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The Effect of Healthcare Managers' Perceptions of Top Management Team Behavioral Integration on Strategic Change and Innovative Performance

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Abstract

Background: Healthcare organizations should constantly update their strategies, follow sectoral trends, provide continuous training and development opportunities to their employees, and create an environment conducive to innovation in order to adapt quickly to changes and gain competitive advantage.

Purpose: The purpose of this study is to reveal the impact of senior managers' perceptions of the behavioral integration of the top management team on their perceptions of strategic change and innovative performance.

Study design/methodology/approach: The study analyzed information obtained from senior managers of 321 private hospitals in Turkey. Multiple regression analysis was used to test the research hypotheses.

Findings/conclusions: The results show that innovative performance is significantly enhanced by collaborative behavior, a sub-dimension of behavioral integration of the top management team. Moreover, another sub-dimension, joint decision making, has a negative effect on the initiation of strategic change, while collaborate behavior has a good effect on the execution of change. On the other hand, strategic change execution is negatively affected by joint decision making. The success of strategic change initiatives and the competitive advantage of the organization may be negatively affected. The influence of some cultural factors on business practices can create resistance to change and make it difficult for the top management team to work together. Overcoming this resistance requires cultural transformation and leadership development efforts within the organization.

Limitations/future research: The study focuses only on the health sector. Further research can focus on other sectors with qualitative study methods.

Keywords: Strategic Change, Innovative Performance, Top Management Team, Behavioral Integration, Healthcare Organization

Introduction

Within the health sector, health institutions are leading among capital, technology, labor and knowledge intensive enterprises. Health institutions have an important position in the health system of most countries. Since health institutions exist in both the public and private sectors, they need a well-planned and efficient administrative structure. For this purpose, most health care organizations have their own board of directors and a professional top management team (TMT) consisting of senior managers. Vainieri et al. (2019) describe healthcare organizations as complex, adaptive systems characterized by diverse organizational structures, numerous vertical and horizontal connections, and a combination of formal control mechanisms with considerable individual professional autonomy and influence. For this reason, teamwork in healthcare

organizations has various challenges. Formal team roles define the expectations for tasks, collaboration techniques, and partnerships. However, individual interactions with colleagues are also heavily influenced by personal affinities, preferences, past relationships, expertise, and professional rivalries (Kisfalvi et al., 2016). Carmeli (2008) demonstrated the importance of top management team behavioral integration (TMTBI) for various organizational outcomes of service businesses. The results of the study show that a behaviorally integrated team, whose members find ways to improve their mutual and collaborative interactions, exhibits better human resource performance and economic success than a less behaviorally integrated team.

As today's business environment becomes more dynamic, many organizations face unpredictable challenges in both their external and internal environments. To sustain their operations, organizations must stay updated in line with environmental conditions. For this reason, understanding the impact of the top management team on strategic change and innovative performance is crucial for both researchers and managers.

The dynamics of the market in which healthcare organizations operate and the specific characteristics of their economic management model led to a high degree of complexity in their structure and management. In recent years, increasing regulatory environmental pressures, technological advances, financial constraints and demand for high quality healthcare services have made strategic change in healthcare organizations inevitable. The impact of strategic change and innovative performance on TMTBI is of significant relevance in the context of private hospital management. Strengthening the links between these concepts and evaluating these elements can contribute to private hospitals to achieve a sustainable competitive advantage. Strategic change, innovative performance and TMTBI constitute the key components of a successful management strategy. In this context, it is important to initiate and implement strategic changes in hospitals with the contributions of senior management and to evaluate their level of innovation.

The study's design is influenced by the incomplete understanding of how TMTBI impacts strategic change and innovative performance in healthcare organizations, as well as the contradictory findings reported in the existing literature. In this context, the aim of the study is to reveal the effect of TMTBI perceptions of senior managers working in private hospitals on their perceptions of innovative performance and strategic change.

For the reasons explained, the research questions were formulated as follows:

1. Is there an effect of TMTBI perceptions of senior managers working in private hospitals on their perceptions of strategic change?

2.Is there an effect of TMTBI perceptions of senior managers working in private hospitals on their perceptions of innovative performance?

1. Literature Review

Most of the research in the literature have employed the upper echelon theory to examine the demographic traits of managers and how they affect decision outcomes in industries other than the health sector (Hambrick & Mason, 1984). Healthcare has a different perspective on top management teams due to its specific structure and unique characteristics. In health care, the TMT is usually composed of both physicians and professional managers. Diversity in senior management teams provides members with different professional perspectives, types of knowledge and decision-making styles. This results in more innovative ideas and greater creativity in the development of situation strategies (Naranjo-Gil, 2015). Thus, to stay competitive in the healthcare sector, it is critical to consider both financial sustainability and quality of care (Parayitam et al., 2007). However, since the perspectives of physicians and professional managers are potentially completely opposite, disagreements may arise among team members trying to establish a careful balance. Physician managers focus on providing high-quality care, leveraging the advantage of their medical background, while administrative managers aim to make financially sustainable strategic decisions. Therefore, strong integration within the team is essential for making better-quality decisions.

Many scholars, building on the work of Hambrick and Mason (1984), have emphasized the crucial role that senior managers play in driving strategic change and making key decisions. Researchers have explored the connection between top management teams and strategic change from various perspectives. Several studies have shown how TMT demographic characteristics (gender, age, tenure, education and experience) shape the cognitive orientations, attitudes and perspectives of

TMT members and how these characteristics can lead to change in strategic decision-making processes (Kelly et al., 2000; Yang & Wang, 2014). Similarly, several studies have demonstrated the impact of top management on strategy execution (Schaap, 2006; Maditinos et al., 2014; Hazarbassanova, 2016). In his work, Okumuş (2003) highlighted the importance of managers' roles in the implementation process and stressed the need for them to have the training they need to implement their best initiatives. Schmidt and Brauer (2006) emphasized that the dynamics within the top management team are shaped by the organization's goals and strategies, and these dynamics play a vital role in the effective execution of the selected strategy. Schaap (2006) postulated that successful strategy implementation would be directly correlated with effective senior leadership behaviors. The study indicated that senior leaders with expertise or experience in strategic planning and implementation are more likely to achieve the organization's performance objectives. The hypotheses established within this scope are as follows:

H_1: The evaluations made by hospital managers regarding the behavioral integration dimensions of the top management team impact their perceptions of strategic change

H_{1a}: The perception of information change significantly affects the initiation of strategic change.

H_{1b}: The perception of collaborative behavior significantly affects the initiation of strategic change.

H_{1c}: The perception of joint decision-making significantly affects the initiation of strategic change.

H_{1d}: The perception of information exchange significantly affects the implementation of strategic change.

H_{1e}: The perception of collaborative behavior significantly affects the implementation of strategic change.

H_{1f}: The perception of joint decision-making significantly affects the implementation of strategic change.

Effective innovation in healthcare relies significantly on strong senior leadership. Leaders who promote an entrepreneurial mindset and support innovative business strategies play a crucial role in improving innovation outcomes (Bagheri et al., 2022; Bocken & Geradts, 2020). In this context, leadership that supports innovation is crucial for improving quality, productivity, and efficiency (Dalton et al., 2021). Avby et al. (2019) revealed that innovation is significantly influenced by entrepreneurial leadership, team collaboration, strict performance standards, and a culture focused on learning. Effective leadership models enable healthcare organizations to create new products and services tailored to the evolving healthcare landscape, enter new markets, expand market share, gain competitive advantages, and develop innovative business models (Bocken & Geradts, 2020). Therefore, innovative performance can be enhanced through innovative business behaviors, leadership practices and an effective senior management team. However, the influence and orientation of senior managers may differ due to both demographics and the composition of the team (Wally & Becerra, 2001). Research shows that TMT diversity and level of education are often seen as characteristics that support an innovation-oriented mindset (Kor, 2006). For example, regarding the educational level of TMT, some studies have shown that educational level positively affects innovative capacity (Camelo et al., 2010; Herrmann & Datta, 2005). Research on family businesses demonstrates that sources of TMT diversity unique to family businesses, such as the number of family members working for the company, the number of generations employed, and the generation in charge of the business, have an impact on overall business performance and, consequently, innovation performance (Calantone et al., 2003; Rosenbusch et al., 2011).

