy protection
Digitized economy: smart economy; e-business; e-commerce; industry 4.0; agricultural technique, financial technology, automotive technology	Smart products and services; informed users; new jobs, new digital skills; cyber security and data privacy protection	Industrial reconfiguration (automation and robotics); sophisticated production; digital transformation of production; cyber security and data privacy protection	Digital innovation; management of public services (education, health, justice, security)
Outcome	Development and sustainability	Productivity and sustainability	Efficiency and sustainability

Source: Economic Commission for Latin America and the Caribbean (2021)

Table 2: Overview of 5 different types of flexibilisation in the organisation

Policy type	Policy examples	Connection types	Employee benefits	Employer features
Schedule (Employees can create their schedules on a daily, weekly and monthly level)	Flexible working hours; Independent creation of the schedule	Schedule; Work place; Continuity; Load	More control over the working day, The ability to meet non-working needs during working hours, A greater sense of creating one's own time	High productivity; Orientation for employees; Less absenteeism; Less overtime work
Workplace (employees can work remotely using technology and other types of communication)	Remote work, virtual offices, hybrid forms of work	Schedule; Work-place	Less time for local driving; Less time for intercity or international travel; Closeness to family and friends	Less traffic; Lower overhead costs; Retaining quality employees; Focus on talents
Continuity (Employees can choose how they will work)	Leave (family, maternity, sick leave, military, for education and training)	Schedule; Continuity; Load	Time for parenting, education, and skill development Longer illness recovery, Possible return to work with job sharing and part-time work	Smaller volume of work; Retaining quality employees
Load (employees may choose to work less than full-time for reduced pay)	Job sharing; Honorary work	Schedule; Continuity	Less load; Less burnout; Less conflict; Better balance between work and family	Smaller volume of work; Retaining quality employees
Mode of operation (employees determine the degree to which they work outside the work-place)	Work in the office; Hybrid work, and remote work	Schedule; Work-place; Continuity; Load; Mode of operation	Ability to coordinate and perform work using technology	Higher productivity; Lower costs of office space

Source: Kossek & Michel (2011)

Compared to traditional organisations, modern, flexible organisations usually have a better identity developed through a specific product or service, a strong and clear vision, expertise and expert knowledge (know-how), developed networks and significant intangible assets and create flexible practices.

Table 2 below provides an overview of the flexibility of work in the organisation (Kossek & Michel, 2011). The first type, schedule flexibilisation, allows employees to create schedules, enhancing control over their working day and meeting non-work needs. This leads to high productivity and reduced absenteeism for employers. Workplace flexibility, including remote and hybrid work, reduces commute time and brings employees closer to family,

while employers benefit from lower overhead costs and retaining quality staff.

Continuity flexibilisation offers options like family or sick leave, allowing time for personal needs and gradual work reintegration. Load flexibilisation, through part-time or job-sharing arrangements, reduces burnout and work-family conflicts. Finally, the mode of operation flexibilisation enables employees to work outside the office, using technology to coordinate tasks, resulting in higher productivity and reduced office space costs for employers. Each type of flexibilisation offers unique benefits, promoting a better balance between work demands and personal life for employees and operational efficiencies for employers.

More and more reports and research actively study new forms of work. Among the more significant ones that shape working environments today, we include Eurofound reports such as “New Forms of Employment Update 2020” (Mandl, 2020), which follows the Mandl et al. (2015) and Mandl and Biletta (2018) studies, which both identify nine new forms of employment in Europe, which have emerged due to the need for increased flexibility by both employers and workers. These forms of employment, which include temporary work, part-time work, and self-employment, have transformed the traditional employer-employee relationship and are often characterised by unconventional work patterns and locations. While some of these new forms of employment may benefit employers and employees, there are concerns about their impact on working conditions and the labour market. The European Employment Strategy (EES) is a key governance mechanism for labour markets in the European Union, aimed at ensuring the survival of the European Social Model (Palpant, 2020). Despite widespread job insecurity in Europe, there is little evidence of significant changes in objective job security measures.

Technological forces are driving significant changes in work and the workforce. Digital technologies and advanced communication tools are changing the way of life and business. 90% of the world’s data was created in the past few years, 2.5 exabytes are produced daily, and 140 million e-mails are sent every minute (Davenport & Rosner, 2016). According to Datareportal (2023), in 2023, there are 5.30 billion Internet users in the world. Globally, the number of Internet users is growing at an annual rate of 3.7 percent, but year-on-year growth is even higher in many developing economies. It is noticeable that the number of Internet users has grown continuously over the past few years. The global number of internet users was predicted to increase continuously between 2024 and 2028 by 1.2 billion users. After fifteen consecutive growing years, it is estimated that the number of users will reach 7 billion and, therefore, reach a new peak in 2028 (Statista, 2023). All presented data affect organisations’ ability to explore new business models. The effective implementation of digital strategies introduces significant changes in the structure and dynamics of work and the connection and communication of the organisation’s stakeholders.

The question arises as to who and what can work in transformative digital ways, considering the emerging need for the ability to solve complex problems through creative thinking. According to research, part of the solution in the digital workplace offers a solution to today’s challenges. In a survey of almost half of the surveyed managers regarding remote work experience, more than half (57%) said they believe that remote work will remain in the future, according to a Eurofound study (Burke, 2023).

4 Flexible working arrangements

Digitisation of workplaces carries untapped potential for further development of the ways of work and workforce. The use of technology will affect the development of the economy and social growth and changes, i.e. new realities in the labour market (Stockton et al., 2018); organisations will be created that can implement the potential value and innovations that come with new technology by exploiting human capital and setting new standards. Organisations and these new realities focus on development opportunities such as exponential organisations, learning organisations, flexible organisations, and virtual organisations based on new workforce skills; work ethics, social responsibility, and innovations.

The digital workplace can be considered a natural evolution of the workplace. It supports changes in work styles that enable employees to work more flexibly and personalise, more transparently, unify offline and online communication and provide anywhere and anytime access to tools and information. The digital workplace is a progressive and innovative environment chosen by digitally aware individuals, so in the hunt for talent, the “head hunter” can help attract the best (globally). The workplace continues to evolve in line with digitisation, while employee expectations are consequently changing, so organisations that do not embrace full digitisation risk falling behind. This trend will accelerate as the number of satisfied employees who create productive business relationships grows. Adopting business plans makes the digital workplace a measurable business with clear values while reducing risk.

Opportunities in the labor market perceive new realities through how work tasks are performed. Although there is no single definition of flexible working, flexible working is a way of working that suits the needs of employees, e.g. having flexible start and finish times or working from home (CIPD, 2019).

Table 3 presents a comprehensive overview of flexible working arrangements, illustrating the varied nature of contemporary employment options. These include part-time work, where employees work fewer hours than a typical full-time role, and term-time work, allowing for leave during school holidays. Job-sharing, flexible working hours, and compressed working weeks offer alternatives in job structuring. Innovations like work-from-home, mobile work, zero-hour contracts, and on-call working adapt to changing workplace demands. Other forms encompass career breaks, seasonal, temporary, and work-on-demand through digital platforms. Finally, freelance or consulting work represents the pinnacle of flexibility, giving individuals total control over their work engagements.

Table 4 shows the benefits of flexible forms of work for employees and employers (Howington, 2020). It outlines the benefits of flexible work arrangements for both

employees and employers. For employees, such arrangements enhance work-life balance and job satisfaction, as they value autonomy and freedom. This flexibility reduces stress and costs associated with commuting, subsequently improving mental and physical health. Additionally, this autonomy often results in greater productivity and reduced work absences, making attracting and retaining talent easier.

On the employer side, flexible work forms increase employee productivity and engagement. Employees who control their work schedules are more motivated, contributing to reduced labour turnover and a more diverse workforce. Employers also benefit from cost savings on overheads and office expenses, access to a larger talent pool, and business continuity during unexpected events like natural disasters or health crises. Overall, flexible working arrangements present a win-win scenario, enhancing em-

ployee well-being and employer efficiency.

Concerning work changes and the necessity of flexibility, we follow the process of solving the regulation of new flexible forms of work with three main directions: obtaining work status, obtaining work rights and social protection, ensuring fairness and accountability, and increasing transparency (European Commission, 2021). Work flexibility can also be claimed as a right. In the European Union, employees with children up to (at least) 8 years of age have the right to request flexible working conditions. This may include telecommuting, flexible working hours, or reduced working hours, and it has to be considered, and reasons for any refusal have to be considered. Legislative proposals were made to improve the working conditions of persons who provide services, all in order to create dignified, transparent and predictable working conditions.

Table 3: Flexible working arrangements

Arrangement	Main characteristics
Part-time work	Employees work less than full-time.
Term-time work	A contract for performing a specific job is established with the employee. The employee remains on a permanent contract but may take paid/unpaid leave during the school holidays.
Job-sharing	Two (or occasionally more) employees share responsibility for the work.
Flexible working hours	Employees are given the choice of when to start and finish work.
Compressed working hours	Redistribution of work into smaller and longer blocks during the week; examples are weeks of four and a half days and two weeks of nine days
Annual hours of work	The total number of hours to be completed during the year is fixed, but there is flexibility during the year regarding performance.
Work from home	Employees work from home for all or part of their working time.
Mobile work	Employees work all or part of the working week at a location far from the employer's workplace.
Zero-hours contracts	Contracts are without specific working hours, but the work is determined and paid according to the hourly rate.
Nine-day fortnight	It includes individual employees who have one day off every other week. The actual day off can vary if the employee follows an alternating pattern of five days a week followed by four days a week.
A four-and-a-half-day week	It usually involves a normal work week ending earlier on Fridays. The short day does not necessarily have to be Friday, but this is the most obvious and common.
On-call working	Work is accomplished by calling for the performance of work.
Career brakes	Career breaks or sabbaticals are extended periods of leave – usually unpaid – of up to five years or more.
Seasonal work	Seasonal work allows employees to work intensively during a certain time of the year and have free time in the off-season.
Temporary work	Temporary or contract work allows individuals to work for a fixed period.
Work on demand	Includes platforms and apps that connect workers with short-term or sporadic tasks such as ride-sharing, food delivery, and micro-tasking platforms.
Freelance/consulting work	Starting your own or consulting business provides the ultimate flexibility, allowing individuals to choose their clients, projects, hours and working conditions.

Source: CIPD (2019)

Table 4: Benefits of flexible forms of work for employees and employers

For employees	For employers
Improved work-life balance	Increased employee productivity
Reduced stress and costs when travelling to/from work	Cost savings – overhead and office costs
Increased job satisfaction - employees value autonomy and freedom	Reduced labour turnover
Health and well-being - reducing stress and having a better work-life balance can lead to improved mental and physical health	Improved employee engagement - employees who have control over their work classes are often more engaged and motivated
Greater productivity is a consequence of job satisfaction	A diverse workforce
Reduced absences from work	A larger talent pool
Attracting and retaining talent	Business continuity during unforeseen circumstances such as natural disasters or health crises

Source: Howington (2020)

CIPD (2023) indicates the following as the key reasons for implementing the possibility of flexible work: (i) Increase the ability to attract and retain employees (60%); (ii) Work-life balance support (60%); (iii) Employee motivation/productivity support (54%); and (iv) Support for employee mental health and well-being (54%).

The same report (CIPD, 2023) indicates that the following key reasons for not implementing flexible working options are the business priorities of organisations for which flexibility is not a priority because of the challenges faced by organisations (60%) and the challenge of job design, as some jobs in organisations require specific working hours and flexible hours would have perceived as an unfair practice if they are not available to everyone (27%).

Flexible work practices, which empower employees to decide when, where, or how much they work, have been around for some time. Numerous studies revealed a significant prevalence of these practices: a majority offered flexible schedules, around half provided telecommuting options, and a substantial proportion had shortened work weeks, job sharing, and reduced working hours. Today, the popularity of these practices on a global scale is a pressing issue. Thanks to the established advantages of flexible work, organisations now have greater opportunities to balance personal and organisational benefits. However, embracing such flexibility necessitates an acceptance of continual change. Experimenting, encountering failures, learning, revising, improving, and effectively implementing these practices is crucial. Successfully identifying and combining the best policies, design, and activation strategies for flexible practices within organisations is key to their effective utilisation.

Ultimately, a shift like telecommuting is underway, and three different approaches are possible, each with different implications. “Working from home” replicates

office working conditions to the greatest extent possible, with well-defined legal provisions regarding hours, equipment and even space; “objectively based work” does not foresee the implementation of working hours: employees have tasks that they must complete in the ways they see fit and with the equipment they have at hand, similar to freelancers. It was often applied out of necessity during the shutdown. “Mixed work”, also known as “smart work” in some countries, combines working from home and in the office, which means meetings with other colleagues and sharing a desk on agreed days (Global Workplace Analytics, 2020). The driving force behind these possibilities is digital technology, and human resources must complement their resources by developing their skills and knowledge. Characteristics of the new reality of the labour market (Stockton et al., 2018): (i) Emphasise the cooperation between man and machine and contrast them as competition; (ii) Identify the most important value chains in business and invest in the transformation of work; (iii) Employees, especially those of the younger generation, expect companies to play a positive role in shaping society.

5 Flexibility of working time

The ability to work remotely has become important when deciding on employment. Hybrid working is no longer nice: more than 70% of candidates now insist that companies have a flexible work policy (International Workplace Group, 2022). Today, organisations are focused on hyper flexibility, part-time commutes, green dividends, suburban revitalisation, virtual collaboration, productivity metrics, workforce dispersion, experience design, reduced overheads, and new organisational paradigms. From an organisational perspective, there are many strategies to or-

ganise different remote elements of work that can be combined (Kossek et al., 2021): people – split (some workers on site, some remotely); time – split (individual work in time of best fit for working, respecting personal and business balance, multiple smaller working periods) or remote first (remote work is the default, on workplace face –to – face on demand).

The flexibility of working hours is developed through the possibility of digitising workplaces. The implications and recommendations for organisations on flexible working hours can be summarised (CIPD, 2023). First, through internal policies, enable employees to recognise flexibility from the first day of employment, wherever possible, that jobs can be performed flexibly, thus attracting candidates looking for flexibility. Second, to raise awareness of different forms of flexible working throughout the organisation. Third, to develop ways to create a stronger connection between employees and the purpose as well as the culture of the organisation while continuously reviewing, adapting and improving flexible work by co-designing developing clear and transparent policies and principles on eligibility for and access to said practices. Fourth, to assess organisational risks related to equality and inclusion of employees in flexible work practices and develop an action plan and guidelines for implementation as well as opportunities for learning and development, as well as rewards and recognition, regardless of where and when people work. Finally, to train managers on managing flexible and hybrid teams effectively and provide support around performance management, remote communications, collaboration and relationship building, and employee development and advancement.

Stockton et al. (2018) introduced a new workplace ecosystem based on flexibility, collaboration and connectivity. Workplaces act as ecosystems that are important to business goals and ultimate success. Workplace ecology, therefore, is when organisation, space and technology are in harmony to support the human endeavour. The main organisational effort is on technology, place, space and talent. The report discusses why flexible working should be implemented. For example, in a four-day working week, two models are dominant. The first model is a compressed work week with a schedule of four (instead of five) working days with 10 hours of working time for 40 working hours per week. Another model is a shortened working week according to the 100-80-100 principle, which is 100% work in 80% working time for 100% salary.

The advantages of a four-day working week are (LQ, 2022): additional days off; a better balance between private and business time; less time is wasted on the way to and from work; a decrease in the level of recorded fears, fatigue or sleep problems; workers are sick less often; increase in employee satisfaction and they are reciprocally ready for some other concessions; and reduction of costs in the case of an increased number of sick days and especially

long sick days in the case of mental illnesses.

The world's most extensive four-day workweek trial, in which 2,900 workers from 61 companies in the U.K. participated from June to December 2022, has released its full findings (Laker (2023). Various four-day-week models were followed, such as Fridays off, staggered, decentralised, and annualised. The trial found that the four-day workweek significantly increased job satisfaction, improved work-life balance, and reduced employee stress. The results also showed improved product quality, customer service, and a significant reduction in absences and sick days. Such a workplace can help risk management to overcome any situation because of its flexible, adaptable approach to the workplace: private workplace in different locations, available immediately for an unlimited number of days per year and 24/7 for working, assuring flexible individual arrangement.

Flexible work is the future. It reduces the ecological footprint, revitalises rural environments (working locally), improves mental health, and improves skills, mainly due to the need to review the previous aspects of work and to put a greater focus on the values of individuals.

6 Conclusion

The investigation and analysis of evolving work structures reveal a growing inclination towards non-standard work forms. This trend suggests increasing employee preference for flexible work arrangements, with projections indicating a continuous rise in their numbers. Consequently, the traditional office setting is no longer deemed essential for employment; instead, flexible work environments are emerging as sought-after workplaces.

Digitisation integrates a major impetus for progressive structural change. Access is universal, while capacity development depends on developing digital skills and, thus, the range of use. The digital transformation of workplaces has begun, and those who do not adapt will be significantly left behind. The working status of workers of new forms of arrangement is currently being considered because it is necessary to regulate each form of work in a way that enables unimpeded further development. There are many arguments why more people are opting for flexible forms of work, which is why regulation is needed. All concepts of flexible work enable a better balance between business and private obligations, thereby increasing the employee's well-being. The business of the future is shaped through new business models and flexible workplaces.

In conclusion, this literature review has provided a comprehensive analysis of the evolving dynamics in the labour market, with a particular focus on workplace flexibility. The study has successfully utilised descriptive and compilation methodologies to delve into grey literature, offering unique perspectives on the impact of digitalisation and sustainable digitisation policies on labour mar-

ket trends. The research has highlighted three significant themes: the influence of digitalisation on the labour market, the emergence of flexible working arrangements, and the growing importance of working time flexibility.

The findings underscore that the digital revolution, further propelled by the challenges and changes brought about by the pandemic, fundamentally alters work practices and lifestyles. This transformation is leading to the creation of new forms of work that prioritise optimisation and flexibility, which are essential in today's fast-paced and digitally-driven world. Adopting these new work forms has been shown to enhance productivity and efficiency while simultaneously reducing operational costs.

Moreover, integrating technology in the workplace reshapes job structures and significantly impacts the quality of work and the competencies required from employees. This shift necessitates reevaluating workforce strategies to meet the changing needs and skills demanded in the modern labour market.

Overall, the study illuminates the critical role of digitalisation in shaping future work practices and policies, providing valuable insights for both academic research and practical applications in labour market studies and digital technology implementation. The trends identified in this review offer a roadmap for navigating the challenges and opportunities of the evolving landscape of work flexibility and digitalisation.

One notable limitation of this study is the potential for publication bias within grey literature, as it may not represent a comprehensive view of all existing research and opinions on the subject. Additionally, grey literature sources' inherent diversity and varying quality can challenge standardising and comparing data. While comprehensive in these areas, the focus on digitalisation and workplace flexibility may have inadvertently overlooked other emerging trends in the labour market. Furthermore, the temporal scope of the literature reviewed may not capture the most recent developments, particularly in such a rapidly evolving field.

Future research could expand on this study by incorporating a wider temporal range of grey literature, ensuring the inclusion of the most recent developments in digitalisation and workplace flexibility. There is also an opportunity to explore the varied impacts of these trends across different industries and demographic groups, providing a more nuanced understanding of their effects. Comparative studies across different regions or countries could offer insights into how cultural and economic factors influence the adoption and impact of digitalisation and flexible work arrangements. Additionally, investigating the long-term implications of these trends on career trajectories, employee well-being, and organisational structures would be valuable. Finally, future studies could explore the interplay between digitalisation and other emerging technologies, such as artificial intelligence and automation, and their collective impact on the future of work.

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Delovna prilagodljivost: Identifikacija novih trendov in smeri iz sivih virov literature

Ozadje in namen: Pričujoči pregled literature preučuje trende na trgu dela, pri čemer se osredotoča na delovno prilagodljivost. Analizira sivo literaturo in statistična poročila, da bi razumela vpliv politik, ki spodbujajo trajnostno digitalizacijo. Analiza si prizadeva razumeti, kako so te strategije vplivale na dinamiko trga dela.

Metodologija: V raziskavi smo uporabili opisne in kompilacijske tehnike za analizo sive literature, pri čemer smo se osredotočili na teoretične okvire in časovne trende. Analizirali smo netradicionalne publikacije, poročila in statistične podatke, da bi razumeli nastajajoče trende na trgu dela, zlasti glede delovne prilagodljivosti in trajnostnih politik digitalizacije. Ta pristop je omogočil edinstvene vpogleds onkraj tradicionalnih akademskih publikacij.

Rezultati: Pregled sivih virov literature je identificiral tri glavne teme. Prva je vpliv digitalizacije na trg dela, druga so prilagodljive delovne ureditve, tretja pa je prilagodljivost delovnega časa.

Zaključek: Digitalna revolucija spreminja življenjski slog in prakse, kar vodi v nove oblike dela. Pandemija je pospešila ta trend, pri čemer je poudarek na digitalizaciji za optimizacijo dela in prilagodljivost. Nove oblike dela povečujejo učinkovitost produktivnosti in zmanjšujejo operativne stroške. Tehnološka integracija vpliva na kakovost dela in kompetence zaposlenih.

Ključne besede: *Prilagodljive oblike dela, Prilagodljive delovne ure, Digitalna delovna mesta, Digitalne veščine, Sivi viri literature*

Intercultural Communicative Competence in Virtual and Face-to-Face Teamwork: A Quantitative Analysis of Culturally Diverse Teams

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Purpose: Owing to the COVID-19 pandemic, the importance of virtual teams has increased during this period. There is a gap in current literature about the transformation of cultural diversity, how it appears in face-to-face interactions, and how it does in virtual teamwork. Global, virtual coworking requires different skills in order to communicate efficiently and understand the team members. This paper analyzes the importance of intercultural communicative competence in virtual and face-to-face teamwork.

Methodology: The research was conducted with a quantitative methodology to see the pattern regarding teamwork throughout culturally diverse teams. A total of 133 questionnaires were obtained for the data analysis. The collected data were then analyzed by using the IBM SPSS Statistics 27 program.

Findings: The results found that intercultural communicative competence is crucial in virtual teams. With better intercultural competence, cultural differences can be identified and considered during project management. However, in face-to-face teamwork, it seems to be more complex. Willingness to discover another culture and eagerness to understand fellow teammates makes a higher priority than being temporarily effective due to intercultural competence.

Conclusion: Intercultural communicative competence is a crucial workplace requirement in today's globalized world, regardless of branch, profession, or geographic location. The ability to understand people with different cultural backgrounds is an increasingly important competency both virtually and in face-to-face interactions.

Keywords: *Intercultural communicative competence, Culturally diverse teams, Global virtual teams, Virtual teams, Cultural differences*

1 Introduction

Regardless of their size and purpose, global virtual teams have become a preferred form of collaboration for successful organizations in today's global economy (Cathro, 2020; Paul et al., 2018; Jimenez et al., 2017; Neeley, 2015). Owing to the COVID-19 pandemic, the importance of virtual teams has increased. Global virtual teams (GVTs) consist of geographically, organizationally, and temporally dispersed members collaborating through information and

telecommunication technologies to perform tasks (Powell et al., 2004). GVTs are virtual teams whose members are separated by national borders, and they might have never met each other before (Pervez et al., 2022; Zwerg-Villegas and Martínez-Dí, 2016). A study by Culture Wizard (2020) highlights the latest trends in the global workplace; it shows that nearly 70% of multinational organizations' employees want to continue working from home at least half the time after the pandemic. 56% of the respondents worked full-time in the office before the pandemic, and

94% of these individuals wish to never return to that system. The increasing relevance of virtual teams has aroused interest in understanding their dynamics (Livermore, Van Dyne and Ang, 2022; Da Costa et. al, 2021; Cañibano, 2018; Ebrahim et al., 2009; Martins et al., 2004). GVTs differ from traditional collocated work teams mainly because of the distance between the members and their reliance on digital communication technology. Technology makes collaboration possible, but personal skills are needed to succeed, both as an individual and as a team. Working virtually is already a shift, but working in GVTs has many more difficulties; team members vary culturally and geographically. Studies indicate that consistent training of all team members positively influences the overall team performance, cohesion and trust, teamwork, and dedication to team goals (Van Rysse and Godar, 2000). However, insufficient training in virtual collaboration often leads to cooperation-related problems (Clark, 2020; Zemliansky, 2012). In order to develop the necessary skills and gain crucial knowledge before entering the labor market is the new demand of the youth. Universities are responding to these developments and are seeking to increase the degree of internationalization in their curricula (Heidemann and Søndergaard, 2022, Schworm et al., 2017; Çiftçi, 2016; Vriens et al., 2010) and are already using methods that can support students to improve their intercultural competence (Baber, 2021; Bao, 2020; Swoboda and Batton, 2019).

Intercultural competence is a crucial workplace requirement in today's globalized world, regardless of branch, profession, or geographic location. Multinational organizations operate across national or international borders and demand personnel to perform well during cross-cultural challenges (Mihalache et al., 2021; Alvarez, 2019; Lehmborg and Hicks, 2018; Taras et al., 2013; Dearsdorff and Bok, 2009). Communication with customers, colleagues, and business partners across international borders is a daily affair for most employees. Therefore, employing people who possess the ability to communicate effectively with people from different cultural backgrounds is an actual business value. Intercultural competence is a complex construct that involves more than one component (Dearsdorff, 2006a). Thus, internationalization strategies need to address the development of intercultural competence components in various ways. These could be established during the course of one's education, for example, course work, study abroad, and on-campus interaction with students from different cultural backgrounds; and improved within the organizations, with cross-cultural training, mobility, and diverse team settings (Ratten, 2023a; Palumbo, 2022; Baber, 2021; Tiwari et al., 2021; Barnes, 2020; Allen et al., 2019).

There is a gap in current literature about the transformation of cultural diversity, how it appears in face-to-face interactions, and how it does in virtual teamwork. The theoretical contribution is to develop new thinking about how

cultural diversity appears during virtual teamwork and the ways in which this cultural diversity differs from face-to-face teamwork. The practical contribution is to help to gain a better understanding of the GVTs and their cultural diversity. The current study focuses on intercultural communicative competence during virtual teamwork and face-to-face teamwork. The next section gives an overview of the related literature, which is followed by the methodology and then the summary of the results and the detailed analyses of these outcomes are discussed. Finally, in order to finalize the paper, the overall conclusion is highlighted and managerial implications are given, limitations as well as possible future direction of the research are mentioned.

2 Literature Review

2.1 Face-to-face and virtual teamwork

Bergiel, et al. (2008) note that the core elements of success are common in both face-to-face and virtual teams: trust, communication, and leadership. They emphasize that the virtual environment can alter the process through which these elements can develop. Computer-mediated communication operates with different rationality and requires different kinds of skills, abilities, and knowledge than face-to-face communication (Schulze et al., 2016). Virtual communication is routinely asynchronous; the time delay element can change the nature of collaborative efforts (Berry, 2011). Virtual teams can produce decision quality that is equivalent to face-to-face teams, but it needs more time. The quality of group decisions seems higher in face-to-face teamwork (Nosratabadi, et al., 2022; Urbig et al., 2020; Hearn et al., 2017) since through more interaction, same time presence in the office, trust can be gained easier, and with this, group decisions can be made more efficiently and frequently. Group leaders can be elected with a higher level of trust. Also, the group members can divide up the workload and trust each member to deliver their part. Group dynamics can benefit from this trust. In face-to-face interactions, team members, due to their greater resources, stimulate creativity, positive impact on comprehension, and development of interpersonal skills. Also, it is important to mention that virtual assessments are not without emotional content, nonverbal elements, or interpretation (Bilgetürk and Baykal, 2021; Carrier et al., 2015; Cheshin et al., 2011). Despite all of these, virtual teams and cooperation can enhance cultural understanding.

The altered nature of the communication process in online teamwork requires different skills and techniques to promote virtual team effectiveness. Reliance on physical dominance, body language, voice tone, and other non-verbal communication, which are common in face-to-face settings, are all "virtually" eliminated in many online exchanges. All of these points are influenced by culture, so

if these are indeed eliminated, then some cultural factors could be considered to be eliminated too. Without these elements, the dynamics of group development, leadership, and individual influence attempts could potentially shift. Hearn, et al. (2017) highlight the irony that the virtual world may be more skillful at tracking meaningful contributions than a face-to-face setting. This is mainly due to the fact that actual content, ideas, and specific information will be more likely to be prioritized in a virtual group. The pressure of visibility and individual dominance is eliminated; the focus is solely on the task. Virtual and physical visibility manifest themselves in entirely different ways since someone attending a face-to-face class might be perceived as contributing by their mere physical presence, even if that participation is relatively passive. Despite this, virtual participation is less passive by nature. Virtual group members wish to contribute to the project; they must log on, review the assignment, see the teammates' written comments, develop a contribution, and share it on their common platform so that the others can also review their material. The risk of uneven efforts is lower in this case. All of this work can not be avoided, as it may happen with face-to-face meetings when members, in many cases, only attend the meetings, but do not even contribute.