The health sector is changing rapidly and organizations that can keep pace with this change and even lead it gain competitive advantage. Strategic change and innovation play an important role in enabling organizations to gain flexibility, seize new opportunities and achieve sustainable success in this dynamic environment. However, it is critical that the top management team exhibits consistent behavior in the process of change and innovation and that this behavior is spread to the entire organization. At this point, the relationship between strategic change and innovative performance and top management team behavioral integration constitutes one of the cornerstones of organizational success. In this context, this relationship determines the organization's ability to cope not only with its internal dynamics but also with external environmental factors. TMTBI is an important factor determining the way healthcare organizations manage change processes and have an impact on innovative performance and strategic change. While strategic change draws a roadmap

towards the organization's goals, innovative performance provides the flexibility and creativity needed to achieve these goals. In this context, to be successful in strategic change, organizations need to adopt a culture and top management team that fosters innovative performance. The hypotheses established within this scope are as follows:

H_2: Hospital managers' evaluations of the dimensions of TMTBI influence their perceptions of innovative performance.

H_{2a}: Perceptions of information exchange significantly affect innovative performance.

H_{2b}: Perceptions of collaborative behavior significantly affect innovative performance.

H_{2c}: Perceptions of joint decision making significantly affect innovative performance.

2.Methodology

2.1. Data Collection Instruments

In the study, a questionnaire form was utilized as a data collection tool. The survey form used within the scope of the research is provided in the appendix. Four parts make up the questionnaire. The first part of the questionnaire form consists of 9 questions that determine the individual characteristics of the managers such as age, gender, educational status, position and working time in the institution and the organizational characteristics of the hospitals they work in such as field of activity, number of beds, number of employees and year of establishment.

The Strategic Change Scale, created by Herrmann and Nadkarni (2014), was employed in the second section to gauge managers' opinions regarding strategic change. The scale comprises 10 statements total, 5 statements per dimension, and is composed of two sub-dimensions: implementation of strategic change and initiation of strategic change. The Likert scale used for the study has five points, ranging from 1 (no change at all) to 5 (severe change). After assessing the scale's validity and reliability, the Cronbach's alpha value was found to be 0.85. The strategic change scale's Cronbach's alpha value in this investigation was determined to be 0.84.

The Innovative Performance Scale, created by Sicotte et al. (2014), was employed in the third segment to gauge managers' opinions of innovative performance. There are eight one-dimensional items and five points on the Likert-type scale. From 1 (strongly disagree) to 5 (strongly approve), the scale is rated. After the scale's validity and reliability were examined, a Cronbach's alpha value of 0.88 was determined. In this study, the Cronbach's alpha value for the innovative performance scale was determined to be 0.96.

The integration of managers into the top management team was assessed in the final section using the Top Management Team Behavioral Integration Scale, which was created by Simsek et al. (2005). The three sub-dimensions of the scale are cooperative conduct, information sharing, and group decision making. There are three statements for each dimension, for a total of nine statements. The scale has a range of 1 (strongly disagree) to 5 (strongly agree), based on a Likert-type scale. After the scale's validity and reliability were examined, a Cronbach's alpha value of 0.80 was determined. In this study, the Cronbach's alpha value of the TMTBI scale is 0.86.

2.2. Study Population

The research covers 566 senior managers of private hospitals in Turkey (Sağlık Bakanlığı, 2019). The research aimed to encompass the entire population rather than select a sample. In each hospital, it was aimed to reach one of the general manager, chief physician or hospital director serving on the board of directors. In this context, all private hospital senior managers in the universe were tried to be reached face to face. After the questionnaire form was created, the managers were contacted, and the questionnaire forms were sent individually by mail to the managers who voluntarily accepted to participate in the study. The researcher asked the managers for their commitment to complete and return the questionnaire forms. The study was conducted with the participation of 321 private hospital senior managers. The participation rate was calculated as 56.71% with the collected questionnaires.

Table 1 Distribution of Hospitals and Collected Questionnaires by Geographical Regions

Regions	Private Hospital		Surveyed Private Hospitals	
	n	%	n	%
Mediterranean	88	15.55	46	14.33
Eastern Anatolia	21	3.71	12	3.74
Southeast Anatolia	46	8.13	28	8.72
Aegean	71	12.54	41	12.75
Marmara	236	41.70	130	40.50
Black Sea	31	5.48	20	6.23
Central Anatolia	73	12.89	44	13.70
Total	566	100	321	100

Source: the authors

Table 1 shows that responses were received from every region and the distribution of managers across regions was very close. The Mediterranean Region is where 15.55% of all private hospitals are located, and 14.33% of the managers participating in the study work in hospitals that operate there. While 41.70% of the private hospitals constituting the research population are in the Marmara Region, 40.50% of the managers participating in the research work in hospitals operating in the Marmara Region. In this regard, the fact that the distribution of the hospitals in which the hospital executives reached because of the research according to the geographical regions of the hospitals where they work is close to the distribution in the universe suggests that the research has a good representation power of the universe.

2.3. Statistical Analysis

After transferring the collected data to the computer environment, the SPSS-23 software program was utilized for data analysis. To assess the reliability of the scales, the internal consistency coefficient (Cronbach's Alpha) was computed. Frequency, percentage, mean, and standard deviation values were used to determine descriptive findings about the organizational and individual characteristics of managers and their responses to the scales measuring innovative performance, strategic change and TMTBI. To determine if the data on TMTBI, innovative performance, and strategic change factors followed a normal distribution, skewness and kurtosis coefficients were analyzed. Hahs-Vaughn and Lomax (2020) state that acceptable ranges for skewness and kurtosis values for a normal distribution are -2 to +2.

Multiple regression analysis was used to examine the research hypotheses to determine how TMTBI affected innovative performance and strategic change. To investigate the existence of multicollinearity and autocorrelation in the regression models, the Durbin-Watson coefficient and Variance Inflation Factor (VIF) were calculated. The significance level of 0.05 was used for all statistical analyses.

3.Results

3.1. Descriptive Findings

Table 2 displays the distribution of the findings related to the individual characteristics of senior managers participating in the study. In this context, 34.3% of the managers participating in the research are female, while 65.7% are male. 29.9% of the participants were 40 years old or younger, 25.9% were 36-40 years old, 29.6% were 41-45 years old, 25.9% were 46-50 years old and 14.6% were 51 years old or older. Of the managers participating in the study, 16.2% had an associate's degree, 37.7% had a bachelor's degree, 31.5% had a master's degree, and 14.6% had a doctorate degree. Additionally, the organizational characteristics of the hospitals where the senior managers participating in the study work are as follows: According to the field of activity of the hospitals where the executives in the scope of the research work, 36.8% are regional, 19.3% are national and 43.9% are national and international. Of the hospitals in the study, 15.32% have 50 or less beds, 40.2% have 51-100 beds, 26.5% have 101-150 beds, and 18.1% have 151 or more beds.