2.2 Intercultural communicative competence

In order to understand intercultural competence, as the fundamental requirement of multinational organizations from their members, especially from their leaders, the term "intercultural communicative competence" (ICC) needed to be analyzed. ICC has been defined by many scholars in recent decades (Sercu, 2022, 2002; Fantini, 2020; Kim and Ebesu Hubbard, 2007; Byram, 1995, Chen, 1987) from their research purposes. In the current research understanding, the meaning of ICC Deardorff's Delphi process was analyzed and used to put the related literature in order. Deardorff (2006a), using a Delphi process, asked intercultural scholars and higher education administrators to propose definitions of ICC, pool their views, and reach a consensus on critical fundamentals and proper assessment methods. In the literature of ICC, one of the most exhaustive and influential definitions is provided by Byram (1997), whose model incorporates holistic linguistic and intercultural competence and has clear, practical, and ethical objectives. According to the administrators, the Delphi study has proven that this definition is deemed most applicable to institutions' internationalization strategies. According to Byram, intercultural communicative competence is: "Knowledge of others; knowledge of self; skills to interpret and relate; skills to discover and to interact; valuing others' values, beliefs, and behaviors; and relativizing one's self. Linguistic competence plays a key role" (1997, p. 34). The second highest-rated definition was Lambert's

(1994) definition, which can be summarized as follows: "Five components: World knowledge, foreign language proficiency, cultural empathy, approval of foreign people and cultures, ability to practice one's profession in an international setting" (Lambert, 1994, as cited in Deardorff, 2004, p. 230). Both definitions emphasize the importance of self-knowledge and constant self-reflection during interaction with others. Language is needed but it is simply enough to interpret others' behavior and culture.

In the Delphi study, based on the data generated from intercultural scholars, the top-rated definition was one in which intercultural competence was defined as "the ability to communicate effectively and appropriately in intercultural situations based on one's intercultural knowledge, skills, and attitudes" (Deardorff, 2006b, p. 247-248). From this point of view, knowledge encompasses cultural self-awareness, widening culture-related information, and fostering linguistic knowledge; skills refer to the ability to communicate across cultures; and attitudes include being open to and welcoming towards other cultures and having positive attitudes towards different cultures. Similarly, Chen and Starosta (1996, p.352) viewed ICC as "the ability to effectively and appropriately execute communication behavior to elicit a desired response in a specific environment." According to Fantini et al. (2001), ICC involves three abilities: the ability to develop and maintain relationships, communicate appropriately, and reach a mutual understanding with others. Xu (2009) defined ICC as the ability to communicate effectively and appropriately with people from different cultural and linguistic backgrounds. Lei (2020) points out that scholars have different descriptions; it can be concluded that ICC mainly involves awareness of different values, attitudes, and behaviors of others as well as skills that deal with them. ICC models and definitions all shows that ICC has many hard-to-grasp factors, such as cultural sensitivity and emotional adaptability. Context and individual attitude are important, and these influence knowledge and skills. Hence, face-to-face or virtual teams alter ICC since cultural specifics appear different in each case (Zhong et al., 2013; Deardorff and Bok, 2009; Hammer, et al., 2003; Wen, 1999; Lynch and Hanson, 1998; Kelley and Meyers, 1995; Taylor, 1994; Bennett, 1993).

In summary, group projects are an increasingly established element in virtual and face-to-face environments. Peer assessments in virtual environments may operate in a fundamentally different way than it does in face-to-face settings. Also, cultural diversity within these teams can be experienced differently since communication happens on a different platform, and these platforms operate in their own way and require other kinds of skills. The present paper hopes to shed light on the differences between face-to-face and virtual groups in the area of ICC. Therefore, the following hypotheses have been proposed:

H 1: Individuals with international experience tend to think they are 'open-minded.'

H 2: Self-defined 'open-minded' individuals score higher in the Intercultural Communicative Competence Questionnaire (ICCQ).

H 3: Individuals with high Intercultural Communicative Competence (ICC) tend to recognize cultural differences.

H 4: Efficiency is the highest priority (more important than getting to know each other) in virtual teamwork.

H 5: Members in face-to-face teamwork are eager to know each other better within the team, despite the cultural differences.

3 Methodology

The current paper contributes to the emerging literature on GVTs after the pandemic, focusing on the ICC within the teams. It was established, based on online survey data, studying ICC and analyzing it in GVTs and face-to-face teamwork. The research was conducted with a quantitative methodology to see the pattern regarding teamwork in culturally diverse teams (Margherita, 2022; Szüle, 2017). All of the collected data were analyzed by using the following listed statistical methods via IBM SPSS Statistics 27 program for Windows. This data-driven research is people analytics (Ratten, 2023b, p.91); the goal was to understand how attitude, knowledge, and skills can appear differently in face-to-face and virtual teamwork based on statistical data. For data collection, a survey was designed, titled 'Cross-cultural Management Challenges,' which included initial qualifying questions, Intercultural Communicative Competence Questionnaire (ICCQ), and questions regarding GVTs and face-to-face teamwork.

The current study is based on a three-part survey. It comprises 65 items, ten questions, and 55 statements rated on a 5-point Likert scale. The first part included initial eleven qualifying questions. Ten demographic and background-related questions, such as education, international experience, and the type of international experience. The last part of this section was a statement focusing on self-reflection regarding open-mindedness. The second part was dedicated to the ICCQ by Mirzaei and Forouzandeh (2013). This was used in order to investigate the ICC of undergraduate international business studies students. In the ICCQ, there are 22 items in total, and based on a 5-point Likert scale, 1 stands for strongly disagree, 2 for disagree, 3 for undecided, 4 for agree, and 5 for strongly agree. This part of the survey was based on Deardorff's (2006b, p. 254) pyramid model, which had three components: knowledge, skills, and attitudes. The 22 ICCQ questions can be organized into the following categories: twelve items belongs to the 'knowledge' component, these are all about cultural awareness and information; 5 items belong to the 'skills' component, related to communicative abilities such as listening, interpreting, and relating; the rest of the five items

were organized under the 'attitudes' component, that assess the characteristics of the sample regarding cultural issues such as being respectful, open-minded and tolerant towards diversities. In ICCQ, fifteen items can be coded; the other seven are reverse-coded (Saricoban and Oz, 2014). The third part of the survey included 32 statements regarding teamwork. Sixteen statements were standardized; the same statements appeared regarding virtual and face-to-face teamwork; this was important to see the two types of cooperation and teamwork through the same factors.

The present research started with ethical considerations before the questionnaire was administered. First, the permission of the university's ethical board was taken to collect data. Then, the English online questionnaire link was shared with everyone attending the Cross-cultural Management course. Information notes about the research and background information were given to the participants in order to inform them. A reminder was sent to them on a weekly basis for a duration of four weeks. Initially, the online questionnaire was shared with four individuals (two lecturers and two students) and pilot-tested to ensure the construct validity and the reliability of the instrument as well as to give feedback regarding the clarification, filling out time, and order of the statements. After checking, the survey was shared with the larger participant group. The anonymous questionnaire was disseminated among 167 students studying 'International Business,' and the language of instruction was English throughout the 4-year program. The participants completed the survey and were initially informed about the study's goal. Data was collected using the online survey software known as Qualtrics. It took approximately ten minutes to fill out the questionnaire. The incomplete questionnaires were eliminated. In the end, out of 167, 166 filled out the questionnaire, and 133 questionnaires were obtained for the data analysis. The data was collected in May 2023. The participants were, on average, 20 years old, and 62.4% were female. 67% were Hungarian; the remaining individuals came from a variety of countries in Asia 26% (China, India, Kazakhstan, Turkey, Russia), Eastern Europe 3% (Romania, Slovakia), Western Europe 2% (Spain), and Africa 1% (Ghana), North America 1% (Canada). In the CCM course curricula, it was stated that the attendees have two projects during the Spring semester, which have to be managed in teams of five-six. The first project is virtual teamwork; at the beginning of the semester, since there is no need for physical attendance, every group manages their task virtually. The second project includes several in-class materials, and everyone has to attend face-to-face classes and group meetings. Due to this setting, everyone gains experience in both GVT and face-to-face teamwork. This setting gave a foundation on which the survey could be built.

4 Results

In order to have a better understanding of the importance of international experience, the kind of international experience (professional, private), and the effect of this on cultural open-mindedness (H1), the analyses started with crosstabs. The question which focused on self-evaluation regarding open-mindedness was analyzed in the survey with questions regarding international experience. Out of 133 individuals ($\chi^2 = 1,814$, $p=0.404$), 99 have international experience; these individuals were analyzed further to see if they judge themselves differently, considering they have international experience. 53% of these 99 individuals had both private (vacation, family visits) and professional (education, work, internship) experience abroad. In this case, there was no significant difference ($\chi^2 = 2,768$, $p=0.597$). 2 individuals rated themselves as not open-minded (1-strongly disagree on a 5-point Likert scale), these were eliminated, and the analysis was done with only 97 individuals who rated themselves as open-minded (either 4-agree or 5-strongly agree). Even with a sample that consists of 97 individuals who have had intentional experience (either private or professional or both) and rated themselves as open-minded (agree or strongly agree) still ($\chi^2 = 2.237$, $p=0.327$) somewhat stronger, but no significant effect can be seen, international experience has no effect on the level self-evaluated open-mindedness.

Non-parametric, Mann-Whitney U test was conducted to analyze ICC levels and self-defined open-mindedness. The result shows ($U=1736$, $p=0.220$) that there is not enough evidence to conclude that only the open-minded individuals (4- agree, 5- strongly agree) score high on

the ICCQ. Out of 133 individuals, 131 were included in this test, and two individuals were excluded since they rated themselves as not being open-minded (1 strongly disagreed). In the Mann-Whitney test, the highly rated open-minded individuals were analyzed further. Almost double of those that agreed (48 individuals scored 4, 'agree') individuals were 'strongly agreeing' (83 individuals scored 5, 'strongly agree'). However, among these two groups, still, no significant difference can be identified.

Analyzing the ability to see and identify cultural differences in face-to-face teamwork, the results show that individuals do not see cultural differences within the team. Most of the responders, out of 127 individuals, 65 did not see or were not able to identify cultural differences. Of the included 133 individuals, two evaluated themselves as not being open-minded (1- strongly disagree). Therefore, they were not included further in the analyses. Also, analyzing the ability to see cultural differences, four individuals saw cultural differences and also scored highly in the ICCQ (5 – strongly agree) and were considered to have intercultural competence. After excluding them from the analyses, non-parametric tests were performed. Kruskal-Wallis H test result indicated ($H=2.444$, $p=0.485$), still not enough evidence that individuals working in a team and having face-to-face interaction can see or be able to identify cultural-related differences. A Kruskal-Wallis H test was conducted, including the individuals scoring high in the ICCQ (4 individuals with five as average ICCQ score), results are significantly different ($H=7,722$, $p=0.102$), but still, no cultural-related difference can be seen by the individuals in face-to-face teamwork.

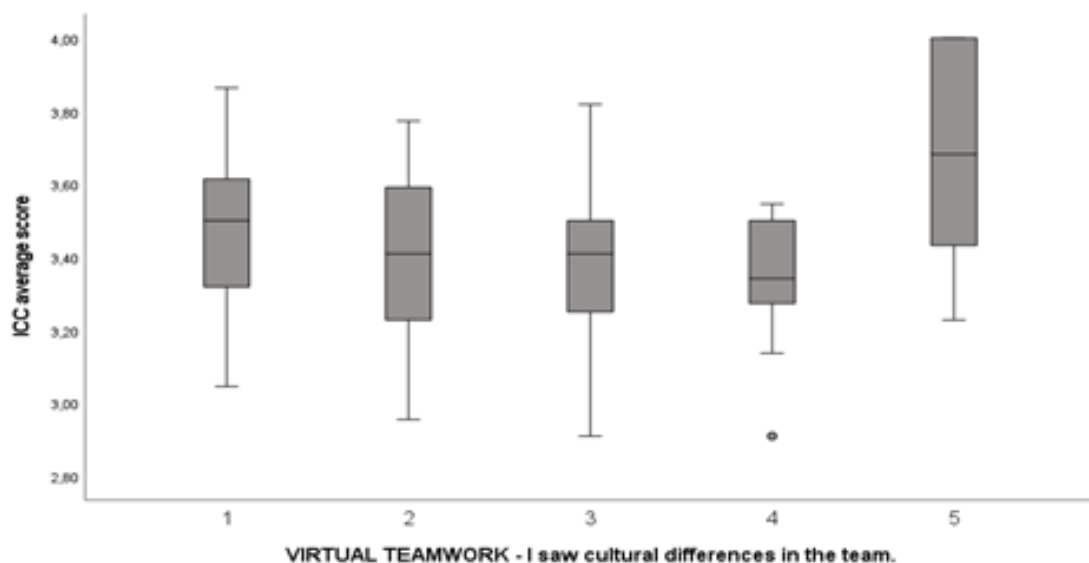


Figure 1: ICCQ average scores by identified cultural differences during virtual teamwork

Table 1: Virtual teamwork - Rotated Component Matrix

VIRTUAL TEAMWORK (VTW)	Efficiency	Active participation	Getting to know each other
Every team member participated in most of the team meetings.		,874	
I think every member of our team was able to contribute to the assignment we had.		,865	
We were efficient with our time.	,880		
I think communication was easy.	,817		
I got to know my teammates better (professionally) during our project.			,915
I got to know my teammates better (personally) during our project.			,783
Extraction Method: Principal Component Analysis. - Rotation Method: Varimax with Kaiser Normalization.			
a. Rotation converged in 5 iterations.			

Table 2: Face-to-face teamwork components

FACE-TO-FACE TEAMWORK (FFTW)	Getting to know each other	Efficiency	Cultural awareness
Every team member participated in most of the team meetings.		,924	
I think every member of our team was able to contribute to the assignment we had.		,902	
I saw cultural differences in the team.			,858
Some cultural differences made it easier to work efficiently together. (It had an impact on time management, the result/outcome of the assignment, and misunderstanding during communication).			,861
I got to know my teammates better (professionally) during our project.	,927		
I got to know my teammates better (personally) during our project.	,907		
Extraction Method: Principal Component Analysis. - Rotation Method: Varimax with Kaiser Normalization.			
a. Rotation converged in 5 iterations.			

Table 3: Hypothesis testing result

Hypothesis	Relationships	Results of hypotheses
H1	International relationships and self-defined open-mindedness	Not supported
H2	Self-defined open-mindedness and ICCQ scores	Not supported
H3.	ICCQ and recognizing cultural differences (Face-to-face; Virtual teamwork)	Not supported –FFTW; Supported – VT;
H4	Virtual teamwork and efficiency (as a priority)	Supported
H5	Face-to-Face teamwork and bonding (as a priority)	Supported

Differentiation can be made between face-to-face teamwork and virtual teamwork regarding seeing cultural differences and ICCQ average (H3). Virtual teamwork analyses show significantly different results (Figure 1). 8 individuals with very high intercultural competencies were excluded in order to see the majority of the group and focus on their data. Altogether 123 individuals were included in further analyses. The remaining 123 individuals are able to see cultural differences while working virtually together with their teammates ($H=8,199, p=0.042$). In the Kruskal-Wallis test, if the individuals with the highest ICCQ average are all included, eight individuals with a '5' ICCQ average score ($H=13,145, p=0.011$) altogether 131 individuals, the results show even more significant value. The two groups' ICCQ average and virtual teamwork – seeing cultural differences show statistically significant value in both cases, including and excluding the eight individuals with the highest ICCQ average.

In order to have a better understanding of each case (VTW and FFTW) and understand the reasons behind being able to see cultural differences, factor analyses have been done. In factor analysis, a rotated component matrix represents the relationships between the observed variables and the extracted factors after a rotation procedure has been applied to enhance interpretability. The values in the rotated component matrix, often referred to as factor loadings, indicate the strength and direction of the relationship between each variable and each factor. The high factor loadings of the statements in the rotated component matrix indicate their significance as indicators of VTW and FFTW and their strong association with the extracted factors in the research (Table 1, Table 2). The components have been analyzed further, and in each case, connections and underlying similarities and focus have been studied (title of the components). In virtual teamwork, "VTW efficiency," and in face-to-face teamwork, the "FFTW getting to know each other" component is the main priority (H4 and H5).

5 Discussion

5.1 Intercultural competence and open-mindedness

Results of the current analyses seem to weaken the fact that international experience tends to give a better overview and more complex understanding of another culture. The cultures that differ from one's own can not be understood only by having private or professional experiences abroad. The current research shows that individuals evaluated themselves as open-minded regardless of their international experiences. This can be due to the globalized world we are now living in. In multinational organizations, or even during their studies, individuals can

encounter others with different cultural backgrounds. Understanding another culture needs an open attitude toward the surroundings, knowledge, and skills rather than time spent abroad (Mihalache and Mihalache, 2022; Deardorff, 2006b). Surely international experience can support one with tools and information that can be used in cross-cultural challenges. However, one's own attitude, such as tolerating other cultures, approaching someone with a different cultural background with respect, and being open to discover and being curious about another culture, seems to be more important. Also, knowledge occurs to be crucial. Speaking foreign languages and gaining information about another culture and using this correctly. Skills, such as careful listening and interpreting this information or analyzing a situation and relating to that. Self-awareness, openness, and tolerance towards other values and cultures can support open-mindedness, and it does not depend on international experience.

International experience can be a great chance to improve skills and gain knowledge, but it needs open-mindedness already to have that attitude and willingness that it requires. Evaluating one's own openness has no connection with international experience. Out of 133 individuals, 97 found themselves open-minded (4-agree or 5- strongly agree), and every one of them has had international experience; 54 of them had both (private and professional). There was no connection between these. 36 individuals had no international experience, and their self-evaluation showed no significant difference from the 54 individuals who had both kinds of international experience. Every participant was studying International Business in English. The individuals not spending time abroad rated themselves the same way as the ones with lots of international experience. Speaking a foreign language, working in diverse teams, and studying international business give them the same chances to improve their open-mindedness. International experience can help one learn more and offers more chances to help one with sharpening skills. However, these cannot be gained without willingness. Open-mindedness is a needed requirement that can support gaining knowledge and improving skills during a stay abroad, but only international experience cannot enhance open-mindedness.

According to current research results, open-mindedness is crucial, but there is no evidence that self-defined open-mindedness can be related to high ICCQ scores. Being open-minded does not mean having intercultural competence (H2). Self-defined open-mindedness does not imply that an individual is able to understand a different culture and communicate efficiently with someone with a different cultural background. ICC is a complex competence that rather consists of knowledge, skills, and willingness. Similarly to the international experience (H1) and the implementation of the learning point of such an experience, ICC does not solely rely on open-mindedness. Self-evaluated open-mindedness is the attitude of

the individual through which knowledge and skills can be gained and improved (Deardorff, 2006b; Lambert, 1994). Self-defined open-mindedness needs constant self-reflection and self-awareness. These factors can improve ICC. Appropriate and effective communication across cultures requires language knowledge, culture-related knowledge, and the skill to discover and interpret (Lei, 2020; Xu, 2009). Open-mindedness does not include these naturally. Only two individuals evaluated themselves as not being open-minded. Despite this, everyone scored high in ICCQ.

5.2 Cultural Diversity in virtual and face-to-face teamwork

Research results show that in VTW, team members prioritize managing their time effectively during the teamwork process and focusing on communication within the team to remain smooth and without any significant challenges. This factor indicates that ease of communication and exchanging ideas are considered to be crucial. The common point in both is 'VTW efficiency' in the flow of information. The nature of VTW gives the members a high level of autonomy, so they can individually work and share their part with the team. This way, it contributes to the project (Nurfitransyah, et al., 2023; O'Boyle et al., 2016). The second priority was the level of active participation and engagement of team members in team meetings. It implies active participation and involvement of all team members in team meetings that are considered important for effective intercultural communication and collaboration. Also, the research results highlight the perception that each team member was able to make meaningful contributions to the assigned task. It suggests that the perception of equal contributions and involvement from all team members is important in VTW. The common point among these statements is that these factors refer to the importance of 'VTW active participation.' This component is also strengthening the efficiency component. Every member of the team has to participate, and the workload is divided up equally and can be monitored transparently. On the list after 'VTW efficiency' and 'VTW active participation' in third place comes 'VTW getting to know one's teammates,' the need of the team members to gain a deeper understanding of each other's professional backgrounds, skills, expertise, and work-related aspects during the project. It suggests that the process of enhancing professional knowledge and understanding among team members is essential. In addition to developing personal connections, understanding, and familiarity with teammates on a more individual or on a more personal level during the project.

These results confirm that in VTW, teammates see cultural differences since 'VTW getting to know each other' is not the top priority. Cultural differences occur and have not been addressed or studied; it remains. The most im-

portant during VTW is to do the task and to communicate about the issues that can be directly linked to the joint project. Individual contribution is more transparent than it can be during FFTW. The group can keep track of every member and all their input (Hearn et al., 2017). Meetings can be recorded, participation can be checked, and the workload can be divided and kept track of without any further effort. Every step of the common project happens virtually and can be checked anytime. The joint effort of the group is to focus on the task and accomplish the common goals. However, individuals working together, even from a far distance, can not ignore cultural specificities. Every type of communication, virtual or face-to-face, consists of the content and non-verbal element and the interpretation of these (Carrier, et al, 2015). Therefore, different cultural backgrounds as well as habits and behaviors can not be overseen. Due to these elements, cultural differences can come to the surface, and joint projects can be affected by these. In VTW, effectively working together is more important than getting to know each other within the team because cultural differences remain without even addressing them.

In FFTW getting to know each other is ranked higher (top priority) and hence more important in real-life, face-to-face settings than it occurs in virtual settings. 'FFTW Efficiency' is only in second place, and 'FFTW cultural awareness' is third. In FFTW, team members signify that the awareness and acknowledgment of cultural diversity within the team are considered important. FFTW-related statements in the survey highlight that certain cultural differences positively influenced the team's ability to work efficiently together. It acknowledges that due to these cultural differences, teamwork has been improved. This points out the crucial role of cultural awareness; furthermore, it suggests that the recognition of cultural diversity can actually be an asset to the team (Pervez, et al., 2022). Getting to know each other and building trust is complex in culturally diverse teams. It requires not only communication but understanding of body language, facial expressions, and tone of voice. (Cheshin et al., 2011). Spending real-life time with teammates can improve understanding of each other, and in FFTW, since this is a priority. Therefore, it comes naturally with time. Core elements such as trust and communication are important in both FFTW and VTW (Bergiel, et al., 2008). In FFTW, there are more chances to gain trust, and there are more impressions that can be studied in order to interpret them.

On the other hand, results showed that in FFTW, members could not see cultural differences regardless of the ICCQ scores (except the individuals with the highest scores). This can be understood in a way that culturally diverse teams see cultural differences and try to understand them from the beginning of the common project. Shortly after all of these were addressed and vanished. In FFTW, getting closer to each other and gaining more informa-

tion about the teammates are more of a critical factor than getting the task done. Also, cultural differences are considered advantageous and used as an asset in the project. Cultural awareness is promoted within the group, and this is the attitude throughout the joint project. These factors make the FFTW more understanding of the cultural factors. Being able to see the cultural differences regardless of the individual's ICCQ score. Within the team, all of the cultural factors are paid attention to since getting familiar with each other is the overall goal. Therefore, cultural background and personal information, habits, and behaviors are all seen and understood and not considered to be 'cultural differences.' Despite the VTW in FFTW, there is an eagerness to understand these in order to be a source of innovation and solutions for the joint project. Real-time interaction gives a chance to build relationships and, through them, have a community so that the individuals can belong to their team. This emotional bond and individual satisfaction seem to affect the individual's performance and, over time, the team's performance.

6 Conclusion and recommendation

This paper aims to study intercultural competence in virtual and face-to-face teamwork. The survey was designed for International Business students in order to have a better understanding of their intercultural communicative competence during their virtual and face-to-face teamwork projects. The results show that international experiences do not affect open-mindedness, and self-evaluated high scores do not correlate with actual intercultural competencies. However, almost every individual has international experience. Statistically, there is no significant connection between open-mindedness, international experience, and intercultural competence. It seems it is more about the individuals' attitude and willingness to discover and understand other cultures. During virtual work, efficiency is the top priority; and behaviors and habits due to different cultural backgrounds can affect teamwork. Addressing these is not a priority but a factor that has been identified and considered to be part of common projects. Due to the transparency of every meeting, individual input and joint efforts can be tracked. Short-term projects can be carried out quickly, and checking points can be used to maximum efficiency. During face-to-face teamwork, getting to know each other and understanding the cultural specificities are more crucial than being effective and submitting the project. Cultural awareness is promoted, individual engagement is supported, and learning from each other seems more interesting within groups. This way, long-term, complex, and culturally challenging projects can be carried out successfully. During virtual teamwork, effectiveness, and equal workload distribution are more critical; these are followed by the need to know each other's cultural back-

ground within the team in order to be even more efficient with the sources. Intercultural communicative competence is seen as a tool that can enhance this knowledge. In face-to-face teamwork, gaining trust and becoming familiar with the other's culture is considered an asset from which the common project can benefit. Intercultural communicative competence does not seem to be needed to gain that knowledge.

The current research arrived at the findings using inputs from 133 respondents, and future researchers should collect more input from experienced professionals with significant international experience from a broader perspective. Also, continuing with the qualitative method and conducting interviews and focus-group interviews can give more information to understand the hidden reasons. Future researchers can also assess potential differences between teams only virtually working together and face-to-face or hybrid teams, focusing on team dynamics or cultural awareness.

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Medkulturna komunikacijska kompetenca v virtualnem in osebnem sodelovanju: Kvantitativna analiza kulturno raznolikih ekip

Namen: Zaradi pandemije COVID-19 se je povečala pomembnost virtualnih ekip. V trenutni literaturi obstaja vrzel glede preoblikovanja kulturne raznolikosti, kako se ta kaže v osebnih interakcijah in kako v virtualnem timskem delu. Globalno virtualno sodelovanje zahteva različne veščine za učinkovito komuniciranje in razumevanje članov ekipe. Ta članek analizira pomen medkulturne komunikacijske kompetence v virtualnem in osebnem timskem delu.

Metodologija: Raziskava je potekala z uporabo kvantitativne metodologije za preučevanje vzorcev v timskem delu kulturno raznolikih ekip. Za analizo podatkov je bilo pridobljenih 133 anket. Zbrane podatke smo nato analizirali s programom IBM SPSS Statistics 27.

Ugotovitve: Rezultati kažejo, da je medkulturna komunikacijska kompetenca ključna v virtualnih ekipah. Z boljšo medkulturno kompetenco lahko prepoznamo kulturne razlike in jih upoštevamo pri upravljanju projektov. Vendar se zdi, da je v osebnem timskem delu to bolj kompleksno. Pripravljenost za spoznavanje druge kulture in želja po razumevanju sodelavcev sta pomembnejši od začasne učinkovitosti zaradi medkulturne kompetence.

Zaključek: Medkulturna komunikacijska kompetenca je ključna zahteva delovnega okolja v globaliziranem svetu, ne glede na panogo, poklic ali geografsko lokacijo. Sposobnost razumevanja ljudi z različnimi kulturnimi ozadji je vedno pomembnejša kompetenca tako v virtualnih kot osebnih interakcijah.

Ključne besede: Medkulturna komunikacijska kompetenca, Kulturno raznolike ekipe, Globalne virtualne ekipe, Virtualne ekipe, Kulturne razlike

Human Capital Efficiency and Firm Performance of Quality-Certified Firms from EFQM Excellence Model: A Dynamic Panel Data Study

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Purpose: The study's main purpose is to investigate the impacts of human capital efficiency (HCE) on the firm performance of non-certified and quality-certified firms from the European Foundation for Quality Management (EFQM) Excellence Model. The study also examines the relationship between firm performance and quality-certificates from the European Foundation.

Design/methodology/approach: By using a sample of 282 non-certified and 22 quality-certified firms from 2017 to 2021, the current study employed a two-step system generalized method of moments (GMM) estimation to analyse the empirical data. The dummy variable is used to examine the relationship between quality-certificates and firm performance. The dummy interaction term is employed to quantify the impacts of HCE on the firm's performance for quality-certified firms.

Findings: The results revealed that quality-certificates and firm performance have a positive relationship. Quality-certified firms perform better and earn more profits than non-certified firms. HCE has a positive impact on firm performance for both types of firms. Moreover, the quality-certified firms utilize HCE in an efficient way to earn more profits compared to the non-certified firms.

Originality: This is the first study to use a comprehensive analysis to emphasize the HCE for non-certified and quality-certified firms separately. The effects of quality-certificates on firm performance in the context of HCE are also being highlighted for the first time in this research.

Practical implications: The current study's findings are fruitful for academics, managers, researchers, policymakers, and other firm management. The findings will encourage the management of the firms to implement the total quality management (TQM) approach within their firms.

Keywords: *Human capital, Quality management, Czech firms, Firm size, Firm age*

1 Introduction

The European Foundation for Quality Management (EFQM) was established in Brussels in 1989. The primary goal of this European Foundation was to promote long-term growth in European economies and increase the competitiveness of European organizations. The Foundation has become the most popular Foundation among European

organizations to establish the total quality management (TQM) approach and implement a performance management tool (Zapletalová, 2023; Vukomanovic et al., 2014; Westlund, 2001). The EFQM Model is based on TQM principles. According to Giménez-Espín et al. (2020), the Model could be used to improve the performance of any firm and to improve attaining and maintaining excellence. Most of the earlier studies investigated that quality

award-winning firms perform better and earn more profits than non-award firms (Zink, 2012; Zhang and Xia, 2013; Boulter et al., 2013; Augustyn, 2021; Zhang et al., 2022; Tarí et al., 2023). Some authors report the same results for those firms that have quality-certificates from the European Foundation (Yousaf, 2023b; Yousaf and Bris, 2020; Yousaf, 2022a; Yousaf and Bris, 2021). Although the European Foundation is quite popular worldwide for implementing the TQM approach, Czech firms are not keen on implementing quality models. As a result, in the context of the TQM strategy, Czech firms are not in competition with those of neighbouring nations (Zapletalová, 2023; Nenadál et al., 2018). Hence, empirical studies are important for Czech firms to examine the impact of quality-certificates (and awards) on firm performance.

The Value-Added Intellectual Coefficient (VAIC) model is a monetary-based measuring approach that helps to determine the efficiency of intellectual capital (IC). The VAIC model was developed by Pulic (2000). Human capital efficiency (HCE) is used as a component of IC efficiency in the VAIC model (Faruq et al., 2023; Soewarno and Tjahjadi, 2020). An efficient use of human capital (HC) at firms' level is an important factor in increasing the overall performance of firms. HCE refers to how effectively a firm uses its HC: the knowledge, skills, and experience of its employees. Several scholars used the VAIC model in their studies to investigate the relationship between IC and firm performance; however, studies on the relationship between firm performance and HCE separately are limited (Mohan, 2020). Therefore, more studies are needed on this important topic.

There are many studies that explore the impact of quality awards on firm performance. But there are rare studies that discuss the impacts of quality-certificates from the European Foundation on firm performance (Yousaf, 2022a). These quality-certificates from the Foundation are very important for implementing the TQM approach in firms and to obtain Global and Prize Awards from the Foundation (Yousaf, 2022a). As stated earlier, there is rare literature that focuses separately on HCE and firm performance. Hence, the current research is going to fill these gaps. According to our best knowledge, this is the first study that highlights the impacts of quality-certificates on firm performance in the context of HCE. Furthermore, this is the first study to separate the HCE for non-certified and certified firms in order to conduct a comprehensive analysis. With the purpose of quantifying the association between HCE and quality-certificates as well as the association between HCE and the firm performance of the quality-certified firms, we incorporated a dummy variable and a dummy interaction term. Thus, the current study makes a valuable contribution to the existing body of literature and holds practical implications in the fields of econometrics and statistics, as it elucidates the conceptualization of the dummy variable and dummy interaction term from

financial and economic perspectives. Consequently, this research contributes not solely to academic literature but also to practical knowledge within various contexts.

Following the introduction section of this current research, the next section emphasizes the literature review and hypotheses development. After the methodology section, the empirical findings are described briefly in the empirical results section. The last section discusses conclusions, the scope of further study, and the practical implications of the present study.

Literature review and hypotheses development

Human capital efficiency (HCE)

Human capital (HC) is a broad concept that has been defined by a number of academics. According to Tran and Vo (2020), there are three concepts of HC. The first concept is called the investment perspective, which means HC is the result of the investment, so the value of HC is invested to improve personal intelligence and physical strength and expand skills and knowledge. The second concept of partial output considers that HC is the exclusive skills, knowledge, experience, and appropriate working capacity of technical innovators and managers. The third concept of HC is the total value of personal skills, intelligence, knowledge, and physical strength used to produce products. This concept of HC is not limited to technical personnel or managers; it could be the working capacity of any person. Micah et al. (2012) and Baron (2011) argued that human resources are knowledge, talents, skills, development ability, and energy that can be used to deliver services or produce goods. According to Rehman et al. (2022), the quality of the workforce can be improved by investing in HC, as it is a very important source of economic growth.

An educated and skilled workforce plays an essential role in improving efficiency by developing and adopting new skills and promoting knowledge (Mohan, 2020). Therefore, HCE is an important part of national wealth and a primary source of organizational growth. According to Yousaf (2022a), HCE originates from the HC theory, and it helps firms to gain further opportunities and to decrease market threats. Managers of the firms observe and monitor their workforce and then use this information for goal setting, continuous improvement, and improving the quality of their products and services. Nikandrou et al. (2014) argued that workforce training is important as it provides firm-specific knowledge and skills to improve firm performance. Therefore, these workforce characteristics are important to improving the firm's performance. HCE is a function of value-added and HC, and it is used as a component of IC efficiency in the VAIC model (Tran and Vo, 2020). Hence, HCE is computed by the ratio of value-added and HC by employing firm-level data to explore the impacts of HCE on firm performance. With or without using the VAIC model, many authors explored the relationship between HCE and firm performance (Slavković et al., 2023; Bataineh et al., 2022; Aybars and Mehtap, 2022; Xu

and Li, 2020; Nguyen, 2020; Bayraktaroglu et al., 2019).

Firm performance

Firm performance is an important topic in the literature for academics, managers, policymakers, leaders, and many others. Several proxies, such as return on equity (ROE), return on invested capital, return on capital employed, return on assets (ROA), etc., have been used to measure the firm's performance in the earlier studies. The same proxies are also employed by several authors in previous literature to measure firm profitability (Niazi et al., 2023; Jaworski and Czerwonka, 2022; Yousaf et al., 2021). A study by Yousaf and Dey (2022) revealed that ROA is the best proxy to measure firm performance after analyzing 297 Czech firms' data from three sectors. However, ROA and ROE are the most common proxies used in the previous literature (Dženopoljac et al., 2023; Habib and Dalwai, 2023; Kayakus et al., 2023; Nawaz and Ohlrogge, 2022; Olohunlana et al., 2022; Kayani et al., 2020; Ahmed and Bhuyan, 2020; Samo and Murad, 2019). Therefore, both ROA and ROE are employed as proxies to measure firm performance in the present research.

Quality certificates and firm performance

The findings of prior research studies have revealed that firms that have obtained quality awards demonstrate a higher level of performance compared to their rivals (Zapletalová, 2023; Augustyn et al., 2021). Several scholars have explored the aforementioned results pertaining to firms that have been accredited for their quality by the European Foundation (Yousaf, 2023c; Yousaf, 2022b). In comparison, a limited number of scholars have examined the conflicting results. To illustrate, Yousaf et al. (2021) conducted research utilizing data from 332 firms, among which 20 were certified firms, in order to investigate the relationship between firms' profitability and management of working capital. The findings indicated that the acquisition of a quality certificate from the European Foundation was linked to a decrease in the firms' profitability. In a comparable vein, based on data derived from 112 Iranian firms, the research carried out by Safari et al. (2020) demonstrated that there was no significant connection between obtaining quality awards and the financial performance of firms. Consequently, the authors concluded that the models of excellence are not suitable for Iran's business environment. This empirical investigation underscores the fact that quality certification does not automatically ensure a competitive advantage for firms. However, the majority of the results obtained from the previous investigations have focused on the examination of the favourable influence exerted by quality certificates and accolades on firm performance. Hence, as a logical consequence, the subsequent hypothesis has been developed:

H1: The European Foundation's quality certificates have a positive impact on firm performance.

HCE and firm performance

The relationship between HCE and the firm's perfor-

mance has been examined by numerous authors. In the prior literature, most scholars have reported a positive relationship between HCE and the firm's performance (Maji and Goswami, 2017; Chowdhury et al., 2019; Tran and Vo, 2020; Nguyen, 2020; Slavković et al., 2023; Faruq et al., 2023). On the other hand, a few scholars have reported an insignificant relationship between HCE and the firm's performance (Smriti and Das, 2018; Puntillo, 2009; Firer and Williams, 2003). A study by Soewarno and Tjahjadi (2020) revealed that HCE is not associated with ROA and ROE in many models. To sum up the above discussion, most of the researchers found a positive relationship between the variables. Consequently, the following hypotheses are formulated for non-certified and certified firms individually.

H2: HCE is positively associated with firm performance for non-certified firms.

H3: There is a significant positive relationship between HCE and performance of the quality-certified firms.

Control variables

Firm age (AGE) and firm size (SIZE) are important variables that affect the firm's performance. Numerous studies have used AGE and SIZE as independent variables (or control variables) to examine the effects of the variables on firm performance. Prior studies revealed that large firms enjoy economies of scale, relatively lower adjustment costs, and easy access to the credit markets (Chandrapala and Knápková, 2013; Tanaka, 2021). A number of scholars, such as Li et al. (2021); Khan et al. (2018); and Molodchik et al. (2016), examined the positive impact of SIZE on firm performance. Conversely, Masnoon and Saeed (2014); Ullah et al. (2017); Tran and Vo (2020); and Ullah et al. (2020) reported the opposite relationship between both variables.

According to Chhibber and Majumdar (1999), new firms frequently go through an initial period of developing skills in marketing, production, and management; therefore, older firms perform better than new firms. Kuntluru et al. (2008) and Tanaka (2021) explored a positive relationship between AGE and the firm's performance. On the contrary, the studies by Park et al. (2010); Charoenrat and Harvie (2013); Li et al. (2021); and Faruq et al. (2023) found a negative relationship between the variables.

To summarise the above discussion, on the one hand, prior studies show that quality awards and certificates improve firm performance. On the other hand, most of the studies stated that the HCE has a positive impact on firm performance. Therefore, it would be interesting to explore the relationship between quality-certificates and firm performance and the relationship between firm performance and HCE for non-certified firms and certified firms. Therefore, the research hypotheses that are formulated based on the conclusions of the earlier studies, the following conceptual framework of HCE, control variables, and proxies of firm performance are presented in Figure 1.

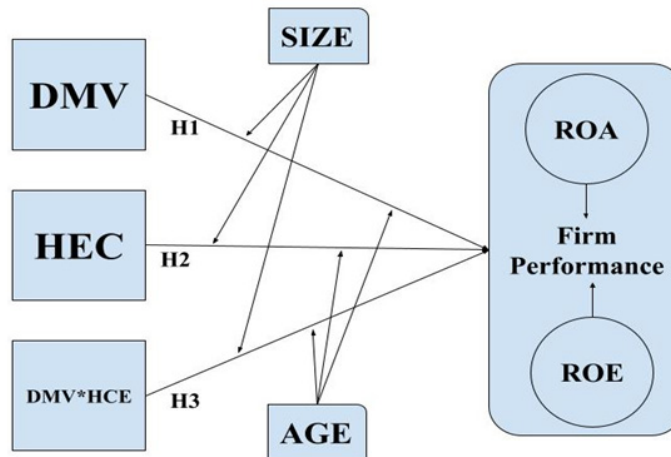


Figure 1: Conceptual framework of the research

Table 1: Summary of selected variables

Variables	Short Form	Formula
Dependent Variables		
Return on Asset	ROA	(Net income) / (Total Assets)
Return on Equity	ROE	(Net income) / (shareholder's equity)
Independent Variables		
Human Capital Efficiency	HCE	(VA) / (HC) Where VA = Value added, HC= Total cost invested on employees
Dummy Variable	DMV	DMV = 1 for quality-certified firms; DMV = 0 for non-certified firms
Dummy Interaction Term	DMV*HCE	HCE of the certified firms only
Control Variables		
Firm Size	SIZE	Log (Total assets)
Firm Age	AGE	Number of years since the firm registered

Methodology

Data

We acquired the data regarding the firms that have been certified for their quality from the EFQM recognition database. The total count of firms that have received quality-certificates is 22, since only 22 firms from the construction and manufacturing sectors have been granted quality-certificates by the European Foundation. The secondary data of 22 quality-certified firms and 282 non-certified firms was obtained from the Albertina database. The Albertina database is very popular and reliable in Visegrad countries (V4). Činčalová and Hedija (2020) contended that the database includes information pertaining to a vast amount exceeding 2.7 million subjects. Additionally, many recent studies (Lososová and Zdeněk, 2023; Yousaf and Dehning, 2023; Hamplová et al., 2022; Dokulil et al., 2022; Drábková and Pech, 2022; Urbancová and Vrabcová, 2022) have used data from the Albertina database. The number of quality-certified firms in the prior studies was also small for the analysis (Yousaf, 2023c; Yousaf, 2022b). The sample of non-certified firms was selected randomly; however, the total sample (304 firms) is enough for the analysis (Fleiss et al., 1969; Israel, 1992).

The quality-certified and non-certified firms are selected from the construction and manufacturing sectors in the present research due to three reasons: (i) Both sectors are the capital-intensive as well as labour-intensive. (ii) There are various specific characteristics of the sectors, for instance, a large amount of investment, a high financial and operating risk, a long development cycle, etc. (iii) The sectors contribute more than 25% of Czechia's gross domestic product (GDP). The share of the construction sector was about 5.20%, and the manufacturing sector was 20.83% of the country's GDP in 2021 (World Bank Statistics). Moreover, Gajdosikova & Valaskova (2022) discussed the same arguments in the context of Slovak firms and argued that both sectors are not only important in the Slovak Republic but also globally. The authors claimed that both sectors have been significantly affected by COVID-19 in recent years. Therefore, the construction and manufacturing sectors need to improve their HCE in order to improve their competitiveness.

Variables

Firm performance (proxies, ROE and ROA) is the dependent variable. The independent variables are HCE, a dummy variable (DMV), and a dummy interaction term (DMV*HCE). The value of DMV=1 if the firm has a quality-certificate from the European Foundation; otherwise, DMV=0. The dummy interaction term (DMV*HCE) represents the HCE of the certified firms only. The control variables are SIZE and AGE. The details of the variables are presented in Table 1.

Regression models

To investigate the relationship between HCE and firm performance, the following regression models are estimat-

ed.

$$\text{ROA } it = \beta_0 + \beta_1 (\text{ROA } it-1) + \beta_2 (\text{HCE } it) + \beta_3 (\text{SIZE } it) + \beta_4 (\text{AGE } it) + \beta_5 (\text{DMV } it) + \beta_6 (\text{DMV} * \text{HCE } it) + \eta_i + \epsilon_{it}$$

Model 1

$$\text{ROE } it = \beta_0 + \beta_1 (\text{ROE } it-1) + \beta_2 (\text{HCE } it) + \beta_3 (\text{SIZE } it) + \beta_4 (\text{AGE } it) + \beta_5 (\text{DMV } it) + \beta_6 (\text{DMV} * \text{HCE } it) + \eta_i + \epsilon_{it}$$

Model 2

In the above Model 1 and Model 2, β_0 is the intercept, the remaining β values denote the regression coefficients, $i=1, 2, 3, \dots, N$ represents the total count of firms, while t signifies the duration spanning from 2017 to 2021. Furthermore, ϵ_{it} stands for error terms at time t for firm i , and η_i signifies unobserved firm-specific effects. DMV is a dummy variable, and DMV*HCE is a dummy interaction term. The value of DMV will be one for quality-certified firms; however, the value of DMV will be zero for non-certified firms.

Empirical results

Table 2 displays the descriptive statistics for non-quality certified firms and quality-certified firms. The values of the mean and median of ROA and ROE are slightly dissimilar from each other. However, it is clear from the positive average values of ROE and ROA that both types of firms earned profits from 2017 to 2021 (during the study period). However, the values of the mean and median of ROA and ROE for the quality-certified firms are higher compared to non-quality firms, which indicates that the quality-certified firms earned more profits and performed better. In general, skewness defines the direction and quantity of the skew. The data is perfectly symmetrical if the value of skewness is zero. The skewness should be zero for a normal distribution, but it is improbable for practical data. Kurtosis defines the height and sharpness of the central peak in comparison to that of an ordinary bell curve. A positive kurtosis value specifies a heavy-tailed distribution; conversely, a negative value of kurtosis illustrates a light-tailed distribution. For the standard normal distribution, Simon et al. (2017) proposed that skewness and kurtosis should be within the range ± 3 , and ± 10 , respectively. Hence, most of the kurtosis and skewness values in Table 2 show the normal distribution according to the range recommended by Simon et al. (2017).

The variance inflation factor (VIF) test and correlation coefficients of total firms are presented in Table 3. All the selected variables are positively associated with ROE and ROA, except AGE. AGE is negatively correlated not only with ROE and ROA but also with HCE. However, DMV and DMV*HCE are positively correlated with the proxies of firm performance. We calculated VIF to address the problem of multicollinearity in the sample. Nachane (2006) posited that the presence of multicollinearity may pose a severe problem, particularly when the value derived from the VIF test exceeds 10. As per the findings presented

in Table 3, it is evident that no issue of multicollinearity is observed in the selected independent variables, as all VIF test values fall below the threshold of 10.

The Breusch-Pagan (B.P.) test is utilized to identify heteroskedasticity in the estimated values of ROA and ROE. The B.P. test's null hypothesis is that the variance remains constant. The p-value obtained from the B.P. test for ROA is 0.126, surpassing the predetermined level of significance of 0.05. Consequently, there is an absence of heteroskedasticity in the data. Similarly, the B.P. test is applied to detect heteroskedasticity in the estimated values of ROE. The p-value derived from the B.P. test for ROE is 0.215, further indicating that there is no presence of heteroskedasticity within the data.

To avoid spurious regression results, the Fisher-type unit root test was used to diagnose the stationarity in the data. Maddala and Wu (1999) suggested that the Fisher test could also apply to the unbalanced panel data, so anybody can apply the individual augmented Dickey-Fuller (ADF) test. To test the stationarity, we proposed the following hypothesis:

H4: At least one panel is stationary.

The Fisher-type unit-root test was applied with two choices: without a time trend and with a time trend. The test outcomes revealed that all the chosen variables are stationary because the p-values are zero in all cases¹.

We employed the two-step system GMM estimation to estimate Model 1 and Model 2 in the current study. Roodman (2009) argued that GMM is the best technique for panel data if "T is small and N is large", as many problems like serial correlation, homogeneity, unobservable heterogeneity, and endogeneity could be handled in GMM. Moreover, with the value of the Hansen test in GMM, one can easily observe the validity of instrumental variables (IV). Additionally, numerous scholars employed the two-step system GMM in the most recent studies (Yousaf, 2023a; Rehman et al., 2022; Gul et al., 2022; Růčková and Škuláňová, 2022; Opong et al., 2019). Consequently, we also employed the two-step system GMM to estimate Model 1 and Model 2².

Table 2: Descriptive Statistic

Stats	ROA	ROE	HCE	SIZE	AGE	DMV	DMV*HCE
Non-quality certified firms							
Mean	4.45	8.63	1.27	5.77	28.49		
Median	4.33	8.03	1.85	8.53	25.72		
S.D.	7.12	12.32	1.83	10.19	6.40		
Minimum	-27.58	-51.07	0.16	4.05	3.54		
Maximum	42.77	68.17	21.54	49.19	48.12		
Skewness	0.71	0.64	8.12	0.62	-0.20		
Kurtosis	6.05	5.15	12.45	3.27	3.88		
N	825	840	832	843	834		
Quality certified firms							
Mean	8.49	13.59	2.47	6.33	24.69	1	2.41
Median	6.12	9.88	1.65	10.22	28.00	1	1.66
SD	8.75	14.31	1.90	20.68	6.07	0	1.87
Minimum	-6.20	-24.78	0.39	5.19	10.00	1	0.39
Maximum	34.07	51.15	10.44	17.88	30.00	1	10.38
Skewness	0.96	0.73	2.43	0.59	-1.03	1.23	2.34
Kurtosis	3.40	3.87	8.87	2.91	2.83	1.09	8.76
N	89	91	87	92	98	98	87

(Source: Authors)

¹ Untabulated results of B.P test and Fisher-type unit root are available from the author(s) on request.

² We also run the regression by switching the values of DMV and got the same results with opposite signs.

Table 3: Correlation coefficients

	ROA	ROE	HCE	SIZE	AGE	DMV	DMV*HCE	VIF
ROA	1							
ROE	0.87*	1						
HCE	0.41*	0.33*	1					1.35
SIZE	0.16*	0.10*	0.30*	1				1.2
AGE	-0.04	-0.12*	-0.05	0.11*	1			1.03
DMV	0.10*	0.07*	0.19*	0.30*	0.01	1		2.75
DMV*HCE	0.15*	0.12*	0.42*	0.36*	-0.04	0.78*	1	3.28

Note: *p < 0.05

(Source: Authors)

Table 4: Empirical results: Two-step system GMM

Variables	ROA (Model 1)		ROE (Model 2)	
	Coefficient	Std. Err.	Coefficient	Std. Err.
Lag of ROA/ROE	0.624	0.120***	0.402	0.094***
HCE	0.427	0.618*	0.942	0.863
SIZE	0.426	6.046	20.414	17.339
AGE	-0.008	0.560	-0.370	1.601
DMV	10.265	4.667**	35.063	20.615*
DMV*HCE	2.041	0.944**	7.162	2.835**
Constant	-2.203	47.028	-104.13	133.696
No. of Observations	939		939	
No. of instruments	9		15	
Wald Chi-square	598.07 (0.000)***		220.73 (0.000)***	
AR (1)	0.008***		0.013**	
AR (2)	0.658		0.703	
Hansen Test	0.139		0.264	

Note: *P < 0.10, **P < 0.05, ***P < 0.01

(Source: Author)

Table 4 shows the two-step system GMM results where DMV = 1 denotes the quality-certified firms, and DMV = 0 represents non-certified firms. When DMV = 0, then DMV and DMV*HCE will become zero, and Model 1 and Model 2 for the non-certified firms will be like this:

$$\mathbf{ROA}_{it} = \beta_0 + \beta_1 (\mathbf{ROA}_{it-1}) + \beta_2 (\mathbf{HCE}_{it}) + \beta_3 (\mathbf{SIZE}_{it}) + \beta_4 (\mathbf{AGE}_{it}) + \eta_i + \varepsilon_{it}$$

$$\mathbf{ROA}_{it} = -2.203 + 0.624 (\mathbf{ROA}_{it-1}) + 0.427 (\mathbf{HCE}_{it}) + 0.426 (\mathbf{SIZE}_{it}) - 0.008 (\mathbf{AGE}_{it}) + \eta_i + \varepsilon_{it}$$

Similarly, Model 2 for the non-certified firms will be like in the following:

$$\mathbf{ROE}_{it} = \beta_0 + \beta_1 (\mathbf{ROE}_{it-1}) + \beta_2 (\mathbf{HCE}_{it}) + \beta_3 (\mathbf{SIZE}_{it}) + \beta_4 (\mathbf{AGE}_{it}) + \eta_i + \varepsilon_{it}$$

$$\mathbf{ROE}_{it} = -104.13 + 0.402 (\mathbf{ROE}_{it-1}) + 0.942 (\mathbf{HCE}_{it}) + 20.414 (\mathbf{SIZE}_{it}) - 0.370 (\mathbf{AGE}_{it}) + \eta_i + \varepsilon_{it}$$

When $\mathbf{DMV} = 1$ for the certified firms, then Model 1 can be estimated for the certified firms in the following:

$$\mathbf{ROA}_{it} = \beta_0 + \beta_1 (\mathbf{ROA}_{it-1}) + \beta_2 (\mathbf{HCE}_{it}) + \beta_3 (\mathbf{SIZE}_{it}) + \beta_4 (\mathbf{AGE}_{it}) + \beta_5 (\mathbf{DMV}_{it}) + \beta_6 (\mathbf{DMV} * \mathbf{HCE}_{it}) + \eta_i + \varepsilon_{it}$$

$$\mathbf{ROA}_{it} = (\beta_0 + \beta_5) + (\beta_2 + \beta_6)(\mathbf{HCE}_{it}) + \beta_1 (\mathbf{ROA}_{it-1}) + \beta_3 (\mathbf{SIZE}_{it}) + \beta_4 (\mathbf{AGE}_{it}) + \eta_i + \varepsilon_{it}$$

$$\mathbf{ROA}_{it} = (-2.203 + 10.265) + (0.427 + 2.041)(\mathbf{HCE}_{it}) + 0.624 (\mathbf{ROA}_{it-1}) + 0.424 (\mathbf{SIZE}_{it}) - 0.008 (\mathbf{AGE}_{it}) + \eta_i + \varepsilon_{it}$$

$$\mathbf{ROA}_{it} = 8.062 + 2.468 (\mathbf{HCE}_{it}) + 0.624 (\mathbf{ROA}_{it-1}) + 0.624 (\mathbf{SIZE}_{it}) - 0.008 (\mathbf{AGE}_{it}) + \eta_i + \varepsilon_{it}$$

Similarly, we can estimate Model 2 for the certified firms in the following:

$$\mathbf{ROE}_{it} = \beta_0 + \beta_1 (\mathbf{ROE}_{it-1}) + \beta_2 (\mathbf{HCE}_{it}) + \beta_3 (\mathbf{SIZE}_{it}) + \beta_4 (\mathbf{AGE}_{it}) + \beta_5 (\mathbf{DMV}_{it}) + \beta_6 (\mathbf{DMV} * \mathbf{HCE}_{it}) + \eta_i + \varepsilon_{it}$$

$$\mathbf{ROE}_{it} = (\beta_0 + \beta_5) + (\beta_2 + \beta_6)(\mathbf{HCE}_{it}) + \beta_1 (\mathbf{ROE}_{it-1}) + \beta_3 (\mathbf{SIZE}_{it}) + \beta_4 (\mathbf{AGE}_{it}) + \eta_i + \varepsilon_{it}$$

$$\mathbf{ROE}_{it} = (-104.130 + 35.063) + (0.942 + 7.162)(\mathbf{HCE}_{it}) + 0.402 (\mathbf{ROE}_{it-1}) + 20.414 (\mathbf{SIZE}_{it}) - 0.370 (\mathbf{AGE}_{it}) + \eta_i + \varepsilon_{it}$$

$$\mathbf{ROE}_{it} = -69.067 + 8.104 (\mathbf{HCE}_{it}) + 0.402 (\mathbf{ROE}_{it-1}) + 20.414 (\mathbf{SIZE}_{it}) - 0.370 (\mathbf{AGE}_{it}) + \eta_i + \varepsilon_{it}$$

Table 4 demonstrates that the statistical significance of both the coefficients of lagged ROA (Model 1) and lagged ROE (Model 2) is observed at the 0.01 level of significance. The positive signs of both coefficients indicate that the performance achieved in the preceding year has a positive impact on the performance observed in the present year. The coefficients of the lagged values of the dependent variables display conformity with the assumption of steady state, which holds great importance in the examination of firm performance and the validity of instruments. This assumption is based on the notion that past performance significantly influences current performance, as evidenced by the studies conducted by Raithatha and Komera (2016) and Okoyeuzu et al. (2021).

The coefficient of HCE is statistically significant at the 0.10 significance level in Model 1 (ROA) for non-certified firms. This positive and significant coefficient of HCE supported H2, i.e., HCE is positively associated with firm performance for non-certified firms. However, the coefficient of HCE of the non-certified firms is statistically not significant in Model 2, as the p-value is greater than the significance level. These findings regarding the positive relationship between HCE and firm performance are consistent with the previous studies (Faruq et al., 2023; Slavković et al., 2023; Tran and Vo, 2020; Nguyen, 2020).

Both coefficients of DMV are statistically significant at the 0.05 level of significance. The positive signs of the coefficients revealed that the quality-certificates have a positive impact on ROE and ROA. The quality-certified firms perform 10.265 units in Model 1 and 35.063 units in Model 2 better than non-certified firms. These significant results supported H1, i.e., The European Foundation's quality certificates have a positive impact on firm performance. These findings are consistent with prior studies, such as Yousaf (2023c) and Yousaf and Bris (2022a), as the authors also reported the same results. Hence, like quality awards, quality-certificates are also helpful to increase the firm's performance. Numerous scholars have made recommendations for quality excellence models to be implemented by Czech firms (Yousaf, 2023c; Zapletalová, 2023; Nenadál et al., 2022; Nenadál et al., 2018). As stated by Zimon and Dellana (2020), the implementation of quality certificates not only improves financial performance but also provides non-financial advantages such as enhanced product quality, increased customer satisfaction, and improved labour productivity, among others. Hence, we propose that firms' management should consider adopting the TQM approach in order to achieve both financial and non-financial gains.

Both coefficients of DMV*HCE are statistically significant at the 0.05 level of significance for the certified firms. The positive signs of both coefficients show that the rela-

tionship between firm performance and the HCE of certified firms is positive. These significant findings supported H3, i.e., There is a significant positive relationship between HCE and performance of the quality-certified firms. The magnitude of HCE for certified firms is greater than the magnitude of HCE for non-certified firms, indicating that the relationship between HCE and firm performance is considerably larger for certified firms ($2.468 > 0.427$ in Model 1 and $8.104 > 0.942$ in Model 2)³. The results of DMV and DMV*HCE show that firms with quality-certificates not only perform better but also utilize HCE in an efficient way to earn more profits compared to non-certified firms. Therefore, quality-certificates are highly beneficial for firms across various contexts. Consequently, we strongly recommend that firms' management implement the TQM approach within their firms.