Table 2 Individual Characteristics of Managers and Organizational Characteristics of the Hospitals They Work In

Individual Characteristics		**Number**	**Percentage**
Gender	Female	110	34.3
	Male	211	65.7
Age	≤40	96	29.9
	41-45	95	29.6
	46-50	83	25.9
	≥51	47	14.6
Education Level	Associate degree	52	16.2
	Undergraduate	121	37.7
	Master's Degree	101	31.5
	PhD	47	14.6
Managerial Position	Chief Physician	113	35.2
	Hospital Director	175	54.5
	General Director	33	10.3
Total Working Time	≤15	55	17.1
	16-20	108	33.6
	21-25	93	29.0
	≥26	65	20.2
Organizational Characteristics			
Hospital Activity Area	Regional	118	36.8
	National	62	19.3
	National and International	141	43.9
Number of Hospital Beds	≤50	49	15.3
	51-100	129	40.2
	101-150	85	26.5
	≥151	58	18.1
Number of Hospital Employees	≤200	145	45.2
	201-300	71	22.1
	301-400	42	13.1
	≥401	63	19.6
Year of Hospital Establishment	≤2000 Year	75	23.4
	2001-2010 Year	139	43.3
	≥2011 Year	107	33.3

Source: the authors

Table 3 presents the descriptive findings showing the mean, standard deviation and the relationships between these variables regarding the statements in the strategic change, innovative performance and TMTBI scales used in the research. In this context, the average score for participants' responses to the initiation of strategic change, derived from the sub-dimensions of the strategic change scale, was computed as 3.42 with a standard deviation of 0.76. The average score for participants' responses to the implementation of strategic change was determined to be 2.82 with a standard deviation of 0.96. Given the obtained findings, the managers perceptions of the initiation of strategic change are above the medium level, while their perceptions of the implementation of strategic change are at the medium level. The mean score for the responses provided by the managers on the innovative performance scale was found to be 3.72, with a standard deviation of 0.97. These findings indicate that managers' perceptions of innovative performance are above average. The average score for managers' responses to the information exchange sub-dimension of the TMTBI scale was 3.59 with a standard deviation of 0.88. For collaborative behavior, the average score was 3.34 with a standard deviation of 0.87, and for joint decision-making, the mean score was 3.40 with a standard deviation of 0.86. These findings suggest that managers' perceptions of TMTBI are above average.

Table 3 Managers' Responses: Mean, Standard Deviation and Correlation Values

	Mean	SD	(1)	(2)	(3)	(4)	(5)	(6)
Initiation of Strategic Change	*3.427*	*0.766*						
Implementing Strategic Change	*2.821*	*0.961*	**.373****					
Innovative Performance	*3.721*	*0.972*	-.081	**.270****				
Information Exchange	*3.592*	*0.888*	-.034	-.022	.031			
Collaborative Behavior	*3.347*	*0.877*	-.104	.106	**.187****	**.438****		
Joint Decision Making	*3.405*	*0.860*	**-.221****	-.099	.041	**.537****	**.437****	

*** p<0,01 *, p<0,05 ; SD (Standard Deviation); Initiation of Strategic Change (1); Implementing Strategic Change (2); Innovative Performance (3); Information Exchange (4); Collaborative Behavior (5); Joint Decision Making (6)*

Source: the authors

To examine the relationships between variables, correlation analysis was performed in the research. The findings indicate a low positive correlation (r=0.270, p<0.001) between innovative performance and the implementation of strategic change. Additionally, a low positive correlation (r=0.187, p<0.001) was observed between collaborative behavior and innovative performance. In contrast, a significant negative correlation (r=-0.221, p<0.001) was identified between joint decision-making and the initiation of strategic change.

3.2. Findings About Regression Analysis

Table 4 displays the results of the regression analysis performed to evaluate the influence of TMTBI sub-dimensions on the initiation of strategic change. The model is significant and valid, according to statistical calculations (F=6.752, p<0.05). To assess multicollinearity, VIF and Durbin Watson coefficients were scrutinized. Typically, the Durbin Watson value should fall between 0 and 4, while the VIF value should be 10 or less (Altunışık et al., 2007). Based on the analysis results, VIF and Durbin-Watson values indicate that there is no problem with autocorrelation. Moreover, the model shows that TMTBI explains about 6% of the total variance in strategic change initiation. Analysis of the t-test results for the regression coefficient reveals that the statistically significant effect is associated with the joint decision-making dimension. Specifically, an increase in managers' perceptions of joint decision making corresponds to a statistically significant decrease in their perceptions of the initiation of strategic change (t=-4.067, p<0.05). Within the context of these findings, hypothesis H_{1c}, which posits that joint decision making among the sub-dimensions of TMTBI in hypothesis H_1 has a statistically significant effect on the initiation of strategic change, is accepted. Conversely, hypotheses H_{1a} and H_{1b}, which predict that information exchange and collaborate behavior, respectively, have a significant effect on the initiation of strategic change, are rejected.

Table 4 The Effect of Top Management Team Behavioral Integration Dimensions on the Strategy Initiation Dimension of Strategic Change

Variables	B	SE	β	t	p	VIF
Constant	3.973	0.208		19.055	<0.001	
Information Exchange	0.112	0.058	0.130	1.944	0.053	1.513
Collaborative Behavior	-0.037	0.055	-0.042	-0.672	0.502	1.332
Joint Decision Making	-0.242	0.060	-0.272	-4.067	<0.001	1.511
R=0.245	*R^2=0.060*	*F=6.752*	*p<0.001*	*Durbin Watson=1.645*		

Note: B (Beta Coefficient); SE (Standard Error); β (Beta Standardized Coefficient); t (t-value); p (p-value); VIF (Variance Inflation Factor)

Source: the authors

Table 5 presents the findings of the regression analysis conducted to determine the effect of TMTBI sub-dimensions on strategy implementation. The established model is significant and valid, according to statistical estimations (F=4.106, p<0.05). Furthermore, the VIF and Durbin Watson values indicate no issues concerning autocorrelation. According to the model, TMTBI explains about 3.7% of the total variance in strategic change implementation. Analysis of the t-test results for the regression coefficient indicates that statistically significant effects are present in the dimensions of collaborative behavior (t=2.941, p<0.05) and joint decision-making (t=-2.591, p<0.05). Accordingly, an increase in managers' perceptions of collaborate

behavior statistically enhances their perceptions of the implementation of strategic change. Conversely, an increase in their perceptions of joint decision making statistically decreases their perceptions of the implementation of strategic change. Hypotheses H_{1e} and H_{1f}, which state that cooperative behavior and joint decision making among the TMTBI sub-dimensions in hypothesis H_1 have a major impact on the implementation of strategic change, are accepted in light of these findings. On the other hand, hypothesis H_{1d} is not supported, indicating that information exchange amongst the behavioral integration sub-dimensions of the top management team has a major impact on the execution of strategic transformation.

Table 5 The Effect of Top Management Team Behavioral Integration Dimensions on the Implementation of Strategic Change

Variables	B	SE	β	t	p	VIF
Constant	2.839	0.265		10.720	<0.001	
Information Exchange	-0.010	0.073	-0.009	-0.139	0.890	1.513
Collaborative Behavior	0.205	0.070	0.187	2.941	0.004	1.332
Joint Decision Making	-0.196	0.076	-0.176	-2.591	0.010	1.511

R=0.193 R^2=0.037 F=4.106 p=0.007 Durbin Watson=1.578

Note: B (Beta Coefficient); SE (Standard Error); β (Beta Standardized Coefficient); t (t-value); p (p-value); VIF (Variance Inflation Factor)

Source: the authors

Table 6 shows the results of the regression analysis to determine the impact of TMTBI sub-dimensions on innovative performance. In this context, statistical estimations of the established model reveal that the model is significant and usable (F=4.246, p<0.05). In addition, VIF and Durbin Watson values show that there is no problem in terms of autocorrelation. According to the model, TMTBI explains about 3.9% of the total variance in innovative performance. Reviewing the t-test results for the regression coefficient reveals that the statistically significant effect is observed in the dimension of collaborative behavior. Accordingly, the increase in managers perceptions of collaborate behavior statistically increases their perceptions of innovative performance (t=3.486, p<0.05). Based on these findings, hypothesis H_{2b}, which asserts that collaborative behavior among the TMTBI sub-dimensions significantly affects innovative performance, is supported. In contrast, hypotheses H_{2a} and H_{2c}, which propose that information exchange and joint decision-making among the TMTBI sub-dimensions significantly impact innovative performance, are not supported.

Table 6 The Effect of Top Management Team Behavioral Integration Dimensions on Innovative Performance

Variables	B	SE	β	t	p	VIF
Constant	3.209	0.268		11.994	<0.001	
Information Exchange	-0.056	0.074	-0.051	-0.751	0.453	1.513
Collaborative Behavior	0.246	0.070	0.222	3.486	<0.001	1.332
Joint Decision Making	-0.032	0.077	-0.029	-0.424	0.672	1.511

R=0.197 R^2=0.039 F=4.246 p=0.006 Durbin Watson=1.782

Note: B (Beta Coefficient); SE (Standard Error); β (Beta Standardized Coefficient); t (t-value); p (p-value); VIF (Variance Inflation Factor)

Source: the authors

4. Discussion

The aim of the study is to reveal the effect of TMTBI perceptions of senior managers working in private hospitals on their perceptions of innovative performance and strategic change.

The study's findings indicate that the joint decision-making sub-dimension of TMTBI has a statistically significant negative effect on the initiation of strategic change. In the literature, there is no study on the impact of TMTBI on strategic change in the health sector. Although they are different concepts, a study revealed that extraverted personality traits of senior executives are negatively correlated with the joint decision-making dimension of the TMTBI (Grant et al., 2011). In another experimental study, it was concluded that groups under stress are less likely to utilize the resources of their members, leading to lower quality decision making (Kerr & Tindale, 2004). On the other hand, some studies have shown that diversity in management causes conflicts and negatively affects strategic change (Nielsen, 2010).

However, some research indicate that top management teams with greater diversity may experience slower decision-making, challenges in reaching consensus, and difficulties in initiating strategic change (Knight et al., 1999). Therefore, if the top management team is under stress and pressure, it will have a negative impact on the team in making the decision to initiate strategic change. Moreover, the different attitudes, personal backgrounds, worldviews, social connections, beliefs and experiences of the members of the senior management team can complicate the joint decision-making process. The results obtained in this context are regarded as significant contributions to the existing literature.

Another finding indicates that the sub-dimension of TMTBI, namely collaborative behavior, has a statistically significant positive effect on the implementation of strategic change. In contrast, joint decision-making is found to have a statistically significant negative impact on the implementation of strategic change. In the literature, there is no study on the impact of TMTBI on strategic change in the health sector. However, some studies have revealed that the demographic characteristics of the top management team can shape the cognitive orientations, attitudes, and opinions of team members and influence their strategic decisions leading to change (Kelly et al., 2000; Yang & Wang, 2014). The relationship between these variables and TMTBI is thought to indirectly influence strategic change in organizations. Similarly, studies have shown that top management has a positive impact on strategy implementation. The study's findings align with existing literature, except for the observation that joint decision-making negatively affects the implementation of strategic change, which contradicts previous research. To enhance the quality of decision-making, fostering collaboration, joint decision-making, and information sharing between managers and board members is essential (Uhlaner et al., 2021). In other words, a high level of TMTBI may mean that the strategic change outcomes of the organization will also be high. In the literature, shared decision-making behavior is generally accepted to have positive effects on strategic change (Wu, 2018). However, if the opinions of each member of the senior management team are not taken separately in making strategic decisions, the team members may not show the expected cohesion in the implementation of the strategic decisions. It has been shown that the lack of interaction between the senior management team members may result in the failure of the strategic implementation phase when they do not know what kind of strategy implementation they will take part in due to their different understandings of the strategic plan (Sminia, 2005). Different views and interests can lead to disagreements and conflicts in joint decision-making processes. These conflicts can complicate the implementation of strategic changes and disrupt team cohesion. Thus, the negative impact obtained as a result of the study may be due to these reasons.

According to another finding of the study, shared behavior, one of the sub-dimensions of TMTBI, has a statistically significant and positive effect on innovative performance. In the literature, there is no study in the health sector that examines the effect of senior managers perceptions of senior management team behavioral integration on their perceptions of innovative performance. A study on new product development teams in the technology sector in China revealed the positive impact of information exchange and collaborate behavior on innovative performance (Liu et al., 2015). In some studies, conducted with different concepts, positive relationships between TMTBI and exploratory innovation, green innovation and innovative consensus were determined (Hoegl & Proserpio, 2004; Hashmi et al., 2023). The study by Afshar Jahanshahi and Brem (2017) found a positive relationship between top management team behavioral integration and the innovativeness of team members. These findings are consistent with the current literature on the topic. On the other hand, functional diversity within the top management team's tenure has been found to positively impact innovation in research examining the relationship between top management team diversity and innovation (Lyon & Ferrier, 2002). According to research, there is a strong correlation between innovative performance and gender diversity in the senior management team (Ruiz-Jiménez et al., 2016). In this context, it is seen that the findings of the study are supported by the results evaluated in different studies in the literature.

The observation that members of the top management team may harbor negative ideas during information sharing and decision-making stages, yet struggle to implement these ideas, underscores a critical challenge. The reluctance to collaborate among top management team members can indeed hinder business innovation. Therefore,

the finding that an increase in managers' perception of information exchange and joint decision-making correlates with a decrease in innovative performance aligns with existing literature. These contradictions and the paucity of conclusive findings highlight a novel concept within upper echelon theory: organizational decisions and outcomes cannot be solely attributed to the composition of top management team members. In fact, several studies in the literature on the elements influencing the behavioral integration of individual senior management team members emphasize the significance of procedures such information exchange, collaborative behavior, and joint decision making. Simsek et al. (2005) have underlined the significance of processes including information exchange, joint decision making, and collaborative behavior in promoting information exchange among members of senior management teams. Conversely, other studies, like those by Li and Hambrick (2005), emphasize the significance of how top management team members interact and the potential for conflict or consensus arising from their diverse characteristics. Consequently, while some diverse groups excel in communication, discussion, and consensus-building, others may face challenges. Behavioral integration in top management teams plays a crucial role in mitigating the disadvantages of polarization and leads to improvements in decision-making processes during periods of polarization (DeBode et al., 2024). These arguments are substantiated by the findings of this study.

Conclusion

According to the study's findings, the joint decision-making sub-dimension of top management team behavioral integration has a negative effect on the initiation of strategic change. As managers' perceptions of joint decision-making behavior increase, their perception of initiating strategic change decreases. Among the sub-dimensions of TMTBI, shared behavior has a positive effect on the implementation of strategic change, while joint decision-making has a negative effect on the implementation of strategic change. Variables such as the size of the top management team, diversity within the team, education level, and average age affect the teams' innovative perspectives. Among the sub-dimensions of TMTBI, shared behavior has a positive effect on innovative performance. Among the sub-dimensions of strategic change, the initiation of strategic change has a negative effect on innovative performance, while the implementation of strategic change has a positive effect on innovative performance.