Considering the findings of the control variables, the coefficients of the AGE are statistically not significant in Model 1 and Model 2. These non-significant findings revealed that young and old firms do not significantly differ in terms of their firm performance. Similar to the AGE, both SIZE coefficients are statistically not significant. The findings explored that the size of a firm does not significantly affect the firm's performance.

Regarding post-estimation tests, AR (1) is the first-order autocorrelation, and AR (2) is the second-order autocorrelation. In Table 4, the insignificant p-values of AR (2) in both Models (Model 1 and Model 2) encourage us to accept the null of no autocorrelation. The p-value of the Hansen-test is statistically not significant, it means that all instruments used in the Models are valid. The insignificant values of Hansen Tests specify that instrumental variables are not correlated with error terms. Roodman (2009) suggested that the Hansen Test's p value should be within the limits of 0.10 and 0.25. Table 4 shows that the Hansen Test's p value in Model 1 falls within the suggested limit. But the p-value reported in Model 2 is slightly higher than the suggested limit. However, some researchers have reported the outcomes of the GMM technique, whereby the Hansen Test's p-value was much higher than the suggested limit (Yousaf, 2023c; Wintoki et al., 2012). Consequently, similar to the outcomes of Model 1, the outcomes presented in Model 2 are also valid.

Conclusion

The current study's main purpose is to investigate the impact of HCE on firm performance for both quality-certified and non-certified firms. To explore the main purpose, secondary data was gathered from the Albertina database of 282 non-certified and 22 certified firms from the European Foundation. The two-step system GMM estimation was used to test the hypotheses. The outcomes revealed that there is a positive relationship between HCE and firm

³ We also run the regression by switching the values of DMV and got the same results with opposite signs. Untabulated results are available from the author(s).

performance for both types of firms. The quality-certificates from the European Foundation have a positive impact on the firm's performance. Furthermore, the relationship between HCE and firm performance is significantly stronger in certified firms than in non-certified firms. The empirical findings of the current research showed that firms with quality-certificates not only performed better and earned more profits but also utilized their HCE in an efficient way compared to non-certified firms. As a result, we propose that the Czech Society for Quality encourage firms to implement quality models. We also recommend that the management of the firms take part in the quality award and certificate processes and implement the TQM approach within their firms.

The following limitations should be considered for the current research: (i) A period of only five years (2017-2021) is considered for the analysis as the latest and most available data from the Albertina database covers only five years. (ii) The consequences of coronavirus disease (COVID-19) could be felt globally. Czech firms are also affected by the pandemic. But the current research did not include any factor that is related to COVID-19. (iii) Many economic, financial, and social factors affect the firm's performance. However, only the two most important variables are included as control variables based on the previous studies. (iv) Only 22 certified firms are selected because there are only 22 firms from the construction and manufacturing sectors that have quality certificates from the European Foundation.

There are numerous avenues for further investigation into the relationship between HCE and firm performance. One country, two sectors, one methodology, and a short time period were taken into account in the present research. Further research should be done by considering more countries, more sectors, and a longer time period. Future research can also be possible by including other quality-certificates and awards, such as those from the International Organization for Standardization (ISO), and by considering other proxies of firm performance, such as return on invested capital, return on sales, and return on capital employed.

This paper offers several contributions to the literature and practical knowledge. Theoretically, the research contributes by extending the literature on quality-certificates from the European Foundation because the research contributes to the literature on how quality awards and certificates impact firm performance. Most of the prior literature shows that quality awards have a positive impact on firm profitability or performance. The findings of the current study show that quality-certificates also have a positive impact on the firm's performance. The quality-certificates from the European Foundation not only increase firm performance but also ensure that the quality-certified firms have significantly higher HCE than non-certified firms. Hence, the study's findings will motivate the management

of the firms to implement the EFQM Model in their firms. In this way, firms can improve their performance in many contexts.

Data availability statement: The data that support the findings of this study are available at the Albertina database homepage, <https://www.bisnode.cz/produkty/albertina/>

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Učinkovitost človeškega kapitala in uspešnost podjetij, certificiranih po modelu odličnosti EFQM: Študija dinamičnih podatkovnih plošč

Namen študije: Namen študije je preučiti vpliv učinkovitosti človeškega kapitala na uspešnost podjetij, ki niso certificirana, ter podjetij, ki imajo certifikat kakovosti po modelu odličnosti Evropske fundacije za upravljanje kakovosti (EFQM). Študija prav tako preučuje odnos med uspešnostjo podjetij in njihovim posedovanjem certifikatov kakovosti EFQM.

Metodologija: Na vzorcu 282 necertificiranih in 22 certificiranih podjetij je bila, za obdobje od 2017 do 2021, v raziskavi uporabljena dvostopenjska metoda splošnih trenutkov (GMM). Uporabljena je bila dvojna spremenljivka za preučevanje odnosa med certifikati kakovosti in uspešnostjo podjetij. Dvojni interakcijski izraz je uporabljen za kvantificiranje vplivov HCE na uspešnost podjetja pri certificiranih podjetjih.

Ugotovitve: Rezultati so pokazali, da imata spremenljivki certifikat podjetja in uspešnost podjetja pozitiven odnos. Certificirana podjetja se izkažejo bolje in ustvarijo več dobička kot necertificirana podjetja. HCE ima pozitiven vpliv na uspešnost podjetja. Poleg tega certificirana podjetja učinkovito izkoriščajo HCE za večji dobiček v primerjavi z necertificiranimi podjetji.

Izvirnost: To je prva študija, ki uporablja celovito analizo za poudarjanje HCE za necertificirana in certificirana podjetja. Učinki kakovostnih certifikatov na uspešnost podjetja v kontekstu HCE so prav tako prvič poudarjeni.

Praktične implikacije: Ugotovitve te študije so koristne za akademike, vodje, raziskovalce, oblikovalce politik in druge upravljavce podjetij. Ugotovitve bodo spodbudile upravljanje podjetij k uvedbi pristopa celovitega upravljanja kakovosti (TQM) v svojih podjetjih.

Ključne besede: Človeški kapital, Upravljanje kakovosti, Češka podjetja, Velikost podjetja, Starost podjetja

An Analysis of Methods and Techniques Used for Business Process Improvement

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Background: More than 50 process-based approaches, methods, and techniques have been developed in recent decades to achieve more efficient operation of organizational systems. Due to increasingly rapid changes in the business environment, the question of which method or technique will have the most significant impact on increasing the organizational system's competitive advantage is becoming increasingly important.

Purpose: In the presented research, we focused on identifying methods and techniques often cited in the literature and most often used in practice as efficient for improving business processes.

Methods: We prepared a 4-phase structured review of the available literature and supported the findings with survey research.

Results and Conclusion: Based on the results, we designed a set of appropriate, most frequently used, and efficient methods and techniques for improving business processes. The completed research can serve as a starting point for answering the question about the appropriate methods and techniques for the chosen approach. In continuing the research, it would be reasonable to check other properties and the use of methods and techniques.

Keywords: *Business Process Management, Business process improvement, Approaches, Methods, Techniques*

1 Introduction

In business processes, added value and simultaneously a significant share of costs are created. As a result, they became the core of the demanded changes in the organizational system. Business Process Management is a discipline with which we focus on improving business process efficiency (Harmon, 2007, in Lahajnar and Rožanec, 2015). Its purpose is to support the modeling, managing, and analyzing the business processes (Weske, 2007). It is a complex discipline that includes a set of principles, approaches, methods, techniques, and tools and combines the knowledge of management, industrial engineering, and information-communication technologies sciences (Weske

et al., 2004; van der Aalst, 2013; van der Aalst et al., 2016) and psychology (Lahajnar and Rožanec, 2015).

The life cycle of Business Process Management contains six phases, i.e. (Dumas et al., 2013):

- business process identification,
- business process discovery,
- business process analysis,
- business process improvement,
- business process implementation,
- business process monitoring and control.

In the last decades, over 50 approaches, methods, and techniques to improve business processes have been developed (Vila, 2006; Mežnar, 2021; Krhač Andrašec, 2022). They have more or less unified goals: reducing

the processes' business cycle, increasing the added value in the processes, and gradually increasing the quality of products and organizational system's services, reducing the processes execution's costs while maintaining suitable quality and needed time ratio, increasing reliability and consistency of the process implementation and the quality of products and services. Simultaneously, they differ in the terms of business process execution improvement:

- the improvement's ambitions aspect (major or minor gradual improvements),
- the nature or characteristics of the improvement aspect (an analytical or creative approach to improvement),
- the process view aspect (an internal or external view of the improvement).

The Business Process Management phases use a variety of approaches, methods, and techniques. However, they are not consistently named in the literature. For example, Lean is commonly used in literature as a method (Kim et al., 2006), an approach (Massingham and Al Holaibi, 2017), or in combination with techniques (Warner et al., 2013). Often, it is also mentioned as Lean Six Sigma, representing a combination of two approaches (Crema and Verbano, 2013). Non-unified naming causes confusion and unsuitable use by the users. In our study, we use individual terms in the sense as they are explained in the Oxford English Dictionary (2021):

- an approach is a way of dealing with a situation or a problem; for example, we need an entirely new approach to work;
- a method is a special systematic procedure for achieving or getting closer to something; for example, labor-intensive production methods;
- a technique is a way of performing a particular task, especially in executing an artwork or a scientific process; for example, it is a skillful or efficient way of working.

Based on the basic terms' meaning and their uses overview in the available literature, we perceive that approaches are slightly wider than methods and techniques. These are selected in the concept phase because their purpose is to realize the chosen approach. In literature, we can come across different methods and techniques for improving business processes; however, their use and combination are left to the managers' ideas in individual organizational systems (Debevc et al., 2018; Galof and Balantič, 2021; Maletič et al., 2023).

The research aimed to identify the most commonly used and relevant approaches, methods, and techniques of

business process improvement. Additionally, we investigated the potential differences in the usage of individual methods or techniques of business process improvement between the organizational systems based on different criteria for their classification¹ (e.g., predominant purpose, size, etc.).

2 Methodology

The research is divided into two parts, i.e., a 4-phase structured literature overview was designed and conducted, a questionnaire was developed, and the answers were analyzed.

Due to the large set of terms used in improving business processes and their various naming, we initially carried out an in-depth overview of the multidisciplinary collections. To identify relevant approaches, methods, and techniques mainly used and reflected in the wanted results, a 4-phase structured overview of the available literature was carried out.

A Basic Overview of the Multidisciplinary Collections

In the first phase, we focused on Web of Science, ProQuest Dissertations & Theses, Science Direct, and Emerald, where the following combinations of phrases are used:

- basis: Business Process Improvement/Reengineering/Redesign/Optimization,
- complement: principle/concept/approach/method/technique.

We searched for the relevant terms in titles, abstracts, keywords, and the entire history of the multidisciplinary collections. Due to numerous hits, we have sometimes set limits and reduced the number of hits to a manageable level. Usually, we limit the year of the source's publication, the availability of the source, and the number of citations. We examined the reduced hits and extracted the more often identified terms. In this phase, 947 hits (sources) were examined, and 65 terms were extracted. When reexamining the sources, in which we discovered new terms or terms that repeat once, we excluded 18 terms from the research because of irrelevance.

Defining the Narrower Set of Terms

Based on the calculations of the 10% of the maximum hits in the second phase, the remaining terms were categorized into two groups. A closer examination was carried out for terms with fewer hits than 10% of the maximum hits in the first phase. The exclusion criteria are the year and the publication type (journal with or without the impact factor, book, conference). The term Simulation was changed to

¹ The criteria for classifying organizational systems are predominant purpose (energy production, material production, and non-material production), business area (21 areas), size (micro, small, medium and large), technical and economic structure (mainly for business areas with production work processes - e.g., number of repetitions of execution, integration of processes...), a legal-formal form of organization (systems with profit-making work - entrepreneur, company with limited liability, systems with non-profit work) and location - wider, narrower and internal location (Kern, 2017).

Process Simulation to adapt the term to the field. The terms were reexamined based on the number of hits according to Web of Science. Here, the terms are reviewed according to independent hits from the first phase and the hits in combinations with “Process Improvement” and “Business Process Improvement,” where 10% of the maximum hits for the other two reviews is also calculated. Based on the selected criterion, we considered those terms relevant that have at least in two reviews the number of hits higher than 10% from the maximum number of hits. Additional examination of the suitability of the relevant terms set followed, where years and types of publication and the number of citations were reexamined. Lastly, the term suitability in terms of content based on their definitions was checked. To avoid premature elimination of the relevant terms, the carried-out calculation process was checked additionally with a minimum of 5% hits. The second phase of the theoretical overview is thus finished with a set of 18 relevant terms to improve business processes.

An In-depth Review of the Narrower Set of Approaches

In the third phase, the selected relevant approaches underwent an additional in-depth review to emphasize the relevant methods and techniques. At each approach, several sources were reviewed, focusing on the impact factor, reviewed articles, and books. Following Pettersen (2009), we removed the terms with a few occurrences in the literature from relevant business process improvement methods and techniques.

An In-depth Review of the Remaining Terms and Designing a Set of Relevant Methods and Techniques

In the final phase, an in-depth review of the remaining terms was carried out. It encompassed:

- a re-review of the frequency of the occurrence of the terms in the multidisciplinary collections (in combination with “business process improvement”) – the Scopus collection was also included in the review,
- a review, in which phases of the business process improvement approaches is possible to use an individual term,
- overview of the definitions of the terms.

Based on the first review, significant differences in the frequency of the occurrence of the different terms were discovered. This is why, following the second phase’s example, terms with less than 5% occurrence in their group as the most frequently used term are excluded from further investigation. To keep more possible terms, terms that scored more than 5% of occurrences in at least four hits groups were left in the set. For the remaining terms, the remaining two reviews are carried out. In the second review, we focused mainly on the following phases of the business process improvement approaches: Processes mapping, Processes analysis, and Key processes improvement. At the end of the phase, the terms are also partially examined regarding the quality of the execution description and the

possibility of application in different situations.

The whole 4-phase structured literature overview was conducted from June 2019 to December 2020. Since the multidisciplinary collections have been upgraded with new sources, there is a possibility of discrepancies in certain numbers. However, the same terms were consistently identified throughout all of the phases. We also confirmed the suitability of the relevant approaches, methods, and techniques of the business process improvement with the questionnaire results.

A Questionnaire Survey

A questionnaire survey was chosen to conduct the research due to the research’s size. A questionnaire was prepared in the Slovenian language and translated into German, English, and Croatian. It was prepared in an anonymous form (it did not encompass the respondents’ personal information) and with the help of the Ika tool. Nine employees from various organizational systems validated the questionnaire before the research.

Each selected organizational system from Slovenia, Croatia, Germany, and Sweden received an invitation by e-mail to participate in international research and, in case of non-response, two reminders. We obtained a set of suitable organizational systems, in accordance with purpose and size, with the help of the respective countries’ statistical offices. For every returned e-mail (for example, because of technical issues or a non-existing e-mail address), we forwarded the invitation, and in case of non-response, two reminders to a new contact. The complete research was carried out between April 1, 2021, and July 15, 2021, and the country-specific questionnaire was available for 90 days.

After the data collection, at least partially completed questionnaires were included in the analysis. A response rate analysis is prepared based on the responses, showing the highest response rate in Slovenia (14.7%) and the lowest in Sweden (0.8%). The overall response rate of the questionnaires is 7.6%. The response rate analysis results are suitable, as a more recent evaluation of research with a response rate above 5% confirmed that research with a lower response rate is negligibly less accurate than research with a higher response rate (Morton et al., 2012). A calculation of the adequacy of the achieved sample size based on the freely available calculator is also prepared (Raosoft, 2004). The size of the selected population, the risk level of sampling error, the normal distribution of responses, and the 95% confidence level are entered into the calculator. A sample of 196 organizational systems is recommended based on the entered conditions. We exceeded the recommended sample, and with the 95% trust rate, we can claim that the achieved sample of 213 organizational systems is representative of the selected population survey.

3 Results

3.1 Theoretical Review Results

A Basic Overview of the Multidisciplinary Collections

947 hits in the four multidisciplinary collections are reviewed in the first phase. Table 1 shows the review results in which the identified terms of business process improvement are included.

Defining the Narrower Set of Terms

As mentioned above, in the second phase, the terms are classified into two groups based on the calculation of the 10% in three combinations of the number of hits' searches. Simultaneously, individual terms are reviewed by the year and the publication type. Table 2 shows the results of the described review, where the number of hits within 90% of the maximum number of hits is shown in grey. Based on that, a narrower set of relevant terms is designed; however, a further review of the appropriateness of the set followed, in which the year and type of publication, number of citations, and the suitability of the terms to the content of the definitions were reexamined. On this basis, Risk Management and Data Mining are removed from the set, while Digital Transformation, Just in Time, and Process Simulation are added. Based on the content suitability, Business Process Reengineering and Business Process Redesign are joined into one term, and Business Process Modeling and Process Mapping are merged into another. Consequently, the suggested set encompasses 17 terms.

The calculation procedure is repeated with 5% of hits to avoid the early elimination of the relevant terms. The two calculations differed in only eight terms:

- two of the terms based on content suitability have already been added: Just in Time and Process Simulation,
- two terms are a part of the approaches, reviewed in the third phase in more detail, and they will be added in the next phase: Kanban and UML.

The remaining terms were additionally reviewed in terms of content; namely, all hits in combination with "Process Improvement" were reviewed. Thus, only the PDCA term is added to the set, and the second phase of the theoretical review is concluded with a set of 18 relevant terms for business process improvement.

An In-depth Review of the Narrower Set of Approaches

Ten relevant business process improvement approaches with the most hits in the previous phase go under a detailed examination in the third phase. Table 3 below presents the more often identified terms resulting from an in-depth review of the narrower set of approaches (excerpt shown in Table 4).

The Petri Nets, BPMN, and EPC (Amjad et al., 2018), already partially selected in the previous phase, should be added to the identified terms. It is also reasonable to add to the set terms appearing in several approaches: FMEA (in three approaches), 5 Why (in six approaches), SMED (in two approaches), and Process Simulation (in four approaches).

Table 1: Identified terms of business process improvement

Global citation database	Identified terms
Web of Science	Business Process Reengineering, Simulation, Lean Manufacturing, Business Process Improvement, Business Process Redesign, Petri Net, Business Process Modeling, BPMN, Six Sigma, Lean Six Sigma, Change Management, Event logs, Just in Time, DMAIC, Value Stream Mapping, UML, Business Process Model, QFD, Process Mapping, AHP, Integrated Enterprise Modeling, Automatization, Pareto principle, Kanban, Digitalization, Agile, Risk Management, ABC Analysis, IDEF, IDEF 3, Continuous Quality Improvement, Continuous Process Improvement, Ishikawa Diagram, EPC, Benchmarking, PDCA, FMEA, IDEF 0, Data Mining, Value Chain Analysis, Delphi, Product - Based Design, Big Data Analytics.
Emerald	Lean Management, Six Sigma, Total Quality Management, Process Mining, AHP, Simulation, Delphi, Business Process Reengineering, Agile method, and Kaizen.
Science Direct	Business Process Reengineering, Lean Management, Six Sigma, Value Stream Mapping, DMAIC, and Business Intelligence.

Table 2: Overview of terms by hits and years of publication

Identified term	The first phase hits	Year of publication	The term independently	The term and "Business Process Improvement"	The term and "Process Improvement"
ABC Analysis	2	2000, 2015	458	0	4
Agile methods	3	1998, 2018, 2019	1 173	0	75
AHP	3	2009, 2009, 2017	25 950	3	34
Automatization (Automatisation)	2	2016, 2018	4 572 (705)	0	4
Benchmarking	1	2000	44 498	19	178
Big Data Analytics	1	2017	4 142	1	8
BPMN	9		1 722	10	25
Business Intelligence	1	2016	5 975	7	24
Business Process Improvement	19		389		
Business Process Model	3		1 544	15	27
Business Process Modeling	9		833	10	19
Business Process Redesign	14		298	9	23
Business Process Reengineering	88		1 454	28	72
Change Management	5	2011, 2017, 2017, 2018, 2018	7 499	11	131
Continuous Process Improvement	1	2010	303	4	303
Continuous Quality Improvement	1	2010	3 974	1	86
Data Mining	1	2009	111 500	19	139
Delphi	2	2015, 2019	24 501	0	25
Digitalization (Digitalisation)	2	2018, 2018	7 070 (1 179)	1	7
DMAIC	5		724	7	110
EPC	1	1999	14 576	0	8
Event logs	4	2015, 2016, 2017	1 378	8	19
FMEA	1	1997	3 111	0	35
IDEF	2	2010, 2014	350	1	6
IDEF 0	1	2018	28	1	11
IDEF 3	2	2015, 2018	3	0	1
Integrated Enterprise Modeling	2	1996, 1997, 2018	14	0	0
Ishikawa Diagram	1	2014	198	1	12
JIT	4	2005, 2014, 2015, 2016	8 312	4	37
Kaizen	1	2015	816	3	61
Kanban	2	2015, 2017	1 556	2	25
Lean Management	32		942	2	52
Pareto principle	2	2017, 2018	459	0	1
PDCA	1	2017, 2017	1 197	3	38

Table 2: Overview of terms by hits and years of publication (continues)

Identified term	The first phase hits	Year of publication	The term independently	The term and "Business Process Improvement"	The term and "Process Improvement"
Petri Net	10		11 858	3	22
Process Mapping	2	2016, 2018	945	8	47
Process Mining	16		1 900	13	58
Product-Based Diagram	1	2010	10	0	0
QFD	3	1997, 2007, 2016	2 720	2	25
Risk Management	2	2013, 2017	87 644	4	201
Simulation (Process Simulation)	23		2 610 359 (12 072)	31 (2)	686 (110)
Six Sigma	16		4 265	24	454
TQM	7	1998, 2011, 2015, 2018, 2018, 2019, 2019	4 672	6	138
UML	3	2012, 2016, 2017	13 632	8	44
Value Chain Analysis	1	2010	561	1	1
Value Stream Mapping	5		756	6	49

Table 3: Identified terms by approaches

Approach	Identified terms
Business Process Reengineering	IDEF0, Benchmarking, Process Modeling/Mapping
Change management	Flowchart
Continuous Process Improvement	Flowchart, Pareto Diagram, Check sheet, Control Chart, Histogram, Scatter Plot, Cause and Effect Diagram, 5S
Just in Time	Kanban, Level schedule (Heijunka)
Kaizen	5S, PDCA
Lean Management	Kanban, Poka Yoke, Heijunka, Visual Control, 5S, VSM, Autonomation (Jidoka)
Process Mining	Heuristic miner (approach, mining), Conformance checking, Genetic mining (algorithms), Dependency graph, Alpha algorithm, Inductive miner, Split miner, Transition systems, Region-based mining (state-based regions, language-based regions)
Six Sigma	DMAIC, Cause and Effect Diagram, Statistical Process Control, Process Mapping, Design of Experiments
Total Quality Management	Control Chart, Cause and Effect Diagram, Pareto Diagram, Histogram, Statistical Process Control (SPC), QFD, Benchmarking, Quality circles, Brainstorming, Check Sheet, Scatter Diagram, Run Chart, Flowchart

Table 4: Identified properties by approaches and references

Approach	Reference	Identified properties
Business Process Reengineering	Chiarini (2011)	Mapping, Benchmarking, Brainstorming, Cause and Effect Diagram
	Habib and Shah (2013)	IDEF 0, task elimination, task composition, integral technology, empower, order-assignment, specialist-generalist, integration, parallelism, numerical involvement, Benchmarking, Business Process Modeling
	Xiang et al. (2014) – redesign	Eliminating unnecessary tasks, combining or dividing tasks, re-sequencing tasks in processes, paralleling tasks, integrating business processes, empowering workers with more decision-making authority, assigning workers to perform as many steps as possible for single orders, making human resources more specialized or more generalized, minimizing the number of departments, groups, and persons
Change Management	Inês Dallavalle de Pádua et al. (2014)	Process Modeling, BPMN, Flowchart, Lanes, EPC, Value Chain, Root Cause Analysis, Current Reality Tree (CRT)
	Al-Haddad and Kotnour (2015)	Lewin's method, Judson's method, Kanter, Jick, and Stein's method, Leading change, Luecke's method, the Insurrection model
	Noori and Latifi (2018)	Mistake Proofing, Six Sigma - DMAIC, Design of Experiments, Control Chart, Cause and Effect Analysis, Flowchart, Brainstorming, Pareto Analysis, Process Capability Analysis
Lean Management	Pettersen (2009)	Kaizen/continuous improvement, Setup time reduction, Just in Time reduction, Kanban/pull system, Poka Yoke, Production leveling (Heijunka), Standardized work, Visual Control, 5S, Andon, Small lot production, Time/work studies, Waste elimination, Inventory reduction, Supplier involvement, Takt production, TPM, Autonomation (Jidoka), Statistical Quality Control, Teamwork, Workforce reduction, 100% inspection, Layout adjustments, Policy deployment, Improvement circles, Root Cause Analysis (5 Why), VSM, Flowcharting, Educational/cross training, Employee involvement, Lead time reduction, Multi-manning, Process synchronization, Cellular Manufacturing
	Al-Tahat and Jalham (2015)	Variability reduction, Visual Control, Poka Yoke, Quality at the source, Kaizen, 5S, Root Cause Analysis, TQM, Kanban, Small lot sizes, Pacing by tact time, Heijunka, VSM, Point-of-use materials
	Stevenson (2015)	Cellular layouts, Kanban, Heijunka, Kaizen, Autonomation (Jidoka), SMED, Balanced system, Poka Yoke, Andon, Activity-based costing, Level loading, Visual system, Preventive maintenance, 5S, VSM
Total Quality Management	Hellsten and Klefsjö (2000)	QFD, Design of Experiments, Control Chart, Process maps, Tree Diagram, Ishikawa Diagram, Pareto Diagram, Histogram, ISO 9000, Benchmarking, Quality circles
	Jafari and Setak (2010)	Cause and Effect Diagram, Pareto Analysis, SPC, Quality costing, Departmental Purpose Analysis, Flowcharting, FMEA, QFD, Check Sheet, Histogram, Scatter Plot, Graphs, Mistake Proofing (Poka Yoke), Task lists, Brainstorming, PDCA, Control Chart, Run charts, Why-why Diagram

Table 5: Frequency of occurrence of related terms by global citation databases

	Web of Science (topic)			ProQuest Dissertations & Theses (anywhere)		Science Direct (all fields)		Scopus (title, abstract, or keywords)		Emerald (all content)	
	All the years	Since 2010	Since 2010 ¹	All the years	Since 2011	All the years	The last 10 years	All the years	The last 10 years	All the years	The last 10 years
The term in combination with "business process improvement"											
Autonomation (Jidoka)	1	1	31	191	102	53	50	139	92	157	112
Benchmarking	557	180	34 473	27 852	15 089	15 591	11 613	41 441	26 481	> 20 000	> 11000
Brainstorming	29	23	2 730	37 295	14 849	758	536	5 437	2 918	> 3 000	> 1 000
Conformance checking	2	2	432	5	3	13	12	1	1	3	3
Design of Experiments	39	19	19 733	4 850	2 039	1 610	1 244	2 836	1 841	656	352
DMAIC	106	78	673	861	592	1 414	1 202	557	389	697	531
Genetic (mining, algorithms)	2 (0,2)	1 (0,1)	(19, 59 879)	88 (0,24)	42 (0,12)	31 (1,20)	22 (1,15)	2 (0,2)	2 (0,2)	30 (0,15)	21 (0,12)
Heijunka	1	1	39	160	92	68	62	122	95	109	87
Heuristic (approach, miner, mining)	2 (0,0,0)	1 (0,0,0)	(3 732, 33, 13)	130 (6,1,0)	67 (2,1,0)	38 (3,5,2)	24 (2,4,1)	6 (0,1,0)	5 (0,1,0)	36 (3,1,0)	23 (1,1,0)
Kanban	24	16	893	1 735	611	1 319	1 058	1 413	751	> 1 000	607
PDCA	45	35	1 018	1 500	718	576	507	1 062	715	702	430
Poka Yoke	4	3	132	371	165	267	197	306	191	357	241
Process Mapping	68	50	855	1 615	758	777	529	865	510	> 1 000	764
Process Modeling	287	186	6 163	4 235	1 986	6 313	4 270	10 424	6 018	> 5 000	> 3 000
Process Simulation	94	50	8 256	1 935	784	1 302	916	1 622	1 025	245	143
QFD	62	33	1 889	1 830	642	2 779	1 838	1 533	768	> 1 000	692
SMED	5	5	1 018	672	280	442	342	423	260	363	250
Statistical Process Control	113	38	4 651	3 460	896	2 113	1 291	2 033	725	> 1 000	595
Visual Control	1	1	2 395	1 002	392	102	76	286	161	250	176
VSM	48	46	821	784	532	2 168	1 945	757	633	924	804
5S	24	19	23 257	39 160	7 051	923	823	1 583	680	> 1 000	674
Max. number in the column	557	186	59 879	39 160	15 089	15 591	11 613	41 441	26 481	20 000	11 000
5 % of the max. number	27.85	9.3	2 993.95	1 958	754.45	779.55	580.65	2 072.05	1 324.05	1 000	550

¹ The number of hits by the searched independent term.