This study has certain limitations. This study encompasses senior executives working in private hospitals across Turkey. The research is applicable only to senior executives of private hospitals who agreed to participate in the study and responded to the surveys. Furthermore, the findings cannot be generalized to other sectors. The large geographical coverage of private hospitals nationwide has led to the selection of only one senior executive from each hospital. Consequently, the perception of strategic change, innovative performance, and especially the integration of top management team behavior has been limited to a single executive. This is one of the significant limitations of the study. Additionally, since this study is a cross-sectional type of research, it is limited to the specific time in which it was conducted.

By combining quantitative approaches with qualitative study methods, researchers can explore strategic change and its pre-processes in greater depth and gain richer insights. In this way, researchers can explore the subtleties of the integration of strategic change, innovative performance and top management team behavior and gain a more detailed understanding of the complex phenomena that quantitative research offers. Researchers and business practitioners alike may find great assistance in managing the challenges of organizational change from these findings. Researchers can also add to the body of knowledge by examining changes in the top management team's dynamics over time and how these changes affect organizational outcomes.

Declarations

Availability of data and materials

To provide a link to the Availability of data and materials, detailing how the data can be accessed or put: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Appendix

Questionnaire form

A. Strategic Change Scale
Initiation of Strategic Change
During the past 3 years, your firm has had strategic change related to…

1. 1.Entries or exits in international markets
2. 2.Additions and/or limitations markets
3. 3.New mergers and/or acquisitions completed
4. 4.Buying and/or selling of properties, plants, and equipment
5. 5.İncreases or decreases in R&D expenditures
6. Implementation of Strategic Change

During the past 3 years, your firm has had strategic change related to…

1. Change in organizational structure (e.g., increase/decrease in centralization/decentralization)
2. Restructuring or process changes (e.g., increase or decrease in steps to perform an activity)
3. increase or decrease in number of employees
4. changes in distribution of executive team members' titles (e.g., functional, product, geographical, or hybrid)
5. changes in formal incentives granted to executives

B. Innovative Performance Scale
Firm's performance compared to competitors at the present

1. Our firm's growth rate is higher than our competitors'
2. Our firm creates more customer value through innovation than competitors
3. Number of businesses generated through innovation is higher than in competitors
4. Number of spin-offs and start-ups generated though innovation is higher than in competitors
5. Frequency of major new product releases is faster than in competitors
6. Proportion of revenues generated though new products is higher than in competitors
7. The success ratio of new products is higher than in competitors
8. The improvement of quality for new product is better than in competitors

C. Top Management Behavior Integration Scale
Over the past 3 years, when your top management team made important decision regarding the firm's future

1. The ideas that our team members exchange are of high quality
2. The solutions that our team members put forward are of high quality
3. The dialogue among our team members produces a high level of creativity and innovation
4. When a team member is busy, other team members often volunteer to help her/him to manage her/his workload
5. Team members are flexible about sharing and/or switching responsibilities to make things easier for each other
6. Team members are willing to help each other complete jobs and meet deadlines
7. Team members usually let each other know when their actions affect another team member's work
8. Team members have a clear understanding of the joint problems and the needs of other team members
9. Team members usually discuss their expectations of each other

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Key drivers of pharmaceutical sales in OECD countries

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Abstract

Background: The pharmaceutical industry is constantly evolving, and the increasing growth in pharmaceutical sales has multiple economic and sociological implications. Namely, it has been a long time since prescription drugs accounted for the majority of sales in the pharmaceutical industry, which makes this industry interesting from both investor and regulatory policy perspective.
Purpose: This paper aims to analyse the determinants of pharmaceutical sales at the county level in order to identify fertile markets. A deeper insight into the issue could help managers in this growing industry to discover fruitful markets and policy makers to adjust their policies and regulations for the (online) sale of pharmaceuticals.
Study design/methodology/approach: The empirical part of the paper is based on a panel data analysis conducted for 31 OECD countries in the period from 2010 to 2022. The data was extracted from the OECD Data Explorer database and processed with Stata 13.1. Furthermore, pooled ordinary least squares models, fixed effect model and random effect model were formed, with pharmaceutical sales per person as the dependent variable.
Findings/conclusions: The results show that GDP per capita, the proportion of the population aged 65 and over and the proportion of people who have purchased online in the last 12 months have a positive impact on pharmaceutical sales, while life expectancy and the proportion of people who perceived their health as good/very good do not appear to affect it. Only the results on the effect of employment level indicate a negative influence on pharmaceutical sales.
Limitations/future research: Future analyses should provide a more detailed insight into pharmaceutical sales by expanding the sample, including additional explanatory variables and analysing the determinants of the different categories; i.e. an analysis of pharmaceutical consumption by different disease classes influenced by economic, sociological and medical reasons would be a fruitful future scientific path.

Keywords
pharmaceutical sales, OECD countries, determinants, panel data, country-level

Introduction

The pharmaceutical industry is constantly evolving and pharmaceutical sales are a significant component of healthcare expenditure, both at the individual and country level. Global sales of pharmaceuticals reached USD 1,332 billion in 2023, an increase of 28.5% compared to 2020, with the United States accounting for 50%, while the share of emerging markets (22.4%) is higher than that of Europe (18.6%) (Statista, 2024). This growth in production and consumption is not surprising, as the population in developed countries is ageing, the number of people with various chronic diseases is increasing and consumer habits and attitudes are changing (GBD 2021 Risk Factors Collaborators, 2024). Namely, the pharmaceutical industry reshaped consumers' attitudes toward pharmaceutical consumption by introducing profitable medicines for a range of everyday activities (Fox & Ward, 2008). This pharmaceuticalisation of daily life and the increasing proportion of online purchases of medicines (Lobuteva et al., 2022) are significantly enhancing the demand for pharmaceutical products. In addition to the increasing consumption of pharmaceuticals in developed countries, the strength of the pharmaceutical industry is also growing in emerging markets. These so-called "phamerging" countries are becoming increasingly

important players in the industry as producers and fertile markets.

Given the complexity of the factors that drive the sales of pharmaceuticals, they can be categorised into groups that focus on consumer, producer, industry and country characteristics. In this sense, this paper focuses on the country-specific determinants (c.f. Figure 1), as this segment is under-analysed. More specifically, this paper analyses the influence of various economic and socio-demographic factors on pharmaceutical sales.

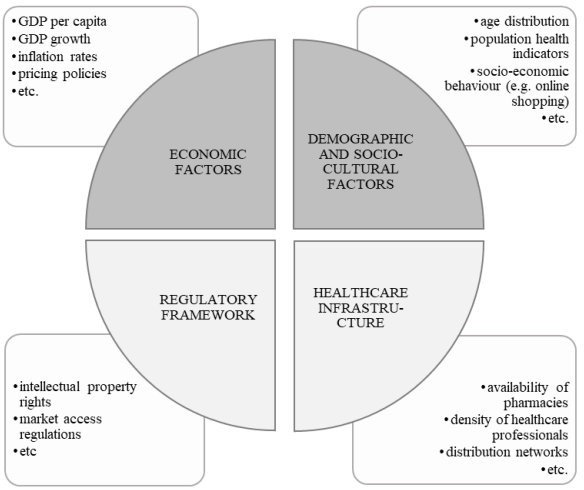

Figure 1 Determinants of country-level pharmaceutical sales
Source: the author

The aim of this paper is to identify and understand the key drivers of pharmaceutical sales at country level in order to provide pharmaceutical companies, policy makers and healthcare stakeholders with insights that could help them develop evidence-based strategies for the development of sustainable pharmaceutical markets and consequently improve public health outcomes. As already mentioned, the consumption of pharmaceuticals in general has increased, which makes this industry interesting in terms of profit. Furthermore, the development of highly expensive, innovative drugs for individualized treatments, alongside a marked increase in antidepressant consumption in Western societies (Di Valero et al., 2024), represents compelling new market niches. In this sense, it is beneficial for managers to detect fruitful markets.