An In-depth Review of the Remaining Terms and Designing a Set of Relevant Methods and Techniques

In the last phase, the final in-depth review of the remaining terms is executed:

- a review of the frequency of occurrence of the terms (in combination with “business process improvement”) – Table 5,

Table 6: Usability of terms in individual phases of Business Process Improvement approaches

	Preparation for improvement	Processes mapping	Processes analysis	Key processes improvement	Solution implementation/ System adaptation	Processes monitoring and control
Benchmarking		M ² in DMAIC (Zare Mehrjerdi, 2011; Antony, 2006)	A ³ in BPR (Habib and Shah, 2013)	D ⁵ in DMADV (Soković et al., 2009)		
Brainstorming	D ¹ in DMAIC (Antony, 2006) and in DMADV (Soković et al., 2009)	Determination of change requirements (Nickerson, 2014)	A ³ in DMAIC (Soni et al., 2013; Antony, 2006)	I ⁴ in DMAIC (Zare Mehrjerdi, 2011; Soni et al., 2013; Antony, 2006)		
Process Mapping	D ¹ in DMAIC (Antony, 2006)	M ² in DMAIC (Soni et al., 2013)	A ³ in DMAIC (Soković et al., 2009), process evaluation (Shin and Jemella, 2002)			
Process Modeling		Process discovery (Dumas et al., 2018), business environment modeling (Valiris in Glykas, 1999)	Business Environment Analysis (Valiris in Glykas, 1999), analysis of business processes (Habib and Shah, 2013)	Streamlining (Valiris and Glykas, 1999)		
Process Simulation			Analysis (Dumas et al., 2018), process evaluation (Shin and Jemella, 2002)	I ⁴ in DMAIC (Zare Mehrjerdi, 2011)		
VSM	D ¹ in DMADV (Soković et al., 2009), identification of the target product/service (Boutros and Cardella, 2016)	Identification of activities and other parts of the process (Boutros and Cardella, 2016)	Process Analysis - waste identification (Boutros and Cardella, 2016)	I ⁴ in DMAIC (Soković et al., 2009), developing a list of opportunities (Boutros in Cardella, 2016)	Lean Implementation phase (Bhamu and Singh Sangwan, 2014)	
5S				I ⁴ in DMAIC and D ⁵ in DMADV (Soković et al., 2009)		

¹ D – Define; ² M – Measure; ³ A – Analyze; ⁴ I – Improve; ⁵ D – Design; ⁶ C – Control; ⁷ V - Verify

- a review of the terms' use in the phases of business process improvement approaches (with emphasis on Processes mapping, Processes analysis, and Key processes improvement) – Table 6,
- an overview of the definitions of the terms.

Based on the review of the occurrence of terms' frequency in the multidisciplinary collections and the calculation of the 5% maximum number of hits, the following terms were excluded from the set: PDCA, SMED, Heijunka, Visual Control, Poka Yoke, Autonomation (Jidoka), Heuristic (approach, miner, mining), Conformance checking, Genetic (mining, algorithms), 5 Whys, Pareto Diagram, Check Sheet, Run Chart, Dependency graph, Alpha algorithm, Inductive miner, Split miner, Transition systems, Region-based mining (or state-based regions, language-based regions).

The following two reviews are carried out for the remaining terms, and the partial results are shown in Table 6.

Based on the last two reviews, the following are excluded from the set of relevant terms:

- DMAIC and Statistical Process Control, as they are broader terms regarding content and are classified as an approach, type of approach, or methodology,
- QFD, Control Chart, Histogram, and Scatter Diagram, as they are more suitable for use in other phases of improvement approaches and support business process improvement methods and techniques,

- Kanban, as it is a consequence of the way of the improvement realization,
- Design of Experiments because it is a statistical methodology enabling the practitioner the statistical correlation examination between the input variables and outputs from the system or process (Astakhov, 2012).

Based on the executed full 4-phase structured review of the available professional and scientific literature, the relevant and most often used methods and techniques of business process improvement are identified:

- methods – Benchmarking, Brainstorming, Process Mapping/Process Modeling, Process Simulation, Value Stream Mapping, and 5S,
- techniques – BPMN, Cause and Effect Diagram, EPC, Flowchart, FMEA, and Petri Nets.

3.2 Questionnaire Results

Basic Characteristics of the Sample

The overall analysis is based on descriptive statistics, where different possibilities of analyzing and visualizing the data based on the question type and the response options were used.

213 respondents completed the questionnaire. The respondents were classified according to three criteria of organizational systems classification: size, predominant

Table 7: Enterprises by size, purpose, and country

		Frequency	Percentages
Size	Micro-sized enterprise (0-9 employees)	0	0.0%
	Small-sized enterprise (10-49 employees)	5	2.3%
	Medium-sized enterprise (50-249 employees)	119	55.9%
	Large-sized enterprise (250 or more employees)	89	41.8%
Predominant purpose	Energy production	6	2.8%
	Material (physical) production	129	60.6%
	Non-material production (services)	78	36.6%
Country	Slovenia	129	60.6%
	Croatia	61	28.6%
	Germany	18	8.5%
	Sweden	5	2.3%

purpose, and the country of business. Table 7 shows that the main respondents to the survey were:

- medium-sized organizational systems (55.9%) and large organizational systems (41.8%),
- material production (60.6%) and non-material production (36.6%) organizational systems,
- organizational systems from Slovenia (60.6%) and Croatia (28.6%).

The respondents also provided information on the business area of the organizational systems, the results of which are shown in Table 8. Most of the participants completed the questionnaire for the following business areas: Manufacturing (41%); Wholesale and Retail Trade, Repair of Motor Vehicles and Motorcycles (13%); Construction (12%), and Transportation and Storage (11%). The rest of the business areas are covered to a lesser extent.

Information on the Improvement Method or Technique Used

The central part of the questionnaire asked about the method or technique used in business process improvement. Firstly, we were interested in the approaches used to improve the business process (Figure 1). Continuous Process Improvement (62%) was chosen the most, followed by Change Management (44%), Business Process Reengineering/Redesign (37%), and Digital Transformation (32%). Lean Management (25%), Total Quality Management (16%), and Just in Time (11%) are slightly less often selected. The remaining approaches are used in less than 10% of the cases. The respondents added a few other terms: a combination of various practical knowledge; ZKP; MIFA; Ishikawa, 5 Why, and Quick Response Manufacturing.

Table 8: Enterprises by business areas

	Responses		Percentages of cases
	N ¹	Percentages	
Agriculture, Forestry, and Fishing	9	2.9%	4.2%
Mining and Quarrying	3	1.0%	1.4%
Manufacturing	87	27.8%	40.8%
Department of the manufacturing activity	75	24.0%	35.2%
Electricity, Gas, Steam, and Air Conditioning Supply	6	1.9%	2.8%
Water Supply, Sewerage, Waste Management, and Remediation Activities	1	0.3%	0.5%
Construction	26	8.3%	12.2%
Wholesale and Retail Trade, Repair of Motor Vehicles and Motorcycles	27	8.6%	12.7%
Transportation and Storage	23	7.3%	10.8%
Accommodation and Food Service Activities	2	0.6%	0.9%
Information and Communication	11	3.5%	5.2%
Real Estate Activities	1	0.3%	0.5%
Professional, Scientific, and Technical Activities	15	4.8%	7.0%
Administrative and Support Service Activities	4	1.3%	1.9%
Human Health and Social Work Activities	2	0.6%	0.9%
Other Service Activities	21	6.7%	9.9%
Total	313	100.0%	146.9%

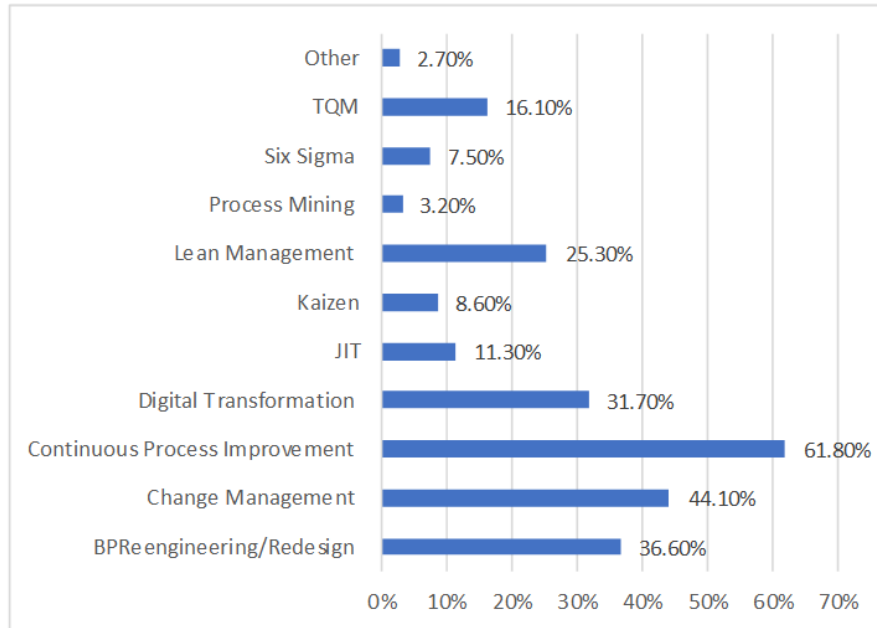


Figure 1: Used Business Process Improvement approaches

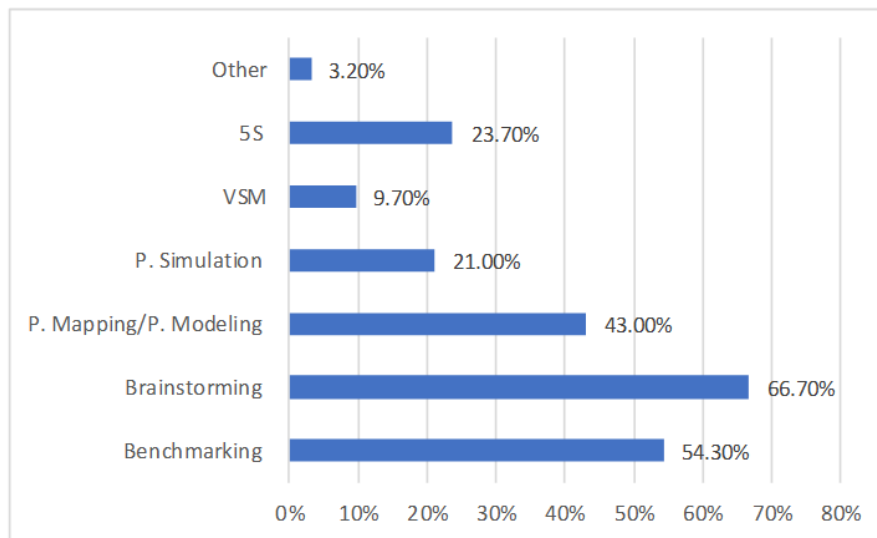


Figure 2: Used Business Process Improvement methods

Questions about the method used (Figure 2) or the technique used (Figure 3) in business process improvement followed. The respondents most frequently used Brainstorming (67%), Benchmarking (54%), and Process Mapping/Process Modeling (43%); the least frequently used was VSM (10%). A few respondents also selected the answer “other” (3%), where they added the Six Sigma methods, basic quality methods; SWOT, materiality matrix, PESTLE, Porter’s Forces, VRIO, Boston Matrix;

PDCA; SWOT and Poka-Yoke, PDCA. An overview of the techniques used (Figure 3) followed. The most used ones are Flowchart (56%), FMEA (29%), BPMN (29%), and Cause and Effect Diagram (28%). The Petri Nets technique (2%) is the least frequently used. The answer “other” is chosen several times (6%), and the following are added: creative team thinking; MIFA; Focus Groups – interviews; taking account of industry developments and global DSV policies.

Next, we looked at which used methods and techniques, according to the respondents, contributed the most to business process improvement efficiency. Brainstorming (30.1 %) and Benchmarking (19.4 %) (Figure 4) are the most frequently chosen, and the least chosen is Petri Nets (0.5 %). Once the option »other« (0.5 %), where PDCA is added, is also chosen.

In this part of the questionnaire, we wanted to gain more information on the method or technique selected:

- the purpose of implementing the selected methods and techniques,
- the consistency of the execution of the selected method or technique,
- the use of the selected method or technique by business process improvement phases.

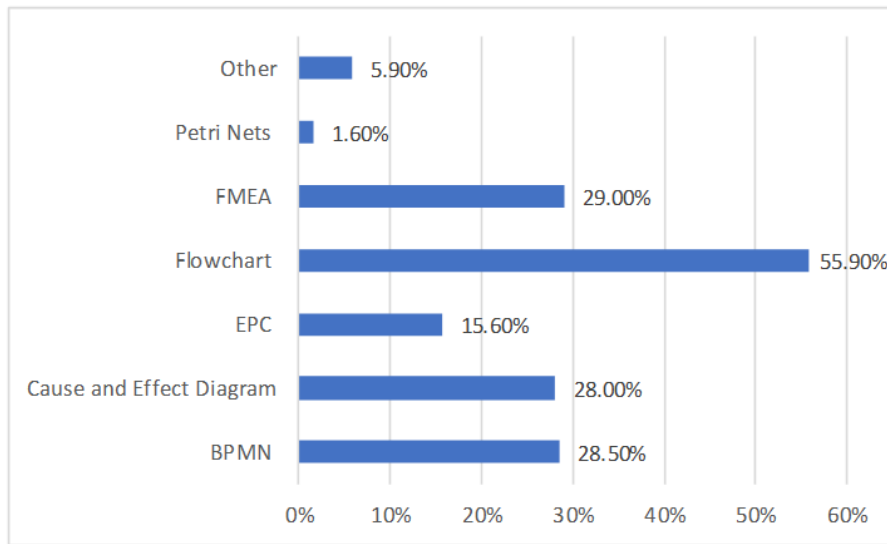


Figure 3: Used Business Process Improvement techniques

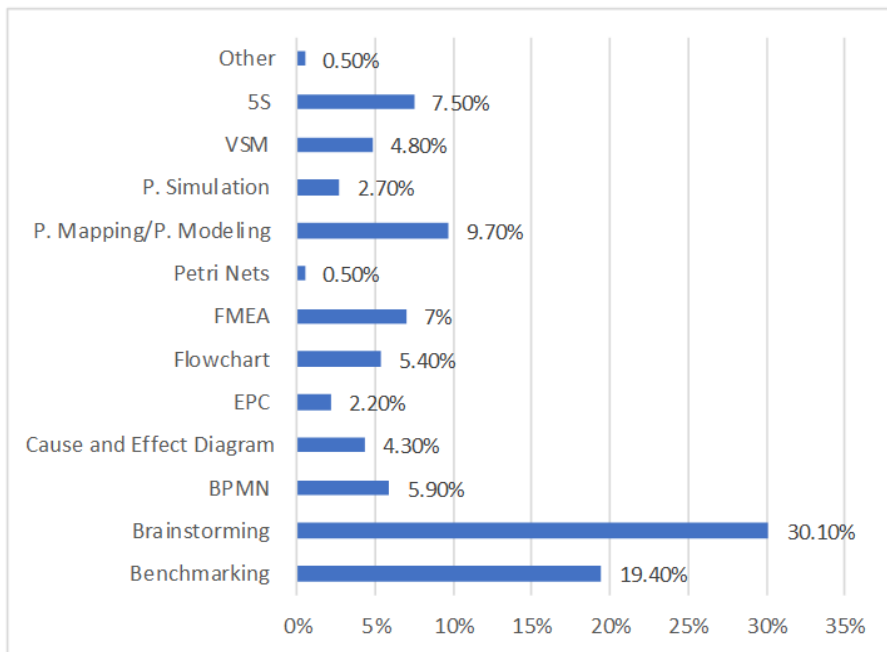


Figure 4: The most effective term for business process improvement

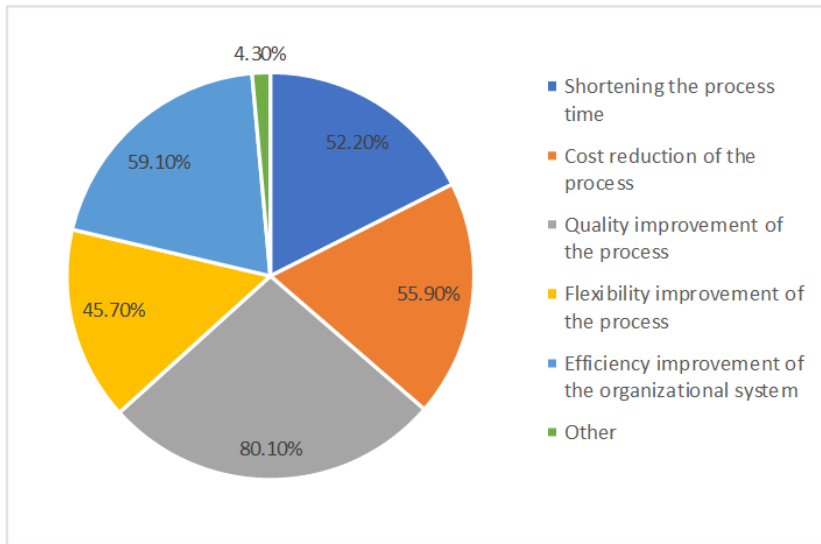


Figure 5: The purpose of implementing the selected term

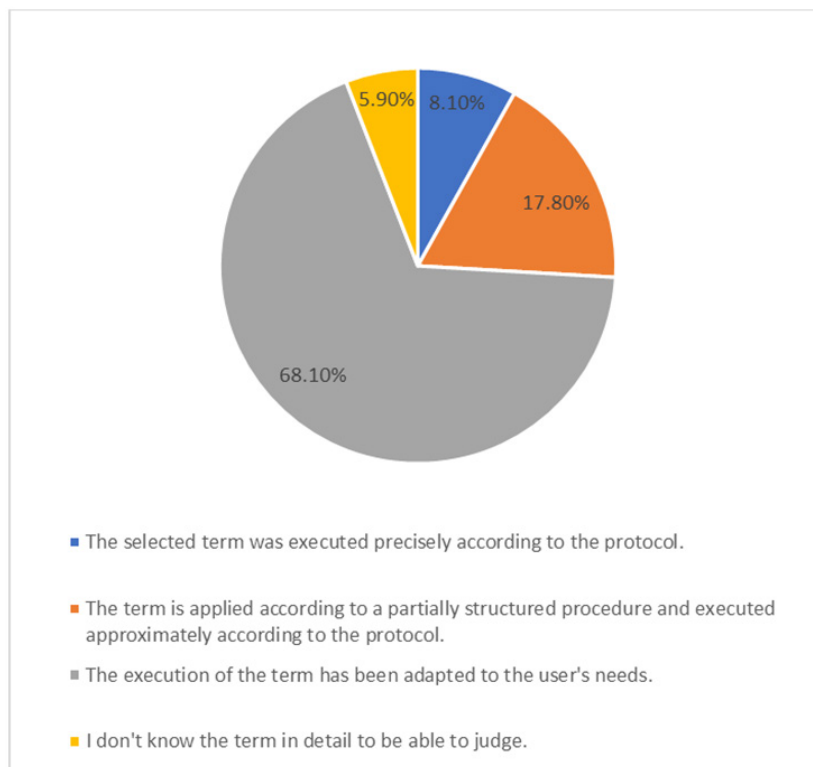


Figure 6: Consistency in the execution of the selected term

Figure 5 shows that the methods and techniques were most frequently implemented to improve process quality (80%). The remaining purposes were relatively evenly chosen. An answer was added a few times, such as Lean Manufacturing and Six Sigma, include all of the above;

strategic marketing, communication improvement between business processes; transparency; customer service improvement; ensuring process transparency; reducing the risk, and achieving a high level of involvement.

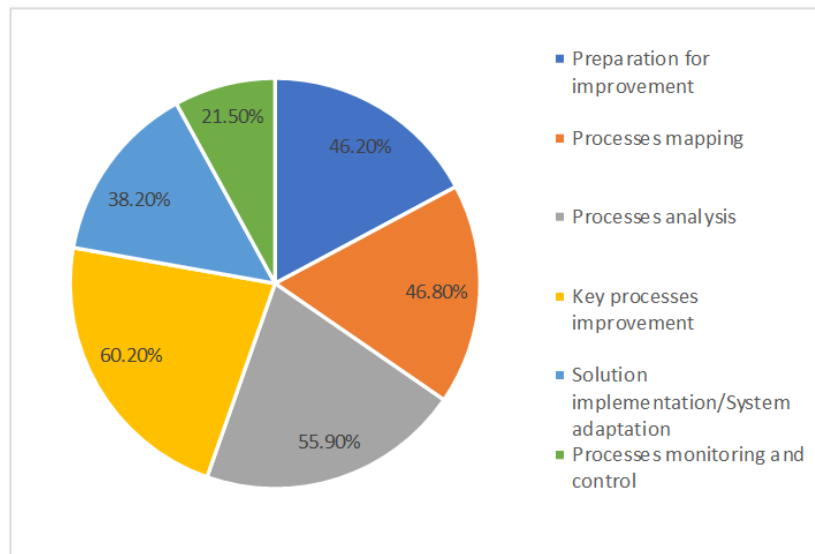


Figure 7: Use of the selected term according to the phases of business process improvement

The question about the consistency of the execution of the selected method or technique offers four answers to the respondents (Figure 6). The third statement (68.1%) about the method or technique execution adapted to the user's needs was the most frequently chosen one. The remaining statements were chosen significantly less frequently. The least frequently selected statement was about not knowing a method or technique (5.9%).

The respondents used the chosen method or technique the most (60%) in the phase of the Key processes improvement (Figure 7) and the least frequently in the phase of Processes monitoring and control (22%). Other business process improvement phases were chosen fairly evenly.

The Suitability of the Selected Method or Technique to Improve Business Processes and Organizational System

The last part of the questionnaire asks the respondents about their opinion on the suitability of the selected method or technique to improve business processes and, consequently, the organizational system. We wanted to know whether the chosen method or technique was useful for achieving the purpose the respondents had set at the beginning of the business process improvement. Most of the respondents answered affirmatively (55.7%), and the least of the respondents answered negatively (0.7%). The rest of the respondents chose the answer that the selected method or technique was partially useful in achieving their purpose.

The end of the questionnaire assessed the difficulty level of the method or technique for the respondents' organizational system. Each difficulty could be rated from 1 to 5, where 1 meant the method or technique was very non-difficult, and 5 meant it was very difficult. On average,

the technical difficulty of the method or technique used is rated 3.29, the time difficulty 3.62, and the cost difficulty 3.03. Therefore, the respondents rated their methods and techniques as the most time-consuming and the least cost-consuming.

An Analysis of Differences in the Methods and Techniques Use

We also wanted to know the potential differences in the use of individual methods or techniques of business process improvement between organizational systems based on three criteria of their classification: purpose, size, and country. The analysis of differences contained analyses of all 13 selected terms. The tests were carried out with the help of the χ^2 test on the sample of 186 respondents.

The theoretical frequencies of the initial tests were less than 5. Consequently, the interpretation of the χ^2 test was not reliable because the test requires theoretical frequencies to be more than 5 in all of the table's cells. Consequently, individual categories are appropriately grouped, i.e., individual variables were re-coded before conducting all the tests again. Small and medium-sized organizational systems were combined in SME organizational systems, and the energy production was combined with material (physical) production. These mergers make sense considering the categorization of other existing organizational systems and the survey sample. For the third criterion, a sensible merger was impossible to perform, and the test was repeated in countries with theoretical frequencies of more than 5 in at least half of the initial tests (Slovenia, Croatia, and Germany).

The theoretical frequencies of the repeated tests are larger than 5 in all cells. Consequently, the χ^2 tests' in-

terpretation is reliable. The test results, for which we can confirm the statistically significant association, are shown in Table 9. In these cases, we thus confirm that the method or technique used differs concerning an individual criteri-

on for classifying the organizational system. Table 9 also shows a contingency coefficient, showing a low correlation in all cases can be confirmed.

Table 9: Results of χ^2 tests for the use of methods and techniques according to purpose, size, and country of enterprises

		The predominant purpose of the enterprise	Size of the enterprise	Country of the enterprise
Brainstorming	p-value			0.024
	$\chi^{2,1}$			7.438
	C ²			0.198
				75 % Slovenia, 17.9 % Croatia, 3.6 % Germany, 3.6 % Sweden
P. Mapping/ P. Modeling	p-value			0.006
	χ^2			10.324
	C			0.231
				44.4 % Slovenia, 33.3 % Croatia, 22.2 % Germany
VSM	p-value	0.013		0.025 ³
	χ^2	6.209		7.352
	C	0.198		0.197
		88.9 % material production, 11.1 % non-material production		44.4 % Slovenia, 22.2 % Croatia, 33.3 % Germany
5S	p-value	0.013		
	χ^2	6.192		
	C	0.192		
		71.4 % material production, 28.6 % non-material production		
BPMN	p-value			< 0.001
	χ^2			14.366
	C			0.270
				45.5 % Slovenia, 18.2 % Croatia, 36.4 % Germany
FMEA	p-value	< 0.001	0.010	
	χ^2	17.556	6.612	
	C	0.305	0.197	
		92.3 % material production, 7.7 % non-material production	53.8 % medium-sized, 46.2 % large-sized	

¹ χ^2 – the value of the test statistic

² C – contingency coefficient

³ 16.7% of cells (1 cell) have a theoretical frequency less than 5 (up to 20% is acceptable).

Based on the analysis, we can confirm that the differences in the use of individual methods and techniques of business process improvement between the organizational systems according to the different criteria of their classification do not exist:

- The use of two methods (out of seven) differs concerning the organizational system's purpose.
- The use of methods does not differ concerning the organizational system's size.
- The use of three methods (out of seven) differs concerning the organizational systems' country.
- The use of one technique (out of six) differs concerning the organizational systems' purpose and size.
- The use of one technique (out of six) differs concerning organizational systems' country.

4 Conclusion

The research aimed to identify the relevant approaches, methods, and techniques of business process improvement and to research the potential differences in their use between the organizational systems according to different criteria of their classification.

Below, we highlight the key findings of the conducted survey:

- Based on a 4-phase structural review of the available literature, relevant and most frequent methods and techniques of business process improvement were identified,
 - o methods - Benchmarking, Brainstorming, Process Mapping/Process Modeling, Process Simulation, Value Stream Mapping, and 5S,
 - o techniques - BPMN, Cause and Effect Diagram, EPC, Flowchart, FMEA, and Petri Net;
- The most frequently used in practice (Figures 1, 2, and 3),
 - o approaches - Continuous Process Improvement (62 %), Change Management (44 %), Business Process Reengineering/Redesign (37 %), and Digital Transformation (32 %),
 - o methods - Brainstorming (67 %), Benchmarking (54 %), and Process Mapping/Process Modeling (43 %),
 - o techniques - Flowchart (56 %), FMEA (29 %), BPMN (29 %), and Cause and Effect Diagram (28 %);
- The findings of the relevant terms from the literature and questionnaire are in accordance, as only a few respondents wrote an additional term (methods - 3 % and techniques - 6 %);
- The most efficient methods for improving business processes, according to the respondents' opinion (Figure 4), are Brainstorming (30.1 %), Benchmarking (19.4 %), and Process Mapping/

Process Modeling (9.7 %);

- Methods and techniques are most frequently (Figures 5, 6, and 7),
 - o implemented to improve the quality of processes (80%),
 - o adapted to the user's needs (68.1%),
 - o used in Key processes improvement phases (60%) and the Processes analysis (56%),
 - o useful to achieve an intended purpose (55.7%),
 - o time-consuming (3.62) and least cost-consuming (3.03);
- The use of individual methods and techniques of business process improvement does not differ between organizational systems according to their classifying ranking criteria (Table 9),
 - o individual methods and techniques are often used in manufacturing organizational systems (for example, VSM, 5S, and FMEA). Gálová et al. (2018) support the findings and characterize VSM and 5S as business domain-dependent methods,
 - o individual methods and techniques are often used in large and medium-sized organizational systems (for example, FMEA); however, no limitations in their use concerning their size in literature are detectable,
 - o the most differences in the use of methods and techniques are noticed concerning the organizational systems' country (for example, Brainstorming, Process Mapping/Process Modeling, VSM, and BPMN). We can conclude that different aspirations of organizational systems from various countries according to the use of specific methods and techniques; however, we cannot define a generalized conclusion about the use of different types of methods and techniques from the results obtained.

The purpose of the research was achieved entirely. In the future, it would be useful to build on the currently emphasized conclusions, i.e., we recommend that the research results be verified on a larger sample and by other criteria for classifying organizational systems.

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Analiza metod in tehnik uporabljenih za izboljšanje poslovnih procesov

Ozadje: V zadnjih desetletjih je bilo razvitih več kot 50 procesnih pristopov ter metod in tehnik za doseganje učinkovitejšega delovanja poslovnih sistemov. Zaradi vse hitrejših sprememb v poslovnem okolju postaja vse pomembnejše vprašanje, katere metode ali tehnike bodo najbolj vplivale na povečanje konkurenčne prednosti poslovnega sistema.

Namen: V predstavljeni raziskavi smo se osredotočili na identifikacijo metod in tehnik, ki so v literaturi najpogosteje citirane in so v praksi najpogosteje uporabljene ter se izkažejo kot učinkovite za izboljšanje poslovnih procesov.

Metode: V ta namen smo pripravili 4-fazni strukturiran pregled dostopne literature in ugotovitve podprli z anketno raziskavo.

Rezultati in zaključek: Na podlagi pridobljenih rezultatov smo oblikovali nabor ustreznih, najpogosteje uporabljenih in učinkovitih metod in tehnik za izboljšanje poslovnih procesov. Opravljena raziskava lahko služi kot izhodišče za odgovor na izpostavljeno vprašanje o ustreznem naboru metod in tehnik za izbran pristop. V nadaljevanju raziskave bi bilo smiselno preveriti še druge lastnosti in uporabe metod in tehnik.

Ključne besede: *Obvladovanje poslovnih procesov, Izboljšava poslovnih procesov, Pristopi, Metode, Tehnike*

Employee Motivation in Contemporary Academic Literature: A Narrative Literature Review

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Background: Using the correct type of motivation is pivotal in triggering employees' affirmative work attitudes, such as work performance, job satisfaction, or voluntary retention, ultimately leading to increasing the organization's overall efficiency. Despite the ongoing academic debate, academics provide practitioners with mixed results on which motivation factors are relevant for targeted employee groups whose needs are under the economic and socio-psychological pressure of the rapidly evolving environment. Elton Mayo was the first to acknowledge these socio-psychological factors as significant motivation drivers almost a century ago.

Methods: Therefore, the purpose of this paper, using the narrative literature review method (supported by a systematic search strategy) on 83 articles, is to evaluate the research findings on employees' motivation (related to their affirmative work attitudes) and to unfold the motivation theory's advancement.

Results: Key motivation drivers were identified and unified into five motivation sets applicable to different employee groups. The findings also suggest that most academic works, theoretically grounded in classical motivational concepts, are quantitative analysis-based.

Conclusion: To increase the efficiency of employees' performance, internal motivation or internalization of external motivation seems to be the best solution. Employees' "floating" needs call for practitioners to be trained in techniques from psychology.

Keywords: *Elton Mayo, Employee motivation, Motivation factor, Motivation theory*

1 Introduction

George Elton Mayo is best known for his series of studies known as the "Hawthorn Study" or the "Hawthorn Experiment" conducted between 1927 and 1932. Based on the studies, using techniques from disciplines such as psychiatry or psychology (e.g., psychoanalysis or counseling), Mayo was the first to demonstrate the complexity of workers' motivation based on a socio-psychological rather

than the economic concept of an individual (Hansson & Wigblad, 2006).

Although Mayo reached this knowledge almost a century ago, the findings still seem more than recurrent as a growing body of practical literature is concerned with employee day-to-day negative experiences (e.g., work-life balance, work stress, mental health, or burnout syndrome). The same applies to academic debate. For instance, Safari (2020) deals with burnout syndrome, Budnick et al. (2020) with work-home boundaries, and Lutz et al. (2020) with

employees' mental health. Even though the phenomenon of "motivation" has played a significant role in academic research for decades (e.g., Gagné et al., 2010; Kuuvas et al., 2017; Ahmed et al., 2021; Li et al., 2023), there seems to be a widening gap between theory and practice as organizations often fail to implement the new theoretical knowledge in practice. The reluctance to adopt the latest concepts might be caused by the lack of theoretical knowledge on the one hand or over-theorizing on the other. Another reason against successful adoption might be scarce resources or poor employee motivation management (Safari, 2020).

This paper uses the narrative literature review method on research articles to identify contemporary employee motivation drivers, current theories, and methods as they appear in the latest academic research. Thus, the research was guided by the following research question (RQ):

RQ: What motivates contemporary employees (what aspects of motivation are analysed in scientific research)?

To fulfil the paper's objectives and to answer the research question (RQ) to the fullest, two supporting sub-questions (SQs) were formulated:

SQ 1: What theoretical concepts are used by the authors under analysis?

SQ 2: What research methods do the authors under analysis use?

To accomplish given objectives, the following subsection presents current theoretical approaches to employee motivation (1.1). Section Material and Methods (2) highlights the method used to identify the studies under review. Section Results and Discussion (3) provides an overview and a summary of contemporary employee motivation as presented in the studies. It also synthesizes theoretical approaches and discusses the methods used in the current research. The review strategy is depicted in Figure 1.

1.1 Current theoretical approaches to employee motivation

Mayo's legacy for contemporary motivational theories

Highhouse (1999) states that radical behaviourism prevailed in industrial/business psychology in the era before

Hawthorn's experiments, which is an approach based on the assumption that an individual's behaviour can be scientifically examined without knowledge of his/her inner mental states. Mayo's thesis that employees are human beings pursuing their interests and attaining self-satisfaction through their work and that the work itself is a social activity, and that is why most people strive for work that is fulfilling and meaningful became a ground-breaking idea at the time, which provided the basis for formulating new theoretical approaches to employee motivation (Khoshnevis & Tahmasebi, 2016). Thereby, it could be concluded that the results of the Hawthorne study have proven and thus shown the crucial importance of socio-psychological factors, such as the sense of belonging to a group, the ability to make decisions, and the importance of an employee as an individual for work productivity and employee satisfaction. The effectiveness of wage incentives is thus dependent on their relationship to other factors. It cannot be considered something that has an individual effect on an individual. Only in connection with interpersonal relationships at work and an individual's personal life it creates key determinants affecting labour productivity (Mayo, 1933). According to Highhouse (1999), this is Mayo's legacy for contemporary motivational theories and human resource management.

Scientists distinguish two theoretical approaches to contemporary employee motivation: the classical (traditional) approach, which is referred to as "classical theory," and the holistic approach, referred to as "modern motivation theory" (Lee & Raschke, 2016; Ryan, 2017).

Classical (traditional) motivational theories

Traditional motivational theories focus on specific factors that motivate employees to perform. According to some authors (e.g., Khoshnevis & Tahmasebi, 2016; Lee & Raschke, 2016), classical theories originated at the turn of the last century and are the most often used by academia and practitioners.

Maslow's hierarchy of needs

According to Maslow (1943), there are five levels of needs. After fulfilling a particular need, the individual is motivated to satisfy another need in the hierarchy—physiological, security, safety, social, recognition, and self-realization needs. If managers know the level of employee

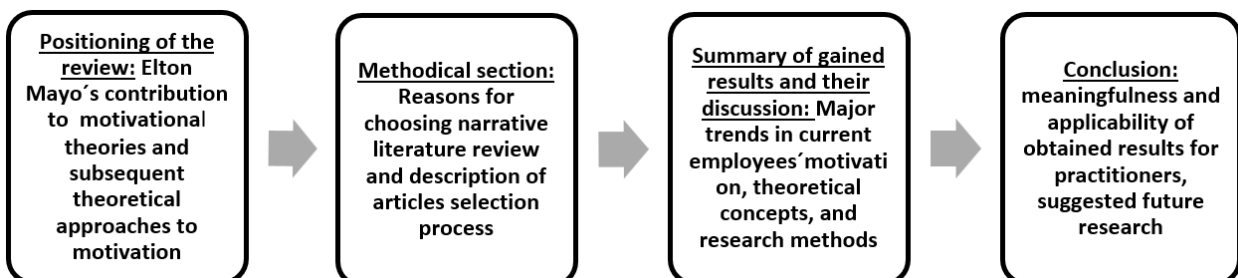


Figure 1: Overview of the study (authors' own work)

satisfaction, they can effectively motivate their employees.

McGregor's motivational theory X and Y

McGregor's Theory X (McGregor, 1960) assumes that employees do not like to work, do not want to be responsible, and do not care about their overall performance. It is, therefore, necessary to force them. In contrast, employees defined by the Y theory (McGregor, 1960) are considered dynamic, capable, and creative individuals. They can make decisions and accept responsibility for their work. McGregor (1960) does not claim that the Y theory can define all employees, but if employees are treated according to theory X, they will behave accordingly. Knowing the right "typology" of employees enables managers to choose appropriate employee management.

Herzberg's theory of two factors

Herzberg et al. (1959) distinguish between motivation and hygiene factors. Motivation factors or motivators bring employee satisfaction (e.g., success, recognition, growth opportunity). Hygiene factors are, e.g., organization policy, working conditions, relations with superiors, relations with colleagues, and financial remuneration. Hygiene factors alone do not satisfy employees, but their absence causes dissatisfaction. A hygiene factor (e.g., financial remuneration) can only motivate an employee if linked to a motivator (e.g., recognition).

Other classical theories include Vroom's theory of expectations (Expectancy theory) (Vroom, 1964), Skinner's motivational theory based on support and positive evaluation of employee behaviour (Reinforcement theory) (Skinner, 1953) or Deci's theory of self-determination (Self-determination theory) (Deci, 1971).

Modern (holistic) motivational theories

Holistic (modern) theories are based on an interdisciplinary approach to employee motivation and use knowledge from neurology, biology, and psychology. For example, Nohria et al. (2008) use knowledge from various fields to explain "human nature" as an elementary factor influencing employee motivation. It is natural for employees to be driven by ownership (e.g., financial reward), belonging (e.g., company culture), understanding (e.g., job description), and feeling safe (e.g., performance management processes and resource allocation). The organization's performance is maximized if these so-called "drivers" effectively motivate employees.

Additional approaches to motivational theories

Another possible way to classify motivational theories is based on the very approach to motivation. Scientists distinguish between theories that deal with motivational factors (Theories on factors of motivation), such as Maslow's Theory of Needs (Maslow, 1943), Herzberg's theory of two factors (Herzberg et al., 1959), or theories that focus on explaining the motivation process itself (General-process theories). These include Vroom's Expectancy theory (Vroom, 1964) and Adams's equilibrium theory (Steers et al., 2004).

2 Materials and Methods

Literature reviews synthesize published literature on a topic and describe its current state of the art (Ferrari, 2015). While a narrative literature review is a comprehensive, critical, and objective analysis of the current knowledge on a topic (Baker, 2016), a systematic literature review identifies, selects, and critically appraises research to answer a clearly formulated question (Ferrari, 2015). In contrast to a systematic review, a narrative review can address one or more questions, and the selection criteria for inclusion of the articles may not be specified explicitly. However, the quality of a narrative review may be improved by borrowing from systematic review methods to reduce bias in selecting articles and employing an effective bibliographic research strategy (Ferrari, 2015).

Thus, due to the fragmented focus of each article under investigation, a narrative and systematic literature review were considered the most suitable.

For the systematic search of articles, in line with Ferrari's (2015) suggestions, one research question (RQ) and two supporting sub-questions (SQs) were formulated reflecting the intended use (see 1 Introduction).

2.1 Article selection strategy

The selection criteria used to identify those studies that responded to the research question (RQ) were as follows:

- The studies were searched in the Web of Science and Science Direct databases.
- To resemble organizations' primary concern - employees' efficiency appraisal (research intentions of Mayo's Hawthorn experiment), the search included terms such as "employee motivation and job satisfaction," "employee motivation and commitment," "employee motivation and voluntary retention," "employee motivation and labour productivity," or "employee motivation and job performance."
- The search was limited to peer-reviewed works.
- The search was limited to works written in English.
- The search was limited to works published between January 2000 and July 2023.

Cleaning strategy

Based on the content analysis of article titles, abstracts, and keywords resembling the search terms, the works that did not meet all the criteria were excluded.

Thus, after excluding those not meeting the criteria, the final number of articles was 83 (FN = 83). The number of articles based on empirical research was 73 (N = 73/83), and the number of articles based on systematic literature review was 10 (N = 10/83).

Selected articles

To answer RQ, due to a very fragmented focus, the 83 articles were divided into five thematic sub-sections (Internal and external motivation, Motivation of Generation Y, Motivation of knowledge workers, Motivation of aging employees, and Motivation for pro-environmental behaviour of employees), as depicted in Table 1.

To answer supporting SQ 1 and SQ 2, only empirical research findings were under investigation (N = 73).

3 Results and Discussion

3.1 Motivation of contemporary employees (RQ)

Internal and external motivation

The most crucial outcome of motivation is employee performance. Thus, we can define internal motivation as a

Table 1: Selected articles division into thematic sub-sections (authors' own work)

Thematic sub-section	Article concern regarding motivation and employee efficiency and productivity appraisal	Individual articles listed in alphabetical order
Internal and external motivation (N=28)	Internal and external motivation, Intrinsic and extrinsic motivation.	Benabou & Tirole, 2003; Bowles & Polanía-Reyes, 2012; Chatzopoulou et al., 2015; Contiu et al., 2012; Deci & Ryan, 2000; Deci et al., 2016; Donze & Gunnes, 2018; Elizur & Koslowsky, 2001; Frey & Jegen, 2001; Gagné & Deci, 2005; Gagné et al., 2010; Haghighatian & Ezati, 2015; Hitka & Balážová, 2015; Howard et al., 2016; Izvercian et al., 2015; Judge et al., 2010; Khoshnevis & Tahmasebi, 2016; King et al., 2017; Kuuvas et al., 2017; Lo et al., 2012; Maxwell, 2005; Mitchell et al., 2020; Moran et al., 2012; Rusu & Avasilcai, 2014; Siu et al., 2014; Vetráková & Mazúchová, 2016; Zámečník, 2014; Zhang & Liu, 2022.
Motivation of Generation Y (N=14)	Generation Y, millennials, internet generation, or young employees.	Allen, 2004; Aycan & Fikret-Pasa, 2003; Campos Monteiro et al., 2015; Chapman et al., 2005; Eisner, 2005; Frye et al., 2019; Lu & Adler, 2009; Lutz et al., 2020; Rosenbaum & Wong, 2012; Stewart et al., 2017; Supanti & Butcher, 2019; Wong et al., 2017; Wood, 2004; Xiong & King, 2019.
Motivation of knowledge workers (N=16)	Motivation of "knowledge," "highly skilled," "executive," "talented," or "creative" employees.	Davenport, 2005; Gupta et al., 2023; Hanaysha & Tahir, 2016; Lee & Kim, 2021; Lee & Suzuki, 2020; Li et al., 2021; Li et al., 2023; Mahjoub et al., 2018; Mládková, 2012; Mládková, 2013; Mládková, et al., 2015; Ng, 2017; Ozkeser, 2019; Pohle et al., 2022; Reboul et al., 2006; Schermuly et al., 2013.
Motivation of aging employees (N=8)	Aging employees, old employees, elderly employees, retired employees, or retiring employees.	Armstrong-Stassen, 2008; Armstrong-Stassen & Ursel, 2009; Budnick et al., 2020; Francis-Smith, 2004; Heslin et al., 2019; Johns, 2003; Kooij et al., 2014; Pak et al., 2018.
Motivation for pro-environmental behaviour of employees (N=17)	Motivation for "pro-environmental," "green," or "pro-philanthropic" employee behaviour.	Ahmed et al., 2021; Aitken et al., 2016; Appiah, 2019; Davis et al., 2020; Giocirlan, 2023; Goh & Ferry, 2019; Graves & Sarkis, 2012; Graves et al., 2013; Graves & Sarkis, 2018; Hu et al., 2016; Macke & Genari, 2019; Maki et al., 2016; Mamun, 2023; Sheldon et al., 2016; Voegtlin & Greenwood, 2016; Yuriev et al., 2018; Zhang & Huang, 2019.

desire to do the task for itself and to experience the satisfaction it provides (Deci & Ryan, 2000). Internal motivation is associated with positive results such as engagement, productivity, and identification with work (e.g., Chatzopoulou et al., 2015; Howard et al., 2016; Deci et al., 2016). In contrast, external motivation is usually defined as a desire to pursue the task to achieve positive consequences, such as incentives, or avoid negative consequences as punishment (Deci & Ryan, 2000; Judge et al., 2010).

Although the research on the relationship between internal and external motivation and its impact on employee performance has lasted nearly half a century, essential questions about the relationship between these motivations and their outcomes still need to be answered. At the general level, there is an ongoing debate about whether these two motivations positively affect each other or whether their effects differ. Therefore, they are mutually exclusive.

Some scientists view both motivations as compatible. The assumption is that external motivation triggered by tangible incentives is positively related to internal motivation triggered by intangible incentives such as social recognition (Stajkovic & Luthans, 2003). Therefore, Donze and Gunnes (2018) suggest that organizations should be more sensitive to social ideals and foster social interaction in the workplace. In other words, investing in social bonding reinforces the effectiveness of monetary incentives and increases average effort, ultimately helping homogenize the workplace and thus making it more productive.

However, other studies have shown that these two types of motivation are contradictory. Deci and Ryan (2000) concluded that tangible incentives or punishments disrupt internal motivation, suggesting that the association is negative. Other studies provided similar evidence (e.g., Frey & Jegen, 2001; Bowles & Polanía-Reyes, 2012). For example, according to Benabou and Tirole (2003), material incentives have signalling properties, indicating that the task requires further strengthening, probably because it is unpleasant. Such incentives undermine the intrinsic interest and change employee preferences (Benabou & Tirole, 2003). Also, the results of King et al. (2017) suggest that employees' work values, based on their former work memories, influence their current performance, with intrinsic values having a positive impact while extrinsic values displaying no significance.

The explanation for these partially contradictory findings may lie in how the tasks are coded in the meta-analyses and the different types of incentives under examination. More precisely, there are differences in the size and timing of incentives, the difficulty in obtaining them, and thus in the percentage of employees receiving them.

Moreover, external motivation has an ambiguous effect on overall work performance. This is partly due to its multi-tasking effect: In the context of tangible incentives, employees focus on tasks they are motivated by the most and neglect those they are motivated by the least. When

employees focus only on achieving positive incentives, affirmative affective states associated with internal motivation (e.g., enthusiasm, engagement, and well-being) are not present. Conversely, external motivation is usually associated with anxiety and lower satisfaction levels, reducing employee concentration and preventing them from fully engaging in the task (Gagné et al., 2010).

Kuuvas et al. (2017) further state that internal motivation is positively linked to work performance but negatively to dismissive outcomes such as an intention to retire, burnout, and conflict between work and personal life. External motivation is negatively linked or unrelated to work performance but positively related to the above-mentioned negative outputs. These findings thus support the crowding-out effect. Likewise, according to Chatzopoulou et al. (2015), the most satisfying motivation factor is the nature of work, irrespective of gender, age, education, or hierarchy at work, even under economic turnaround circumstances.

Hence, Kuuvas et al. (2017) propose that organizations should address internal and external motivation separately. Concerning employee performance, organizations should focus on increasing employees' internal motivation.

Employees should be invited to decision-making and receive feedback when taking the initiative, not only when having problems. Organizations should exercise caution in using enforcement techniques such as conditional tangible incentives, staff monitoring, and benchmarking. These findings are also supported by Mitchell et al. (2020), who, based on a gamification study, conclude that extrinsic motivation can reduce employee autonomy and competence need satisfaction. However, internalizing extrinsic motivation (e.g., through perceived personal values) can support intrinsic motivation. Thus, through suitable development programs, e.g., fitting gamification and simulation-based learning design, organizations could manage the co-existence of extrinsic and intrinsic motivation to their advantage.

The Motivation of Generation Y

Generation Y is a collective term for those born between 1980 and 2000 (Eisner, 2005). They are also referred to as the internet generation or millennials. Generation Y grew up in economic expansion and prosperity but matured over years of economic uncertainty and upheaval (Wong et al., 2017). Many millennials gain work experience before leaving school; therefore, they are assumed to have clear expectations of what they want to do, for whom they want to work, and what they want to achieve (Wood, 2004; Wong et al., 2017). According to Allen (2004) and Lu and Adler (2009), millennials want to set personal goals and do meaningful work.

A study by Chapman et al. (2005) showed that Generation Y requires clear direction and managerial support while requiring competency and flexibility to carry out tasks in their own way. Millennials prefer an inclusive

management style; they do not like the slow pace and require immediate feedback to evaluate their performance (Francis-Smith, 2004). They are willing to fight for freedom and appreciate home and family. Maxwell (2005) admits that job flexibility is a way to achieve work-life balance; therefore, flexibility should be promoted by management and corporate culture.

According to scientists (e.g., Stewart et al., 2017; Wong et al., 2017; Xiong & King, 2019; Supanti & Butcher, 2019), due to more career choices, millennials multiple needs must be met simultaneously; thus, they find it hard to reach a compromise. As a result, they are often motivated to work on multiple needs (Wong et al., 2017). Nevertheless, the prioritization of these needs is changing over time. Employees are often affected by economic changes. For example, millennials placed greater emphasis on financial remuneration and job security during the global financial crisis in 2008 and 2009, while following the 2010-2013 crisis, they increasingly emphasized socio-organizational and self-actualization aspects. Likewise, the role of monetary reward as an extrinsic motivator might be more significant for those for whom access to money is more complex, and thus, as a result, the deprivation of basic needs satisfaction is their daily life experience (Judge et al., 2010; Campos Monteiro et al., 2015). The findings of longitudinal qualitative studies (Wong et al., 2017) also show that wage levels have more weight for fresh graduates, while career success is more important for those working for several years. While an individual's personality traits can affect career and job choices, the influence of family and friends plays an even more important role. Millennials prefer to work for organizations that use advanced technology and enable employees to use social media. However, as Rosenbaum and Wong (2012) suggest, social media can be a potential problem in work performance and employee satisfaction, as internet addiction is related to attention deficit disorder and hyperactivity. Also, "trespassing" work-home boundaries (work-related messaging in the private domain or private messaging in the work domain) has a significant negative effect on employees' emotional well-being (Lutz et al., 2020).

There is a causal relationship between motivation and employee loyalty. There are three types of commitment: commitment to financial reward, commitment to people and organization, and commitment to career success (Aycan & Fikret-Pasa, 2003; Wong et al., 2017). Even if an organization meets the need for financial rewards, millennials do not necessarily stay loyal to the organization. According to some scientists (e.g., Stewart et al., 2017; Supanti & Butcher, 2019; Frye et al., 2019; Xiong & King, 2019), millennials would feel less under pressure, happier and more likely to remain in the organization if the organization responded to their needs for interpersonal relationships, the working environment as well as their development and achievements.

The Motivation of Knowledge Workers

Knowledge consists of two dimensions - explicit and tacit. The explicit knowledge is formally expressed by coding (e.g., picture or language). Tacit knowledge is that part of knowledge gained by nature, learning, or experience. The tacit knowledge is intangible and, therefore, challenging to manage. Managers cannot control how employees work since their results heavily rely on their tacit knowledge. Tacit knowledge may be partially or entirely subconscious.

Knowledge or creative work does not have to be linear. Individual's ideas and solutions can come up randomly, usually when employees are relaxed and outside the organization. Thus, the work results may be difficult to control and manage. They might differ in the short and long term. Also, knowledgeable or creative employees usually work under pressure, are stressed, and lack time. Thus, managers should check the independently working employees to see if they know the organization's goals and are guided by them.

Scientists suggest that knowledge workers are usually highly motivated to perform well, make decisions, self-actualize, and manage their activities (Davenport, 2005; Mahjoub et al., 2018; Ozkeser, 2019; Pohle et al., 2022). However, as various motivation theories show, different employees are motivated by different incentives. Mládková et al. (2015) claim that managers often do not understand the importance of proper motivation when working with such a group of employees. Managers should, therefore, be cautious about aspects that characterize knowledge workers. Knowledge workers can know more about their work than their managers (Li et al., 2023). Tacit knowledge is partially or fully subconscious, and even a knowledge worker may not realize or underestimate its importance for the organization. It is the employee who owns the knowledge, not the organization. When employees leave the organization, their knowledge leaves them (Davenport, 2005; Mládková et al., 2015). Therefore, according to Lee and Suzuki (2020), reciprocity is essential in motivating "information exchange" between an organization and a knowledge worker. Moreover, according to Lee and Kim (2021), symmetrical internal communication and leadership communication enhance creativity, with feedback-seeking behaviour mediating the relationship. These findings are supported by the work of Li et al. (2021), who claim that multisource information exchange partially mediates the relationship between an employee's personality and his or her creativity.

Based on qualitative research and literature review, Mládková et al. (2015) state that the essential motivational factors for knowledge workers are achieving goals, work character, and independence. Significant demotivating factors are the inefficient use of the worker's energy and the manager's low morals (Li et al., 2023).

The motivation of aging employees

As a result of increased life expectancy and declining fertility rates, the workforce's composition is changing in developed countries. Older employees often leave their jobs before the retirement age. However, fewer younger employees are available to replace them entirely. States are coping with rising retirement costs and anticipate labour shortages by encouraging employees to work later, e.g., by increasing their mandatory retirement age and discouraging early exit from the labour market (Ng, 2017). Therefore, organizations should design work so that older workers would continue working and be motivated to do so (Siu et al., 2014; Pak et al., 2018).

Pak et al. (2018) suggest that employee management based on the ability-motivation-opportunity theory (Marin-Garcia & Martinez, 2016) can positively affect older employees' performance. Employees must be able and motivated to work longer (Armstrong-Strassen, 2008; Armstrong-Strassen & Ursel, 2009). Also, they should be given the right opportunities (Pak et al., 2018). Similarly, being in a "learning mode" may enable aging employees to sustain their working careers. Heslin et al. (2019) state that identifying prime sustainable career challenges via self-regulatory career meta-competency is vital. Therefore, constant self-actualization and updating may help employees foster sustainable career development across their lifespan.

According to Kooij et al. (2014), the possibility of continuing work is conceptualized as an organizational climate towards work until a later age. An organizational climate towards work until a later age is defined as the perception of justice or injustice of business processes, practices, and behaviour towards different age groups shared by the "members of a group." People who experience a hostile climate longer want to retire earlier (Schemuly et al., 2013). Alternatively, e.g., the employees' "fear of missing out" does not predict work well-being but higher work burnout and frequent message-checking behaviour (Budnick et al., 2020).

Kooij et al. (2014) constructed a set of personnel procedures to increase the motivation to continue working in older age. The set includes development, maintenance, utility, and adaptation procedures. Development procedures, such as education, internal support, and continuous development, help employees achieve a higher level of performance. Personnel maintenance procedures allow for maintaining their current performance level despite age-related changes, such as health check-ups, reduced working weeks, and ergonomic workplace modifications. Personnel utility practices consider older employees' knowledge, experience, and competencies, such as mentoring roles, participation in decision-making, and second careers. Personnel adaptation procedures help employees work less when maintenance or utility is no longer possible, e.g., partial

retirement or exclusion from overtime.

In conclusion, to improve the skills and motivation of aging employees, practitioners must ensure a sufficient balance between job requirements and job resources, either by reducing job requirements or providing adequate resources to help employees face high workloads. Suppose organizations do not have the means to measure current levels of ability, motivation, and employment opportunities. In that case, they can focus on improving the level of proximal and distal labour resources, which positively impacts the ability, motivation, and willingness to continue working till a later age. According to Pak et al. (2018), autonomy is an example of a proximal labour resource, and managerial support is an example of a distal job resource.

Motivation for pro-environmental behaviour of employees

According to Yuriev et al. (2018), there has yet to be a definitive conceptualization of pro-environmental employee behaviour. Graves and Sarkis (2018) define pro-environmental behaviour as a broad set of environmental responsibilities such as learning more about the environment, developing and implementing ideas to reduce negative environmental impact, developing environmental processes and products, recycling, and questioning practices that harm the environment. Graves and Sarkis (2018) distinguish between basic behaviour, such as recycling or reducing energy consumption, and advanced behaviour, which requires a proactive approach, such as finding new environmentally friendly ways of working or enhancing environmental knowledge. Basic pro-environmental behaviour is short-term, less demanding, and relatively common. Advanced behaviour is more prolonged, more challenging, and less common. Although basic and advanced pro-environmental behaviour tends to be linked, motivation is differentiated (Aitken et al., 2016).

Based on their findings, Graves and Sarkis (2018) claim that internal motivation is positively related to basic and advanced pro-environmental behaviour. On the other hand, external motivation is not positively linked to basic or advanced pro-environmental behaviour, which is a finding contrary to other studies (Gagné & Deci, 2005; Moran et al., 2012; Aitken et al., 2016). External motivation places minimal demands on employees. Therefore, it is unclear whether focusing on external rewards and motivation effectively facilitates pro-environmental behaviour. The effectiveness of such rewards may depend not only on their nature but also on how they are handled (Deci et al., 2016; Maki et al., 2016; Graves & Sarkis, 2018).