However, this increasing consumption hides numerous issues that require policy measures that are not profit-orientated, but address issues such as the availability of necessary medicines, sustainability of public costs of pharmaceuticals (Odnoletkova et al., 2025), the reduction of unnecessary prescriptions, the health risks posed by the consumption of counterfeit and falsified medicines, etc. Hence, policy makers must balance the optimization of drug consumption, which reduces the revenues of pharmaceutical companies, with the fact that these companies are valuable market players whose activities have numerous positive effects on the country's economy. For example, in addition to the direct impact on employment, there are also indirect spillover effects through the increase in early-stage domestic innovation due to higher pharmaceutical spending (Kourouklis & Gandjour, 2022).

The empirical part of the paper therefore looks at the impact of different economic and socio-demographic variables on pharmaceutical sales in OECD countries using a panel data analysis. The above approach distinguishes this paper from similar studies as it uses a country-level analysis for a large group of countries. Namely, as described more extensively in Chapter 1.2., there are similar studies that analyse pharmaceutical sales or expenditures. Compared to this study, however, they either have a significantly smaller sample and use other explanatory variables (Leopold et al., 2014), focus on consumer-level data (Vogler et al., 2015), company-level data (Costinot et al., 2019) or use forecasting models (Bertolotti et al., 2024; Ghousi et al., 2012).

This paper is organised into five chapters. After the introduction, the literature review provides a contextual framework for the empirical analysis. The pharmaceutical industry has been studied for decades and this chapter briefly summarises the key aspects of this study. The data and methodology chapter then presents the variables analysed and formed panel models. A detailed presentation and discussion of the results obtained is provided in the fourth section. Finally, the paper ends with a conclusion that summarises the main findings from the previous sections, outlines their implications for the field and suggests directions for future research based on the shortcomings of this paper.

1. A brief literature overview

Various aspects of pharmaceutical sales are of importance to numerous stakeholders. As a result, numerous studies have explored this topic from a variety of perspectives, including those of consumers, companies, government, and the healthcare sector. Therefore, this chapter first looks at related topics that have a significant economic impact, while the second section of the chapter

provides an overview of studies that analyse aggregate levels of pharmaceutical sales or expenditure.

1.1. Selected economic aspects of the pharmaceutical industry

The pharmaceutical industry is highly capital-intensive industry, so it is not surprising that the high R&D costs and the need to increase efficiency during the drug development process have increased the influence of artificial intelligence in the pharmaceutical industry. In this sense, Kolluri et al. (2022), Lu et al. (2023), and Mak and Pichika (2019) critically evaluate the characteristics and use of artificial intelligence in the drug development process.

In addition, online drug trade has also been analysed for various reasons. On the one hand, it is seen as a threat to the pharmaceutical industry in terms of increased competition in the market. For example, Yang and He (2023) analyse the pharmaceutical e-commerce industry in terms of optimising the omni-channel sales strategy and their study provides interesting suggestions for managerial supply chain stakeholders. Lobuteva et al. (2022), Almohammed et al. (2023), Thaba et al. (2023) and Vera-Martinez (2023) analysed consumer attitudes towards online sales in this industry. At the same time, the increasing sale of counterfeit and falsified medicines online is a serious problem that requires stricter regulations as they can jeopardise consumer health (Mladinić et al., 2024; Sarkar, 2022; Limbu & Huhmann, 2023; Lee et al., 2017; Lavorgna, 2015; etc.).

Another important economic aspect of the pharmaceutical industry is the sales strategies employed. Namely, pharmaceutical companies spend a large part of their revenues on marketing and advertising aimed at healthcare professionals (Ali et al., 2022). It is therefore essential to examine the behaviour of sales representatives and healthcare professionals to determine whether it is ethical, as profit-oriented prescribing, when influenced by sales strategies, may result in unnecessary and/or expensive medicines being prescribed to patients, which may negatively impact their health and well-being (Khan et al., 2024; Noor et al., 2023; Pokorny et al., 2023; Barbaroux et al., 2022; Sawad & Andrews, 2022; etc.)

Besides the strong pharmaceutical industry in developed countries, the pharmaceutical market in emerging markets is also growing rapidly for several reasons: 1) there is a shift towards the use of generic drugs in developed and developing countries, 2) lifestyle changes in emerging markets are leading to changing disease patterns in these countries, and 3) the patent cliff is impacting leading branded drugs (Tannoury & Attieh, 2017). Emerging pharmaceutical countries are new players in the industry and incumbents should expect increased competition from phamerging countries such as Brazil, China, India and Russia. At the same time, these countries are a source of additional demand for pharmaceutical products. With this in mind, the pharmaceutical industry in these phamerging countries has been analysed from many angles. For example, some studies focus on their characteristics, i.e. their performance (e.g. Li et al., 2024; Luo et al., 2024; Nandy, 2022). Others look at the differences between Europe, the US and emerging pharmaceutical markets (Akkari et al., 2016), specific sales strategies (Civaner, 2012), etc.

As mentioned above, the consumption of pharmaceuticals is increasing due to the ageing of the population, the increase in chronic diseases and the habit of consumers to solve their health problems quickly through the use of medicines instead of gradually improving their lifestyle habits (Sinclair et al., 2024; Kip & Parr-Brownlie, 2023; etc.). Therefore, there is more and more pharmaceutical waste to take care of (Luo & Wan, 2024). As a result, many studies address various related issues, such as: a) the need to educate consumers on judicious consumption and appropriate disposal of unused/expired pharmaceuticals (Rogowska et al., 2019), b) the release of pharmaceuticals and their metabolites into the environment, including water, which is recognised as an environmental problem and a risk to human health (Al Smadi et al., 2023; Janik-Karpinska et al., 2023; Wilkinson et al., 2022; Gonzales Pena et al., 2021), c) the concept of anti-consumption in the context of sustainable consumption of pharmaceuticals (Kaladharan et al., 2024), d) sustainable pharmaceutical waste management (Kumar et al., 2025; Agarwal et al., 2024; Kusturica et al., 2022; Okeke et al., 2022, etc.).

Another important aspect of the pharmaceutical industry, considered from the perspective of individual countries, is the issue of access to medicines and the selection of the list of essential medicines. Pharmaceutical products have a significant impact on healthcare expenditure, which must be rationalised without jeopardising people's health. Therefore, pricing policies and

production quality control should safeguard medicine users while not unduly affecting returns in this highly capital-intensive yet lucrative industry. In other words, it is essential that policies related to the pharmaceutical sector are balanced to encourage investment, given the industry's numerous positive spillover effects, without compromising the well-being of the country's citizens. In this sense, there are studies that focus on public pharmaceutical expenditure and pricing policies (Joosse et al., 2023; Li, 2023; Zhou et al., 2023; Main et al., 2022; Rodwin, 2022; Papanicolas et al., 2018; etc.), or on access to medicines (Barber et al., 2024; Koduah, 2023; Mirza et al., 2023; Bjerke, 2022; Blankart & Felder, 2022; Sarkisova et al., 2022; etc.) and lists of essential medicines (Li et al., 2024; Slamang et al., 2024; Isaranuwatchai et al., 2022; Luz et al., 2022; etc.).