The self-determination theory argues that behaviour depends on the type of motivation, not just the amount of motivation and that external and internal motivation coexist because employees have multiple reasons for pro-environmental behaviour (Deci & Ryan, 2000; Deci et al., 2016). Similar results are reported by Ahmed et al. (2021),

whose findings from the hospitality industry setting reveal that green HR practices positively relate to extrinsic and intrinsic motivation. Regarding external motivation, employees behave pro-environmentally because of external incentives, e.g., they expect rewards or praise or want to avoid sanctions (Graves et al., 2013; Zhang & Huang, 2019). In contrast, internal motivation partially stems from the employee and includes introjected, identified, and introspective motivation. Employees with the introjected motivation partially internalized external reports. They believe they should behave pro-environmentally and feel guilty if not (Graves et al., 2013; Zhang & Huang, 2019). For example, in the study of motivational factors of hospitality industry employees (Goh & Ferry, 2019), most respondents reported feelings of guilt when expressing attitudes toward food waste. When motivation is identified, employees behave in line with their values. They fully advocate the importance of sustainability. Those who are motivated introspectively see pro-environmental behaviour as entertaining, interesting, or challenging and find pleasure in, for example, streamlining the waste reduction process. Although the three internal motives for pro-environmental behaviour are theoretically different, they are similar and related to each other due to the common origin of the individual (Sheldon et al., 2016; Giocirlan, 2023).

However, Graves and Sarkis (2018) suggest that employees with strong environmental sensitivity respond more positively to environmental initiatives than those with weak ones. Thus, “top-down” green programs may not work uniformly for green and non-green employees. Organizations committed to sustainability should identify and recruit employees with strong environmental values (Appiah, 2019; Macke & Genari, 2019; Davis et al., 2020). Another option is to shift employee values, but the level of change in values is unclear (Graves & Sarkis, 2018). In this respect, Ahmed et al. (2021) suggest pro-environmental training as the most effective practice. Seemingly, Hu et al. (2016) propose learning as a moderating tool between, e.g., corporate volunteering and work performance. The positive effect of learning might be even strengthened by social support from, e.g., family and friends (Hu et al., 2016).

3.2 Summary of the results on the motivation of contemporary employees (RQ)

To evaluate what motivates current employees' efficiency and productivity appraisal (e.g., work performance, job satisfaction, organization commitment, or voluntary retention), there was a need to divide the selected articles into five thematical sub-sections, which demonstrate the tendencies in current research (Internal and external motivation, Generation Y, Knowledge workers, Aging employ-

ees, and Pro-environmental behaviour). The summarised findings suggest that Mayo's assumptions are a recurrent issue (Table 2).

As a result, we can say that 34 % of works (N = 28/83) deal with extrinsic and intrinsic motivation, which could be assigned to no consensus on the co-existence of internal and external motivation as agreement upon their synergetic effect has not been reached so far. Hence, employees in the same organization may “experience” the same motivation factors differently. To increase employees' performance efficiency, internal motivation or internalization of external motivation is the most efficient and universal solution. Thus, to homogenize workplace values, we suggest the most suitable learning techniques like role-play, gamification, or learning through practical experience (e.g., volunteering). Likewise, we recommend employees' participation in decision-making or getting positive feedback (if successful) and emotionally neutral (in the case of failures). Organizations should address rewards or punishments with sensitivity and caution when benchmarking or assessing employees' performance. These measures indeed call for managers to be trained in techniques from psychology (e.g., cancelling or psychoanalysis) and high morals (e.g., ethical management, spiritual leadership).

Almost the same percentage of work deals with pro-environmental behaviour (20%) and knowledge workers' motivation (19%). This could be credited to increased demand for innovative behaviour, pro-environmental-minded behaviour, and a shift in skill demand (need for soft skills and technical skills due to automatization, digitalization, and robotization across organizational structures and industries).

Surprisingly, only 10 % of work (N = 8/83) deals with finding the right stimuli for aging employees. Organizations should provide employees with suitable motivation stimuli, matching opportunities, and corresponding resources to support their affirmative work attitudes across their lifespan. Employees should work on their self-actualization to be adaptable to changing work environments. Thus, their work-life balance is manageable. This could be managed by being in a “learning mode” across one's lifespan.

If we look carefully at the Identified motivation drivers across the five Thematic subsections (Table 2), we can detect the deep need for autonomy and competence, meaningful work, development and learning, social bonding, feedback-seeking behaviour, and work-home balance, which could be translated into respect seeking behaviour, recognition, forgiveness, and tolerance in case of employee's failure and urge for praise and honour in case of success, and maintaining fulfilling relationships, which we believe make the true essence of every individual, yet at the same time make him or her very fragile, especially in a highly competitive environment, which workplace is. This is why we firmly believe that ethical management

and management practices based on sociopsychology are needed. As a result, for more straightforward practical implications, the motivation drivers were unified into five motivation sets (social bonding, nature of work, flexibility, internalization of extrinsic motivation, and management support). Likewise, an urgent need for life-long learning can be traced in all five thematical subsections under research. Therefore, the suggested practical implications (Social bonding, Nature of work, Flexibility, Internaliza-

tion of extrinsic motivation, and Management support) could be achieved through learning mode, which benefits both the organization (e.g., increased work productivity, job satisfaction, organizational commitment), and the employees (e.g., increased employability, self-realization, self-actualization, social bonding) (Table 2).

These conclusive recommendations are not only in line with the original Mayo's findings (1933) but also with the latest findings of Siu et al. (2014), Hanaysha & Tahir

Table 2: Summary of motivation drivers and suggested implications (authors' own work)

Motivation pursues	Thematic subsections under research	Identified motivation drivers	Authors' suggestions for practical implications
	Internal and external motivation (N =28/83, 34%)	Interpersonal relationships, meaningful work, autonomy, competence, decision-making, feedback, internalization of external motivation	
Employee efficiency and productivity appraisal	Generation Y (N = 14/83, 17%)	Interpersonal relationships, meaningful work, self-actualization, work-life balance, competency, feedback, highly competent and ethical management, tangibles	<p>Social bonding (personalized and shared values, two-way symmetrical communication, ethical management, knowledge-sharing behaviour)</p> <p>Nature of work (self-realization, self-actualization, autonomy, competence, goal achieving, decision-making)</p> <p>Flexibility (work flexibility, employability, self-actualization, work-home boundaries, work-life balance)</p> <p>Internalization of extrinsic motivation (personalizing values)</p>
	Knowledge workers (N = 16/83, 19%)	Interpersonal relationships, meaningful work, autonomy, competence, learning, goal achievement, highly competent and ethical management	Management support (highly ethical and competent management, feedback, adequate resources, and requirements distribution, two-way symmetrical communication)
	Aging employees (N = 8/83, 10 %)	Self-actualization, work-home binderies, internal support and friendly work environment, decision-making, autonomy	
	Pro-environmental behaviour (N = 17/83, 20 %)	Internalization of external motivation, support from family, shared values, learning	

(2016), Lutz et al. (2020), Mitchell et al. (2020), Budnick et al. (2020), and Li et al. (2023).

3.3 Summary of the theoretical background of current scientific research (SQ 1)

The articles (N = 73) analysed for this study employed mainly classical (traditional) theories for theoretical background and further implications. In particular, those are the theory of self-determination (Deci, 1971) - 42%, Herzberg’s two-factor motivation theory (Herzberg et al., 1959) - 9%, or the combination of two or more motivational theories - 15%, e.g., Maslow’s hierarchy of needs (Maslow, 1943) and McGregor’s Motivational theory X and Y (McGregor, 1960). The interdependence of these four theories is depicted in Table 3.

Based on the review results (3.1), we can say that, e.g., knowledge workers, creative employees, executives, or millennials are motivated primarily by factors such as independent and creative work, use of their expertise, or self-actualization. Using Maslow’s theory of needs, this could be explained by the fact that such employees are on “the upper salary scale.” Therefore, their core needs have

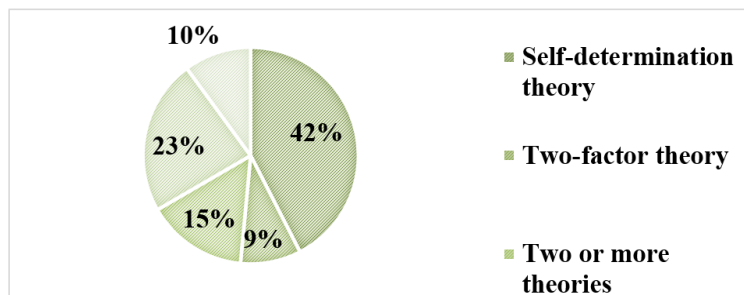
already been met, or these motivation factors resonate with their values. Applying the terminology of Deci’s motivational theory of self-determination (Deci, 1971), these factors can be considered “internal” or “motivational,” if based on the two-factor motivational theory by Herzberg et al. (1959). Analogically, employees, e.g., on “a lower salary scale” or deprived of satisfying their core needs, are motivated mainly by, e.g., financial remuneration, job security, or a well-defined reward and punishment system. These factors can be described as “external” according to Deci’s theory of self-determination (Deci, 1971) or hygienic according to Herzberg’s two-factor motivation theory (Herzberg et al., 1959).

Several analysed works (23%) were based on the above-mentioned classical motivational theories, supplemented with knowledge from behavioural economics or social psychology (e.g., signalling theory, social exchange theory, or social identity theory). 10% of the analysed works did not specify their theoretical grounds (Graph 1).

Those and many other so-called “Classical Theories” (e.g., McClelland, 1951; Vroom, 1964; Skinner, 1965) are, according to Ryan (2017), the “product” of the golden era of social psychological research (the 1950s - 1970s). They were based on long-term and thoughtful theorizing, observation, and experimentation (Ryan, 2017). Therefore, it

Table 3: Interdependence among the most cited motivational theories (authors’ own work)

Maslow (1943)	Herzberg (1959)	McGregor (1960)	Deci (1971)
Hierarchy of needs theory	Theory of two factors	Motivational theory X and Y	Self-determination theory
Physiological needs Security and safety needs Need for togetherness and belonging	Source for hygiene factors	Source for employee’s “X” motivation	Source for external motivation
Recognition needs Self-actualization needs	Source for motivation factors	Source for employee’s “Y” motivation	Source for internal motivation



Graph 1: Used classical motivation theories in analysed articles (authors’ own work)

may not be surprising that recent research based on statistical analytical methods has yielded little or no benefit in developing employee motivation theory. The solution might be, for example, to find better methodological approaches to the study of organizational processes and managing employee motivation. Several studies reached this conclusion (e.g., Woodside, 2013; Lee & Raschke, 2016; Ryan, 2017).

Although the vast majority of works are grounded in theory, the mixed results, absence of micro and macro environment variable influence, and fragmented focus of each investigation call for the clarification of existing theories or for the initiation of a search for a new theory or conceptual approach which would be more comprehensible and universal, and thus easier to follow and apply into practice. Based on the findings, the authors of this paper suggest that the newly formed concepts should be grounded in scientific disciplines such as psychology, psychiatry, or social psychology to depict contemporary employees' true needs, e.g., by adopting such techniques as psychoanalysis or counselling. Unfortunately, these techniques are being paid little or no attention by today's management scientists. On the more conventional side, the Wong et al. (2017) model seems to be the most versatile and flexible. It replicates Maslow's hierarchy of human needs but operates like a dashboard. It considers the employees' demand to meet multiple needs simultaneously or the need to meet different needs regardless of their "location" in the hierarchy. Thus, this model respects the changing needs of employees and the micro- and macro-environment conditions of the organization. To make this model function in practice and not represent only a sunk cost, managers must be empathetic and responsive to employee needs using, e.g., regular monitoring or personnel counselling, as suggested by Elton Mayo almost a century ago (Mayo, 1933). Therefore, managers' training in the principles of employee motivation, cancelling, and the basics of psychoanalysis is more than suggested. Interestingly, although motivation theories support Mayo's thesis, none of the researched

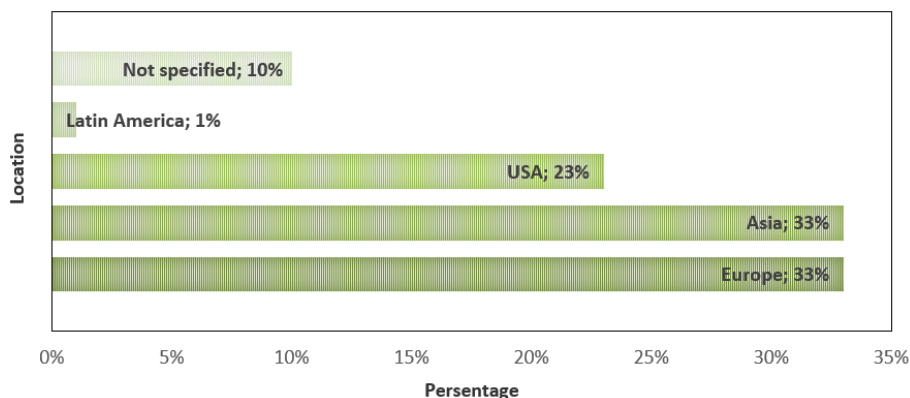
works use it as a theoretical background.

3.4 Summary of current trends in the methodology of scientific research (SQ 2)

Research on the causal relationship between employee motivation and employee affirmative work attitudes is mainly applied to the service sector (68%), namely tourism, hospitality, and health care.

Geographically, most of the research is located equally in Asia and Europe (33%). 23% of research was conducted in the USA. Latin America as a research location was represented by one work only (Campos Monteiro et al., 2015), and Africa as a research location was not presented in the analysed sample (Graph 2).

The investigated works were based on quantitative ($N = 57/73$) and qualitative ($N = 16/73$) analyses. Hence, the predominant method of conducting empirical research is a quantitative analysis ($N = 57/73$, 78%), especially multiple regression, correlation, or factor analysis, which are currently the prevailing methods of conducting social research (Woodside, 2013; Lee & Raschke, 2016). However, Lee and Raschke (2016) believe that these methods aim to find associations (correlations) that are symmetrical and linear but are not the only ways to understand employee motivation and performance. The symmetric analysis assumes that the effects of independent variables are linear and additive. The key to understanding the relationship between motivation and employee performance is not to determine which variable has the most significant impact but whether there is only one combination or several different combinations of conditions capable of generating the same result and how those combinations arise (Delery & Doty, 1996; Lee & Raschke, 2016). Employee performance is a "function" of many factors: motivation, individual abilities, or the work environment (Ryan, 2017). Thus, for



Graph 2: Geographical location (authors' own work)

example, the configuration approach allows organizations to be seen as clusters of interconnected structures and procedures rather than modular or loosely connected entities whose sub-elements can be understood and examined separately (Fiss, 2007). The configuration approach is a holistic and systematic approach to organizations (Delery & Doty, 1996) and is, therefore, more compatible with the so-called “new” motivational theories based on an interdisciplinary approach (Lee & Raschke, 2016; Ryan, 2017).

Conclusion

Even though our literature review simplifies the complexity of motivation, it allows us to trace current tendencies and trends. Despite the diversity of employees, we identified five key motivation drivers (Social bonding, Nature of work, Flexibility, Internalization of extrinsic motivation, and Management support) to homogenize the organization’s approaches and to provide employees with efficient stimuli. The unfolded results demonstrate that the best way to increase employees’ efficiency (e.g., work performance, job satisfaction, or organizational commitment) and to homogenize workplace goal ambiguity is to internalize extrinsic motivation (e.g., through perceived personal values). Thus, development training techniques such as gamification, role-playing, or simulation-based learning designs are suggested. Findings also indicate that self-development programs serve employees’ efficiency and personal interests (e.g., lifespan flexibility, work-life balance, career growth, and self-actualization). To understand the motivation drivers and to unify the pluralistic goals, managers are recommended to be educated and practically trained in techniques from social psychology and psychology (e.g., counselling, mentoring, ethical management, spiritual leadership, or communication).

The studies under investigation rely on traditional approaches to employee motivation. Thus, it would be interesting to find out how much practicing managers know about various motivational theories and how and why they implement them into organizational practice.

As advocates of Mayo’s thesis, we encourage future research on using ethics (e.g., management’s ethical behaviour or an organization’s ethical principles) as employee motivation drivers. The studies under review do not consider organizations’ disposable resources, which might hinder adopting the proposed suggestions. Likewise, we challenge researchers to control both endogenous and exogenous variables, as the effect of exogenous variables on the macro-level was often neglected. We identified a trend towards quantitative studies taking place at the sub-national level. Therefore, we would like to encourage researchers to conduct studies on the national and transnational levels. Conclusively, to advance the motivational theory, a configurational approach (a cluster and fuzzy logic qualitative comparative analysis) could be proposed to analyse and capture the complexity of employee motivation.

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Motivacija zaposlenih v sodobni znanstveni literaturi: Pregled pripovedne literature

Ozadje: Uporaba pravilne vrste motivacije je ključnega pomena pri sprožanju pozitivnih odnosov zaposlenih do dela, kot so delovna uspešnost, zadovoljstvo pri delu ali prostovoljno zadržanje zaposlenih, kar na koncu vodi k povečanju splošne učinkovitosti organizacije. Kljub trajajoči akademski razpravi akademiki podajajo različne rezultate o tem, kateri motivacijski dejavniki so pomembni za ciljne skupine zaposlenih, katerih potrebe so pod ekonomskim in socialno-psihološkim pritiskom hitro razvijajočega se okolja. Elton Mayo je bil prvi, ki je pred skoraj stoletjem priznal te socialno-psihološke dejavnike kot pomembna gonila motivacije.

Metode: Namen tega prispevka je z uporabo metode narativnega pregleda literature (podprte s strategijo sistematičnega iskanja) na 83 člankih ovrednotiti izsledke raziskav o motivaciji zaposlenih (v povezavi z njihovim pozitivnim odnosom do dela) in razkriti napredek teorije motivacije.

Rezultati: Identificirani so bili ključni dejavniki motivacije in združeni v pet motivacijskih sklopov, ki se uporabljajo za različne skupine zaposlenih. Ugotovitve tudi kažejo, da večina akademskih del, ki so teoretično utemeljena na klasičnih motivacijskih konceptih, temelji na kvantitativni analizi.

Zaključek: Za povečanje učinkovitosti uspešnosti zaposlenih se zdi najboljša rešitev notranja motivacija ali pnotranjenje zunanje motivacije. »Lebdeče« potrebe zaposlenih zahtevajo, da se izvajalci usposobijo za tehnike iz psihologije.

Ključne besede: *Elton Mayo, Motivacija zaposlenih, Motivacijski faktor, Teorija motivacije*

Leveraging ChatGPT for Enhanced Logical Analysis in the Theory of Constraints Thinking Process

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Background/Purpose: Artificial intelligence (AI) has traditionally been used for quantitative analysis using explicit data. However, much of the information critical to decision making remains undocumented and is not stored in a structured way. This study explores the integration of AI, specifically ChatGPT, into Theory of Constraints (TOC) Thinking Process (TP) tools.

Method: In this study, we applied ChatGPT to a real-world IT project management case using a variety of research methods, including international literature analysis, observation, and personal experience. The use of the TOC TP allowed us to understand the decision-making process of ChatGPT and to systematically explore its advantages and limitations in creating logical trees of TOC TP.

Results: ChatGPT significantly enhanced efficiency and depth in TOC TP data collection and analysis, effectively addressing logical leaps for more coherent structures. It also promoted deeper analytical thinking and aided root cause identification. The integration of ChatGPT into the TOC TP process led to faster decision-making, reduced bias, and clearer analysis. Challenges of ChatGPT including the need for human oversight, specific TOC TP training, and ethical considerations were noted.

Conclusion: This study provides an initial investigation into the use of ChatGPT in TOC TP tools. The results suggest that ChatGPT has the potential to be a valuable tool for organizations seeking to improve their decision making and performance. However, further research is needed to validate these findings and explore the full potential of AI in TOC TP.

Keywords: *ChatGPT, Artificial Intelligence, Theory of Constraints, Theory of Constraints Thinking Process, Logical Analysis, Decision Making, Structured Analysis Framework*

1 Introduction

Artificial intelligence (AI), notably represented by ChatGPT (Zamfiroiu et al., 2023), presents a transformative avenue for enhancing logical analysis in intricate decision-making processes. Integrating AI into established frameworks, such as the Theory of Constraints (TOC) Thinking Process (TP) (Gaspar et al., 2019; Goldratt, 2008), holds increasing importance as organizations seek advanced solutions. This study explores the integration of

ChatGPT within the TOC TP to improve logical analysis, thereby enhancing decision-making outcomes.

The TOC TP (Dettmer 2007) incorporates essential tools for systematic logical analysis and decision-making. These tools provide a structured approach to identifying and resolving root causes of problems and implementing effective solutions using logical trees: Current Reality Tree (CRT) identifies the root cause of a problem; Future Reality Tree (FRT) envisions the outcomes of proposed changes; Prerequisite Tree (PRT) establishes the necessary

conditions for change; and Transition Tree (TT) develops a roadmap for executing the changes.

Traditional methods for constructing logical trees often involve manual analysis of unstructured data. This process can be time-consuming, error-prone, and susceptible to biases. ChatGPT's ability to process and understand unstructured data presents an opportunity to overcome these challenges, potentially improving the accuracy and efficiency of logical analysis.

The primary research question guiding this study is: How can ChatGPT be effectively integrated into the TOC TP to enhance logical analysis and decision-making outcomes? This study aims to investigate the potential of ChatGPT in integrating with TOC TP, focusing on bias reduction, decision-making acceleration, and clarity and accuracy of logical analysis.

The research design adopts a comprehensive multi-faceted approach, integrating international literature analysis from reputable databases such as SpringerLink and Scopus, alongside direct observation and insights derived from personal experience. Utilizing ChatGPT in this methodology, diverse prompts related to IT project management were posed, ranging from extracting common factors leading to project delays to investigating causes for resource unavailability. This approach ensures a thorough examination of ChatGPT's integration within the TOC TP, particularly in real-world IT project management scenarios.

Despite the transformative potential of AI, the existing body of research in this area remains remarkably scarce. A cursory review of academic databases reveals a limited number of publications, a lack of comprehensive reviews, and a dearth of empirical studies dedicated to this emerging intersection. This scarcity of research highlights the need for further investigation to fully understand the opportunities and challenges associated with this novel combination. By leveraging ChatGPT's capabilities, this study contributes to existing knowledge by exploring the benefits, challenges, and implications of integrating ChatGPT into TOC TP, with a specific focus on constructing CRTs. The findings aim to empower organizations in making informed decisions about implementing ChatGPT into their decision-making processes.

The study is organized as follows. Section 2 provides a brief review of the current research and problem definition on which our study is based. The research methodology in Section 3, while Section 4 presents the results. Section 5 summarizes and discusses the findings and implications for further practice. Section 6 draws conclusions.

The significance of this study lies in its potential to offer organizations an innovative approach to decision-making, bridging the gap between traditional structured analysis methods and the transformative capabilities of AI, as embodied by ChatGPT.

2 Current Research on the Integration of ChatGPT in TOC TP

This chapter provides an overview of the current research landscape related to the integration of ChatGPT and the tools of TOC TP. While this is a relatively new area of research, we aim to explore the existing knowledge and identify potential research gaps to establish a foundation for our study.

The systematic literature review conducted from 18 June 2023 to 21 July 2023 covered the fields of engineering, computer science, decision science, and business management and accounting. Keyword searches in SpringerLink and Scopus databases, combining terms such as ChatGPT, Bias, Theory of Constraints, Theory of Constraints Thinking Process, Logical Analysis, Decision Making, and Structured Analysis Framework, yielded over 1.8 million papers. Refining the search with criteria such as "ChatGPT*" OR "Theory of Constraints Thinking Process" and English language narrowed down the results to 744 papers in SpringerLink and 369 papers in Scopus. A thorough review of abstracts revealed no direct research on the integration of ChatGPT and TOC TP, indicating a significant research gap in this specific area.

While there is no direct research on the integration of ChatGPT and the TOC TP, related research examines their individual components. In the study (Hanmeng et al. 2023), ChatGPT significantly outperformed GPT-4 on logical reasoning benchmarks, indicating its stronger logical reasoning ability. The study (Hackaday, 2023) shows the effectiveness of ChatGPT in solving and scoring logic puzzles. On the other hand, the study (Escape Velocity Labs, 2022) reveals ChatGPT's surprising ability to imitate reasoning, identify fallacies, and solve puzzles. These results suggest that ChatGPT accelerates the construction of logic trees and provides valuable insights for decision making.

Another area of research focuses on using ChatGPT to reduce bias and speed up logical analysis. Using its ability to process large amounts of information and generate unbiased responses could minimize human bias in the construction of logical trees, thereby improving the objectivity and accuracy of decision making. However, research (Fischer et al., 2023 and Frackiewicz, 2023) reveals ChatGPT's vulnerability to unconscious bias.

In addition, a study (Chen et al., 2023) specifically investigated behavioral biases relevant to operations management. ChatGPT exhibits human-like biases in complex, ambiguous, and implicit problems, such as conjunction bias, probability weighting, framing effects, salience of anticipated regret, and reference dependence. It also struggles to process ambiguous information and assess risk differently from humans, exhibiting heuristic-like responses and confirmation biases, which are exacerbated by overconfidence. Moreover, it highlights the importance

of considering potential AI biases in the development and implementation of AI for business operations.

It is noteworthy that the existing body of research in this specific area remains remarkably scarce. This apparent research gap presents significant opportunity for researchers to delve into this unexplored area and conduct original research on this novel combination. By addressing this gap, our study aims to make an initial contribution to the emerging field of ChatGPT and TOC TP integration, thereby advancing the understanding and practical applications of this combination. The specific research questions that this study will address are:

- What are the potential benefits of integrating ChatGPT and the TOC TP?
- What are the challenges and implications of this approach?
- How can ChatGPT be used to accelerate decision making and problem solving in real-world applications?

By addressing these research gaps, this study aims to provide a better understanding of the potential of this approach and how it can be used to improve decision making and problem solving.

3 Methodology

In this study, we adopted a comprehensive case study methodology, focusing on a real-world scenario in IT project management to assess the decision-making efficacy of ChatGPT. This involved examining typical challenges in IT project management, including task management diversity, cross-functional team coordination, and risk mitigation, particularly unforeseen delays, and resource

constraints. The choice of such projects was driven by the need to understand the dynamic interplay of various factors in complex IT environments and how ChatGPT could potentially navigate these complexities.

To effectively evaluate ChatGPT's role in this context, we concentrated on its application within the TOC TP. Our analysis primarily centered around the development of a CRT, utilizing the process outlined by Holt and Aljaž (2020) as shown in Figure 1. This approach was instrumental in dissecting ChatGPT's decision-making process, allowing us to explore its potential benefits and limitations in a structured and methodical manner.

The research design involved a multi-faceted approach, combining international literature analysis (SpringerLink and Scopus databases), observation, and personal experience. Leveraging ChatGPT, we posed diverse prompts related to the IT project management case, such as retrieving common factors contributing to project delays or exploring causes for resource unavailability.

Human validation played a crucial role in ensuring the reliability and accuracy of ChatGPT-generated responses. One person accessed <https://chat.openai.com/> for input prompts, and the generated ChatGPT responses were manually scored by at least two people, with disagreements resolved by majority vote. This approach emphasizes the importance of human oversight in validating ChatGPT generated content.

Our methodology is grounded in the principles of logical reasoning and problem-solving within the TOC, as detailed in (Scheinkopf, 1999). We adapted these principles to incorporate the capabilities of ChatGPT, thus enhancing the traditional framework with ChatGPT driven insights. The process is structured into three distinct steps, as depicted in Figure 2.

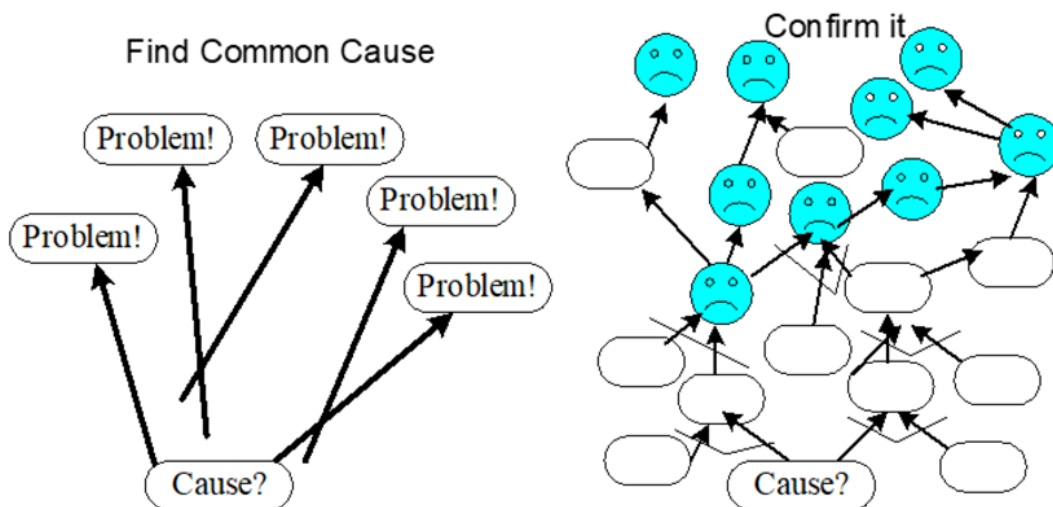


Figure 1: Workflow of creating CRT (Holt and Aljaž, 2020)

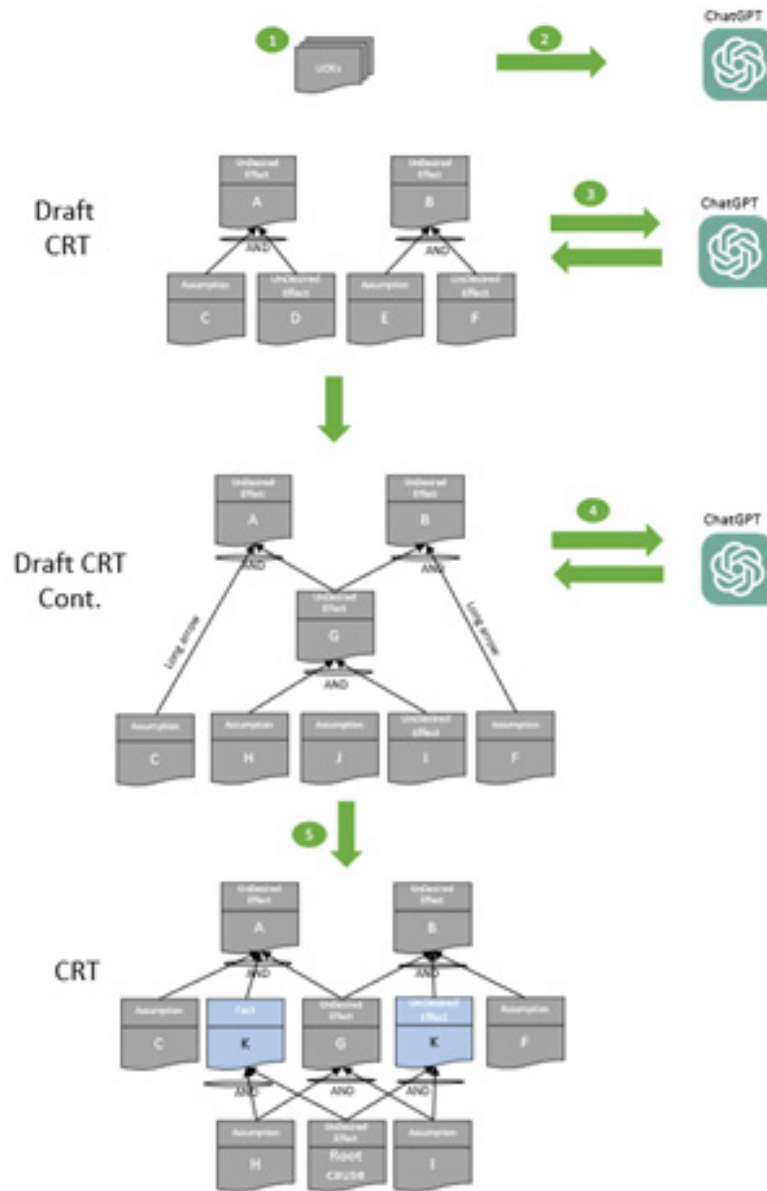


Figure 2: Workflow with ChatGPT in the use case of creating CRT

- Draft analysis: This step involves the collection and identification of relevant data (UnDesirable Effects - UDEs) related to the problem under investigation, gathered from various sources such as observations, interviews, reports, measurements, and ChatGPT. A draft CRT is then constructed that outlines initial cause and effect relationships.
- Leaps of logic: This step involves identifying and analyzing cause and effect relationships. In some cases, data may be insufficient to establish direct links between entities, leading to “leaps of logic” where long arrows connect entities based on theoretical or assumed relationships. ChatGPT helps to validate the draft CRT by identifying inconsistencies or leaps in logic, thereby improving the accuracy and credibility of the analysis.
- CRT: This step involves identifying the root causes of the problem. ChatGPT helps to uncover hidden assumptions and encourages critical thinking about the beliefs underlying the problems.

Example prompts for ChatGPT:

- Draft analysis:
 - “Retrieve common factors contributing to IT projects not being completed on time.”
 - “Explore possible causes for recurring issues with resource unavailability in IT projects.”
 - “Rank identified UDEs based on common patterns in project management.”
 - “Explain the concept of bottlenecks in IT project management.”
- Leaps of logic:
 - “Validate/critically review the logical validity of cause-and-effect relationships in the Draft CRT for potential logical gaps.”
- CRT (finalizing):
 - “Help us identify any hidden assumptions about our team’s productivity and how we can challenge them.”

The time it takes to create a CRT can vary depending on the complexity of the system being analyzed, the experience of the person creating the CRT, and the availability of resources. To empirically assess these variables, a survey was conducted targeting students from FIS Novo mesto and Washington State University. The participants, who were enrolled in courses related to the TOC TP during the years 2016 and 2020, were queried regarding the time they allocated to the creation of logical trees within the TOC TP framework. The survey question posed was: ‘How long did you spend creating logical trees of TOC TP?’ The responses from this survey are intended to provide quantitative insights into the time variability associated with CRT construction in diverse educational and experiential contexts.

4 Results

The integration of ChatGPT into the IT project management area, particularly within the construction of CRTs, has demonstrated notable enhancements in logical analysis. The application of ChatGPT has enabled project teams, the Project Management Office, and other stakeholders to gain deeper insights, develop more accurate assessments, and devise effective strategies for improving project performance.

As outlined in previous section, the TOC TP methodology starts with the identification of UDEs bothering the organization. In the CRT, these identified UDEs are logically linked through intermediate entities, specifying relationships down to a core problem. Analyzing the IT project management area has revealed multiple gaps (UDEs) and their interconnectedness across the organization.

4.1 Draft analysis

ChatGPT can significantly speed up the data collection process during the Draft analysis phase of the TOC TP. By retrieving specific data related to the project(s), ChatGPT can help gain a comprehensive understanding of the current state and identify potential UDEs. Additionally, ChatGPT can communicate with stakeholders in a way that is easy for them to understand, which can help to ensure that stakeholders are on board with the CRT and the solutions that are proposed. An example of UDEs related to our study is shown in Figure 3.

In addition to data retrieval, ChatGPT serves as an effective brainstorming partner during the construction of the Draft CRT. By posing questions and scenarios related to project challenges, ChatGPT prompts the generation of alternative cause-and-effect relationships, uncovering hidden UDEs and potential root causes.

Through the analysis of large datasets and pattern identification, ChatGPT contributes to data-driven decision-making during the Draft Analysis phase.

The model can assist in prioritizing UDEs, as shown in Figure 4, based on their impact and probability, allowing us to focus on high-impact areas for improvement. ChatGPT’s instant responses enable quick answers to specific questions, supporting stakeholders in resolving uncertainties and maintaining productive momentum in the analysis process.

4.2 Leaps of logic (long arrows)

Long arrows, representing leaps of logic, are effectively addressed with ChatGPT during the TOC TP analysis phase. The large language model identifies and mitigates logical leaps that might not be obvious to humans, generating text that comprehensively describes the current reality. Moreover, ChatGPT proposes multiple potential solutions for bridging these leaps, ensuring the identification of optimal solutions.

In the IT project management area, ChatGPT can be utilized to enhance the cause-and-effect relationship in a CRT. Figure 5 illustrates the preliminary cause-and-effect relationships within the IT project management area.

By validating and critically reviewing the logical validity of cause-and-effect relationships, as shown in Figure 6, ChatGPT contributes to improved input for constructing the CRT. This iterative process helps in refining and clarifying the cause-and-effect relationships, thereby reducing the likelihood of errors or oversights in the final CRT.

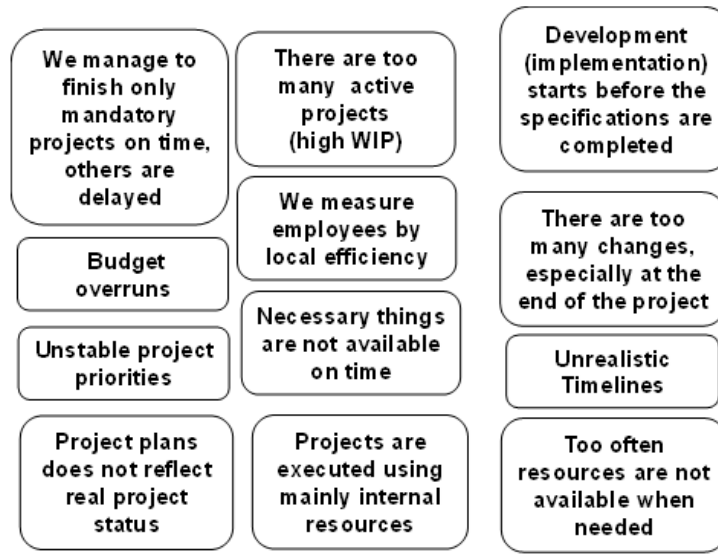



Figure 3: UDEs in the IT Project management area


T Please rank following undesirable effects "We manage to finish only mandatory projects on time, others are delayed", "Budget overruns", "Unstable project priorities", "Project plans does not reflect real project status", "There are too many active projects", "We measure employees by local efficiency", "Necessary things are not available on time", "Projects are executed using mainly internal resources", "implementation starts before the specifications are completed", "There are too many changes, especially at the end of the project", "Unrealistic Timelines", "Too often resources are not available when needed" based on common patterns in project management

 Ranking undesirable effects in project management based on common patterns:

1. "Budget overruns": Overspending can lead to financial constraints and hinder the project's success.
2. "Unrealistic Timelines": Setting impractical deadlines can lead to rushed work, compromised quality, and increased risk of failure.
3. "Too often resources are not available when needed": Resource constraints can cause delays and impact project timelines.
4. "There are too many changes, especially at the end of the project": Frequent changes can disrupt workflow and create uncertainty.

Figure 4: Prioritized UDEs by ChatGPT

T please evaluate the logic validity of the following statement: Premise: Flow of information is not optimal. Conclusion: Project plans do not reflect real project status.

 The provided statement consists of a premise and a conclusion. Let's evaluate the logic validity of the argument:

Premise: Flow of information is not optimal.
Conclusion: Project plans do not reflect real project status.

The premise states that the flow of information is not optimal, meaning there are issues or inefficiencies in how information is communicated or shared within the project.

The conclusion drawn from the premise is that project plans do not reflect real project status. This conclusion suggests that the suboptimal flow of information is the reason why project plans are not an accurate representation of the actual project status.

To evaluate the logic validity, we need to assess if the conclusion necessarily follows from the premise. In this case, there is a logical connection between the premise and the conclusion:

1. A suboptimal flow of information can lead to incomplete or inaccurate data being used to create project plans.
2. If project plans are based on incomplete or inaccurate information, they may not accurately reflect the real project status.

Therefore, the conclusion is logically valid based on the premise provided.

Figure 5: Initial cause-and-effect relationship

4.3 Current Reality Tree

As mentioned in Chapter 1, the CRT is a visual representation of the cause-and-effect relationships within a system, highlighting the root causes of problems and constraints.

ChatGPT can be used to generate text describing the various elements of the CRT and the relationships between them. This text can be used to identify gaps in the analysis and potential areas for improvement. For example, as shown in Figure 8, ChatGPT could be used to ask questions and encourage users to think critically about their beliefs. This approach can engage users in a deeper exploration of their perspectives and viewpoints, leading to more insightful analysis and accelerate creation of CRT.

Additionally, this process could help users uncover the assumptions underlying their problems, which is a crucial

step in the CRT process. As illustrated in Figure 9, by using ChatGPT to probe these underlying assumptions, users can gain a clearer understanding of the foundational beliefs impacting their problem-solving approach. This accelerates the identification and examination of assumptions, facilitating a more efficient and effective creation of CRT. The ability to swiftly pinpoint and challenge these assumptions is particularly beneficial in complex scenarios where they might be less obvious or more deeply ingrained.

The TOC TP is not a one-time activity; it is an ongoing process that can be revisited and refined as new information becomes available or as the system evolves. For example, if a new constraint is identified, the CRT can be updated to reflect this change. An example of a simplified CRT from the area of IT project management is shown in Figure 10.

4.4 Time efficiency in CRT Construction


The time it takes to create a CRT can vary depending on the complexity of the system being analyzed, the experience of the person creating the CRT, and the availability of resources.

To investigate the time it takes to create TOC TP logical trees (without ChatGPT), we surveyed 40 students regarding the time taken to create logic trees. The responses were categorized into five distinct time ranges: 0-3 hours, 4-6 hours, 7-9 hours, 10-15 hours, and more than 15 hours. The data revealed, as shown in Figure 10, a diverse range of time commitments among the participants.

A significant 37% of students completed their logic trees within the shortest time frame of 0-3 hours, suggesting notable efficiency or familiarity with the task among

a significant portion of them. Another 22,2% of students reported needing 4-6 hours, indicating a moderate level of complexity or effort. A considerable segment, 18,5% of the students fell into the 10-15 hours bracket, suggesting a high level of engagement or complexity in the task for these individuals. Similarly, 14,8%, indicated a substantially longer time investment of more than 15 hours, which might reflect the complexity of the task or varying levels of prior experience. Lastly, 7,4% reported spending 7-9 hours on their logic trees, positioning this group between the moderately complex and the more time-consuming categories. These findings highlight the broad range of time investments required to complete logic trees among students, with the variance possibly attributed to factors like individual student's prior experience, understanding of the task, or the complexity of their specific logic trees.


T Are there some potential intermediate steps or additional causes that might help supporting conclusion?

 Yes, there are potential intermediate steps and additional causes that could support the conclusion that "Project plans do not reflect real project status" due to a suboptimal flow of information. While the initial premise suggests that the flow of information is not optimal, it is crucial to consider other factors that could contribute to the inaccuracies in project plans. Some potential intermediate steps and additional causes include:

1. **Inadequate Data Collection:** The suboptimal flow of information may result from insufficient data collection processes. If the project team does not gather complete and accurate data about the project's progress and status, it can lead to gaps in information that affect the reliability of the project plans.
2. **Lack of Timely Updates:** If the flow of information is slow or updates are not provided in a timely manner, project plans may not reflect the most current status of the project. Delayed or outdated information can lead to inaccuracies in the plans.
3. **Miscommunication and Misinterpretation:** Ineffective communication or misinterpretation of information can lead to misunderstandings among team members or stakeholders. This can result in incorrect data being incorporated into the project plans.
4. **Dependency on Unreliable Sources:** If project plans rely on data from sources that are not reliable or trustworthy, the plans may not accurately reflect the real project status.
5. **Lack of Transparency:** If there is a lack of transparency in sharing information across the project team or between different departments, it can lead to gaps in understanding and incomplete information in the project plans.

Figure 6: Improving cause-and-effect relationship for constructing CRT using ChatGPT

T what prompts should i use to ask questions and encourage users to think critically about their beliefs

 Encouraging users to think critically about their beliefs involves prompting questions that challenge assumptions, explore underlying reasons, and promote deeper reflection. Here are some prompts you can use to stimulate critical thinking:

1. Assumption Challenge:

- What assumptions are you making about this situation?
- Are there any hidden assumptions influencing your perspective?
- How might your conclusions change if some of these assumptions were incorrect?

2. Cause-and-Effect Exploration:

- What factors do you think contribute most to this issue?
- Can you identify the root causes behind the observed effects?
- Are there any secondary or indirect causes that might be overlooked?

3. Counterfactual Analysis:

- What would happen if the circumstances were different? How might that change your conclusions?
- Can you think of scenarios that would challenge your current understanding?

4. Comparative Analysis:

- How does this situation compare to others you've encountered?
- Are there analogies or parallels from different domains that could shed light on this issue?

5. Evidence and Justification:

- What evidence supports your current beliefs about this issue?
- How reliable is this evidence, and are there alternative interpretations?

Figure 7: Encourage critical thinking, challenging beliefs, when constructing CRT using ChatGPT

However, for more complex systems, it typically takes several days or even weeks to complete, especially if the analysis requires a deep understanding of the underlying processes and data collection. The time is also affected by how thoroughly the team wants to investigate and validate each causal relationship. It is important to spend enough time to ensure accuracy, but it is also important to avoid overanalyzing and overcomplicating the CRT.


Considering the diverse time investments required to create TOC TP logical trees, as shown in our survey, the integration of ChatGPT technology presents a transformative advantage. ChatGPT's usage in CRT construction significantly reduces the time and resources needed, especially for complex systems that typically demand extensive analysis. Its ability to quickly process and analyze large

datasets enables quicker identification of UDEs and more efficient construction of logical trees. GPT also aids in enhancing the accuracy of the CRT by providing a more thorough examination of causal relationships, minimizing the risk of oversights or errors. This results in a more robust and reliable CRT, ensuring that critical issues are not just identified but are understood in their entirety.

5 Discussion

The integration of ChatGPT into the construction of CRT within IT project management area, as explored in Chapter 4, represents a significant shift in approach and methodology. This chapter reflects on the implications and

T What assumptions are you making about the fact that some project plans are missing important project tasks?

 When considering the scenario of missing important project tasks in project plans, it's important to recognize the assumptions that might be shaping your understanding of the situation. Here are some assumptions you could be making:

- Assumption: All project tasks are known and can be predicted accurately from the outset.**
 - Challenge: Consider that some tasks might emerge as the project progresses, especially in complex or evolving projects.
- Assumption: Project planning is a one-time activity with a fixed scope.**
 - Challenge: Reflect on the need for continuous monitoring and adjustment as the project unfolds.
- Assumption: Project managers have complete visibility into every aspect of the project.**
 - Challenge: Acknowledge that information gaps or unexpected developments might prevent comprehensive task identification.
- Assumption: The project team is aware of all potential tasks and their dependencies.**
 - Challenge: Recognize that team members might have specialized expertise that uncovers tasks not initially considered.
- Assumption: All project tasks have equal importance and impact.**
 - Challenge: Explore whether certain tasks are critical to project success while others might have a more marginal influence.
- Assumption: Detailed task planning is more important than adapting to changing circumstances.**
 - Challenge: Consider whether excessive focus on detailed plans might hinder agility and responsiveness to changes.

Figure 8: Encourage critical thinking, challenging assumptions, when constructing CRT using ChatGPT

challenges of this integration, spanning from draft analysis and data collection to the final construction of CRT.

ChatGPT's role in the Draft Analysis phase (Section 4.1) has shown a substantial improvement in the efficiency and comprehensiveness of data collection and analysis. This advancement is particularly impactful in gaining comprehensive understanding of the current state and identify potential UDEs, enhancing both the speed and accuracy of the CRT construction process. Furthermore, as noted in Section 4.2, ChatGPT effectively addresses logical leaps within the CRT, aiding in the development of more coherent and logically sound structures. This contribution

is crucial in ensuring that the CRTs accurately reflect the complexities and nuances of IT project management area.

Moreover, the findings from Section 4.3 highlight ChatGPT's capacity to encourage deeper analytical thinking, guiding users to critically evaluate their beliefs and assumptions. This aspect of ChatGPT's application enhances the depth of the CRT analysis, leading to a more insightful understanding of the cause-and-effect relationships. Such depth is indispensable for identifying the root causes of problems and devising effective strategies in project management.

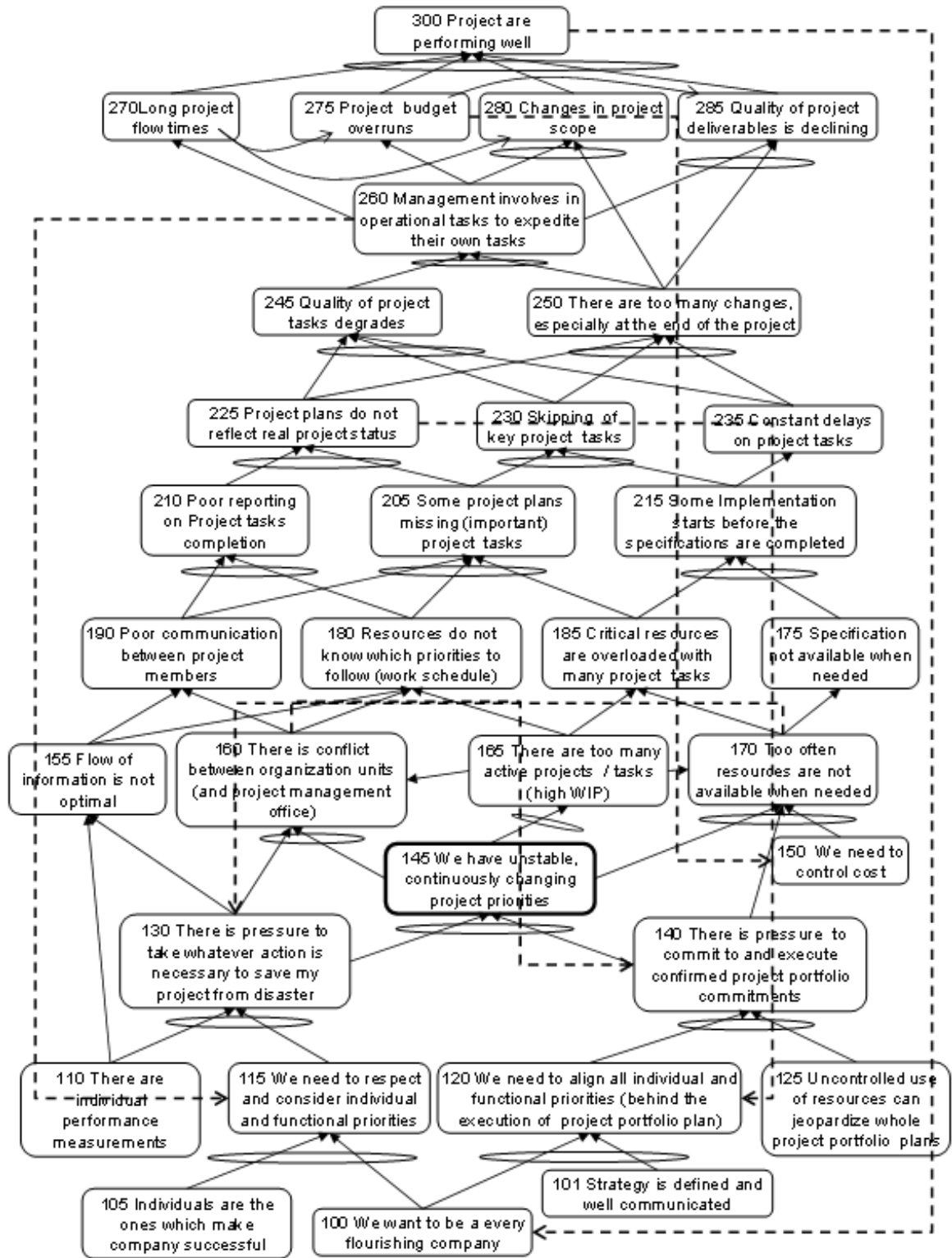


Figure 9: Resulting CRT (simplified) in the IT Project management area

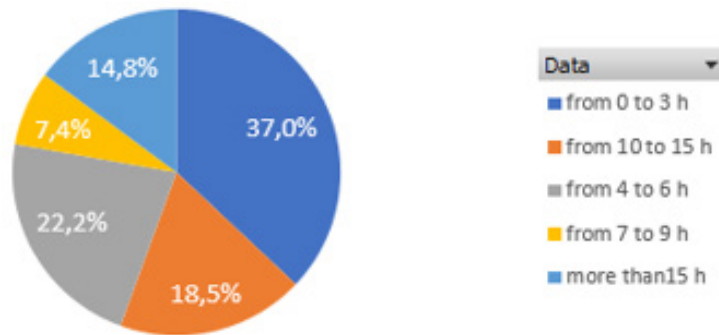


Figure 10: Time needed to create logical trees of TOC TP (without ChatGPT)

The results presented in Section 4.4 also sheds light on the time efficiency gained through ChatGPT integration in CRT construction, particularly in complex systems. This efficiency not only translates into time savings but also enables a more agile and responsive IT project management approach.

However, despite these benefits, several challenges need to be addressed. First, ChatGPT is not perfect and can sometimes generate inaccurate or misleading text. This could lead to incorrect conclusions being drawn during the TOC TP process. Second, ChatGPT is not a replacement for human judgment. Humans still need to be involved in the TOC TP process to ensure that the results are accurate and that the solutions are feasible. Third, ChatGPT is not yet trained on the specific concepts and terminology used in the TOC TP. This means that it would need to be trained on this terminology before it could be used effectively in the TOC TP. Finally, it is important to ensure that ChatGPT is used in a safe and ethical manner. ChatGPT is a powerful tool and could be used to generate text that is misleading or harmful. Thus, maintaining a balance between ChatGPT generated insights and human expertise is essential.

6 Conclusion

The integration of ChatGPT with TOC TP holds immense promise for enhancing logical analysis and decision-making. By leveraging ChatGPT's language capabilities and data insights, organizations can overcome constraints, make more informed choices, and achieve greater success.

Our study demonstrated ChatGPT's substantial impact on accelerating data collection, brainstorming, and validating cause-and-effect relationships within CRTs. However, successful integration necessitates addressing challenges related to ChatGPT's understanding, accuracy, and ethical use. Overcoming these hurdles is crucial for organizations to unlock the full potential of this integration and revolu-

tionize decision-making.

While our research focused on a specific IT project management case study, the findings provide valuable insights that can be extended to diverse organizational contexts. Further research and development are needed to refine ChatGPT's capabilities and expand its applicability across various industries and decision-making domains.

The synergistic combination of AI, exemplified by ChatGPT, and human expertise holds transformative potential for problem-solving and decision-making. Decision-makers can leverage this partnership to drive progress and innovation in a wide range of fields. However, it is paramount to approach this integration with care, ensuring continuous improvements in both technological capabilities and ethical considerations. Responsible, fair, and transparent use of AI is essential for its successful adoption in managerial and societal contexts.

In conclusion, our study contributes valuable insights into the integration of ChatGPT with TOC TP. By embracing ethical considerations and addressing research gaps, we can pave the way for a future where AI augments human decision-making, leading to more efficient, effective, and beneficial decision-making processes.

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Uporaba ChatGPT za napredno logično analizo v miselnem procesu Teorije omejitev

Ozadje in namen: Umetna inteligenca se tradicionalno uporablja za kvantitativno analizo z uporabo eksplicitnih podatkov. Pri tem pa veliko informacij ključnih za odločanje ostaja nedokumentiranih in niso shranjene na strukturiran način. Ta študija raziskuje vključevanje umetne inteligence, zlasti ChatGPT, v orodja miselnega procesa (ang. Thinking Process - TP) Teorije omejitev (ang. Theory Of Constraints - TOC).

Metodologija: V tej študiji smo uporabili ChatGPT v dejanskem primeru upravljanja IT projektov z uporabo različnih raziskovalnih metod, vključno z analizo mednarodne literature, opazovanjem delovnega okolja in osebnimi izkušnjami. Uporaba TP TOC nam je omogočila razumeti proces odločanja ChatGPT ter sistematično raziskati njegove prednosti in omejitve pri oblikovanju logičnih dreves TP TOC.

Rezultati: ChatGPT je znatno povečal učinkovitost in poglobljenost zbiranja in analize podatkov potrebnih za izvedbo logičnih dreves TOC TP ter učinkovito obravnaval logične pomanjklivosti v njih. Spodbujal je tudi poglobljeno analitično razmišljanje in pomagal pri ugotavljanju temeljnih vzrokov. Vključitev ChatGPT v postopek TOC TP je omogočil hitrejše sprejemanje odločitev, zmanjšanje pristranskosti in jasnejšo analizo. Ugotovljeni so bili nekateri izzivi povezani z uporabo ChatGPT, vključno s potrebo po človeškem nadzoru, posebnem usposabljanju s stališča TOC TP in etičnih vidikih.

Zaključek: Študija predstavlja začetno raziskavo o uporabi ChatGPT v orodjih TOC TP. Rezultati kažejo, da lahko ChatGPT postane koristno orodje za organizacije, ki želijo izboljšati učinkovitost svojega odločanja. Da bi potrdili te ugotovitve in raziskali celoten potencial umetne inteligence v TOC TP, pa so potrebne nadaljnje raziskave.

Ključne besede: ChatGPT, Umetna inteligenca, Teorija omejitev, Miselni proces teorije omejitev, Logična analiza, Odločanje, Strukturiran analitični pristop

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