1.2. Pharmaceutical industry - a country-level analysis

The country-specific determinants of pharmaceutical sales are insufficiently analysed, especially when various economic and socio-demographic variables are taken into account. However, there are studies that deal with some factors that affect pharmaceutical sales or expenditure. In other words, there are studies that follow a more or less similar logic to the one presented in this study. In this sense, Leopold et al. (2014) carried out a descriptive analysis of the impact of policies on pharmaceutical sales in eight European countries observed in the period 2008-2011. In turn, Ying et al. (2022) analysed the relationship between economic growth and health status using multiple panel regression models with these two variables as dependent variables using data for 29 selected OECD countries over the period 2000-2019. Akca et al. (2017) used the decision-three method on data from the 35 OECD countries from 2014 and analysed the determinants of health expenditure as a share of GDP, with pharmaceutical sales as one of the independent variables. Similar to the previous study, Kadkhodamanesh et al. (2021) analysed the determinants of the GDP share of pharmaceuticals for selected OECD countries using a panel data analysis for the period 2008-2017, and for Iran using a time series regression for the period 1998-2017. Further, Elek et al. (2017) used aggregated data from 21 European countries between 2000 and 2012 to examine per capita pharmaceutical expenditure using hierarchical linear models, and identified differences between higher and lower income countries.

Bertolotti et al. (2024) used a different approach. They developed a forecasting model which they tested in multiple Italian regions to simulate the future consumption of active pharmaceutical ingredients, integrating consumption data, demographic statistics and information on the prevalence of diseases. Similarly, Ghousi et al. (2012) analysed the use of different data mining techniques as forecasting methods. Using data on different product types with data on demographic specifications of the consumption area from the drug distribution centre in Tehran, they provided a critical overview of the forecasting methods used to predict pharmaceutical consumption. Furthermore, Vogler et al. (2015) used consumer-level data from the European Health Interview Survey (2007-2009) to analyse differences in pharmaceutical consumption in eight countries in Central Eastern Europe based on socioeconomic factors. Costinot et al. (2019) analysed the pharmaceutical sales of 2,650 companies in 56 target countries using data from 2012, but their aim was to test the home market effect, i.e. whether there is a correlation between domestic demand and sales abroad.

2. Data and methodology

2.1. Data and descriptive statistics

The empirical part of the study focuses on the following 31 OECD countries: Australia, Austria, Belgium, Canada, Chile, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Iceland, Ireland, Italy, Japan, Korea, Latvia, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom. These countries are monitored from 2010 to 2022 and the list of variables analysed is shown in Table 1.

Table 1 Description of variables

Variable (code)	Definition
PSales	Pharmaceutical sales; US dollars per person, PPP converted
GDPpc	Gross domestic product per capita; US dollars per person, PPP converted, Current prices
Population65	Population 65 years or over; percentage of population

Employment	Labour force participation rate (labour force divided by the total working-age population); percentage
LifeE	Life expectancy at birth; in years
Health	Perceived health status: Good/very good health; individuals 15 years old or over; percentage of the population in the same age
OnlineP	Individuals who have purchased online in the last 12 months, from 16 to 74 years; percentage of the population

Source: the author

The aim of the study is to analyse the determinants of pharmaceutical sales in a heterogeneous group of OECD countries (see Table 2 for descriptive statistics). Therefore, this value is analysed on a per capita level. Pharmaceutical products, especially prescription drugs, are used when needed and therefore belong to necessary goods (Lubiani et al., 2018), which means that their consumption does not (significantly) increase with an increase in income. However, the sale of pharmaceuticals also includes non-prescription medicines and various products that are not necessary but are intended to benefit consumers' health, and their consumption is expected to increase with income. Therefore, GDP per capita is expected to have a positive impact on pharmaceutical sales. In other words, richer countries are expected to have higher pharmaceutical sales, as residents there can afford to buy various non-essential pharmaceutical products.

The percentage of the population aged 65 and older is expected to increase pharmaceutical sales, as health deteriorates with age, increasing the need for various pharmaceutical products. A similar logic applies to the variable reflecting longevity, i.e. countries with higher life expectancy are expected to have higher pharmaceutical sales. On the other hand, perceived health status is likely to have a negative impact, i.e. the more people rate their health status as good or very good, the lower the sales of pharmaceuticals are likely to be.

With regard to the level of employment, it can be assumed that a high labour force participation rate increases the value of pharmaceutical sales. In countries with a higher level of employment, more consumers are able to afford more pharmaceutical products, especially those that are not essential, i.e. those that do not require a prescription. The percentage of the population shopping online is also included in the analysis, as the number of online purchases is increasing across all product groups (Statista, 2025b) and pharmaceutical products are no exception (e.g. revenue in the online pharmacy market are expected to reach USD 97.18 billion in 2025; Statista, 2025a). This variable is therefore expected to have a positive impact.

The unbalanced panel data were taken from the OECD Data Explorer database and processed with Stata 13.1.

Table 2 Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
PSales	361	479.8942	156.1875	115	1085.9
GDPpc	390	47023.19	19864.44	17343.72	145971
Population65	390	17.49599	3.733426	7.117069	29.00114
Employment	390	61.67233	6.158142	48.14219	81.92857
LifeE	379	80.84222	2.388367	73.1	84.6
Health	342	68.69591	11.41002	30	91.4
OnlineP	338	57.30334	19.89083	5.2335	91.9695

Source: the author

2.2. Methodology

The static panel data analysis is performed using the following Pooled Ordinary Least Squares (POLS) model:

$$y_{it} = \beta_0 + \beta_1 x_{it1} + \beta_2 x_{it2} + \cdots + \beta_K x_{itK} + u_{it} \quad (1)$$

where $i = 1,\ldots n$, $t = 1,\ldots T$, y_{it} is the pharmaceutical sales for the observed country i in year t, and n is the total number of observation units (countries). The parameter β_0 is a constant term, other β are parameters related to six selected explanatory variables, and u_{it} is the error term, which is assumed to be independent and identically distributed by unit of observation and time. Based on the characteristics of its parameter estimates, both the fixed effect (FE) and random effect (RE) models were formed in addition to the POLS model. In order to select the most appropriate

model from these three, the following tests were carried out: the overall F-test (POLS-FE), the Breusch-Pagan test (POLS-RE) and the Hausman test (FE-RE).

3. Results and discussion

As already mentioned, three tests were carried out to select the most suitable model. According to the results presented in Table 3, the RE model is the most appropriate. In this sense, the results presented in Table 3 show that, as expected, sales of pharmaceutical products are higher in countries with a higher GDP per capita. These results suggest that, from a microeconomic perspective, pharmaceutical products are normal goods that are purchased more as wealth increases, which is approximated by GDP per capita at the country level. The results presented here are consistent with the findings of similar studies showing that higher income consumers are more likely to use medicines (Vogler et al., 2015), i.e. that pharmaceutical expenditures are higher in countries with higher GDP per capita (Kadkhodamanesh et al., 2021; Elek et al., 2017).

Table 3 POLS, FE, and RE estimates

Dependent variable: PSales	Model POLS	Model FE	Model RE
GDPpc	-0.00002 (0.00053)	0.0023*** (0.00066)	0.0021*** (0.00061)
Population65	8.1099*** (2.77836)	14.8652** (5.99539)	12.4488*** (4.45495)
Employment	-5.1124*** (1.55269)	-5.9304*** (2.27490)	-5.3659*** (2.01545)
LifeE	9.6657** (3.79828)	-1.3941 (6.55028)	1.4416 (5.57002)
Health	0.1541 (0.92263)	-1.6320 (1.76637)	-1.2654 (1.31656)
OnlineP	3.0267*** (0.63887)	3.0669*** (0.64544)	3.2129*** (0.58620)
Constant	-302.892 (266.4319)	529.8635 (547.6752)	287.7555 (454.7651)
Observations	287	287	287
R-squared	0.2992	0.2467	0.263
POLS vs FE (F-test and Prob > F)		35.94 (0.000)	
POLS vs RE (chibar2 and Prob > chibar2 – BP test)			729.1 (0.000)
Hausman test (chibar2 and Prob > chibar2)		0.95 (0.9662)	

Source: the author

Notes: Symbols ***, **, * denote significance at the 1%, 5%, and 10% significance levels. Robust standard errors are in parenthesis. POLS vs FE - The overall F-test for 29 individual differences (F-test that all α_i=0) shows that there are significant differences between individuals and that the FE model is more appropriate (F test that all u_i=0: F(29, 251) = 35.94). The Breusch-Pagan test (BP) has been used to test for the presence of random effects, i.e., to choose between the POLS and RE model; since there are random effects, RE is preferred over POLS. The Hausman test fails to reject the null hypothesis that the coefficients for the years are jointly equal to zero (Prob > F is 0.9662), which confirms that the RE model should be used instead of the FE model.

The percentage of the population aged 65 and over has a strong, significant positive influence on the dependent variable in the countries analysed. In other words, as expected due to the deterioration in health status with increasing age, the value of pharmaceutical sales is higher in countries with a higher percentage of the population aged 65 and over. Vogler et al. (2015) also confirmed that advanced age is relevant for prescribed pharmaceutical consumption, while Elek et al. (2017) found a weak positive correlation between pharmaceutical expenditure and the proportion of the population aged 65 and over.

The percentage of the population that has bought something online is another variable that is expected to have a positive impact on physical sales. To the best of the author's knowledge, this explanatory variable has not yet been analysed in any comparable study on the pharmaceutical market; consequently, the results presented here cannot be compared with existing studies. However, Duch-Brown et al. (2017) confirmed that

online sales generally have a positive effect on market expansion. In other words, an increased share of online sales in a country's sales is a positive sign for an expected market expansion for all types of products, which then also applies to the pharmaceutical market.

On the other hand, life expectancy and self-perceived health status do not appear to have any influence on pharmaceutical sales. These results may seem unexpected at first, as countries with a higher life expectancy at birth would be expected to have higher pharmaceutical sales due to age-related deterioration in health. However, the results of a study on the determinants of pharmaceutical expenditure by Elek et al. (2017) also confirmed a statistically insignificant impact of life expectancy. On the other hand, Akca et al. (2017) found that life expectancy and perceived health are important while using the three-decision method to analyse the determinants of healthcare expenditure. The study by Kreouzi et al. (2024) on Blue Zones, i.e. zones where people live longer than the expected average, could provide an answer to this question. Indeed, they note that polypharmacy can be harmful for older patients, which means that there could be areas in countries with patients who consume fewer medicines compared to other areas, making it difficult to draw solid conclusions about the impact of these explanatory variables on pharmaceutical consumption at country level. In addition, total pharmaceutical sales are used as a dependent variable in this analysis, and it is possible that the effects of these two variables would be different if prescription drug sales had been separated from over-the-counter drug sales. Also, differentiating the results depending on life expectancy at different ages (at birth, middle age and advanced age as in Magazzino et al., 2024) could be beneficial for explaining the effects of these two variables.

Looking at the influence of these variables on the sale of pharmaceuticals, it seems that the time when pharmaceutical products are only sold when a person has a medical condition that requires their use is over. The results suggest that the value of pharmaceutical sales is likely to be higher in more affluent countries with more customers buying online and with a higher proportion of older people. This is interesting from a management perspective, as the results suggest that the sale of pharmaceutical products seem to follow the pattern of any other commodity when deciding where to direct marketing efforts. That is, companies should promote and sell these products in countries where people can afford them, who are more accustomed to buying online, and where the demand for pharmaceutical products is greater, especially among older consumers.

However, the results relating to the level of employment show that this market has its own peculiarities. The impact of employment levels on pharmaceutical sales is negative, which means that sales are likely to be higher in countries with higher unemployment. At first glance, these results may seem contradictory, but considering that unemployment is positively correlated with depression, leading to higher consumption of antidepressants (Lopez-Vila et al., 2025; Pisarska et al., 2024; Dackehag et al., 2023), future analysis of the structure of pharmaceutical sales could provide more precise information about its determinants. This is particularly interesting considering that pharmaceutical consumption of antidepressants has increased on average by 62% in the observed OECD countries, with significant differences between countries, e.g. observed consumption in Luxembourg in 2022 is only 5.9% higher than in 2010, while values for Estonia are almost 180% higher than in 2010 (OECD, 2024).

The results obtained are also interesting from the point of view of policy decision-makers. In countries with a higher GDP per capita, vibrant pharmaceutical markets with consumers accustomed to buying online and a larger proportion of older people, the policies relating to pharmaceutical markets should be strongly developed. In other words, pharmaceutical companies and online shops that are only after profit will target these markets. Therefore, consumers should be protected by limiting the sales strategies of pharmaceutical companies to avoid over-prescriptions, for instance. At the same time, the online sale of pharmaceuticals in these countries should be strictly monitored to prevent the sale of counterfeit and falsified medicines. In addition, special attention should be paid to the sale and consumption of medicines in countries with high unemployment. Combined with the results of studies examining antidepressant consumption, the results obtained here indicate that consumers are increasingly taking various medications to cope with the negative consequences of unemployment and improve their mental health.

Conclusion

The main purpose of this study was to analyse the factors affecting the sales of pharmaceuticals at country level, as this aspect of the pharmaceutical

industry has not yet been sufficiently investigated. The country perspective is interesting from both the investors' and the policy makers' point of view. This is because the pharmaceutical industry, like any other industry, is profit-driven and seeks to find fertile markets so that it can optimise its returns by maximising profits and minimising costs. In this sense, stakeholders in the pharmaceutical industry should take into account the differences between countries when planning strategies to increase their pharmaceutical sales. However, due to the nature of its products, this industry is often highly regulated, which is why new distribution strategies and channels for pharmaceuticals have been developed for years in order to increase sales. Against this background, policy makers should constantly monitor changes in this market so that they can adapt their policies to protect consumers' health, especially in the case of online sales, without overburdening this highly developed industry with its numerous positive spillover effects in domestic countries. In other words, special care should be taken to ensure that both the healthcare professionals who prescribe medicines and the users of various pharmaceutical products are advised on the latest scientific knowledge on how to optimise the use of medicines. In this way, only the necessary medicines are used and the resulting waste is disposed of properly.

The strength of this study is that it broadens the field by analysing the impact of various economic and socio-demographic factors on pharmaceutical sales in 31 OECD countries. There are studies on pharmaceutical expenditure, pharmaceutical consumption from the consumer's perspective, etc., but to the best of the author's knowledge, this research takes a unique standpoint that provides useful insights into the subject. Indeed, the results obtained show that the pharmaceutical market, while following the expected pattern in certain aspects, also has its peculiarities. Countries with higher purchasing power in terms of GDP per capita, a higher proportion of the population aged 65 and over, and more consumers used to buying online are expected to have higher pharmaceutical sales. On the other hand, life expectancy and self-perceived health status do not appear to have any influence on this. As for the impact of employment levels, one should be cautious in drawing conclusions, as the results of the panel data analysis show that countries with higher employment levels will have lower pharmaceutical sales. Therefore, both investors and policy makers should be aware of the complex relationship and causalities between employment and consumers' physical and mental health that affect pharmaceutical consumption when developing strategic plans to expand the target market or when designing policies that address the pharmaceutical industry. In other words, the findings presented here show that dealing with the pharmaceutical industry requires constant fine-tuning of related sales tactics and regulatory measures.

Several shortcomings of this paper serve as a starting point for future studies in this area. First, the sample is limited to OECD countries as a heterogeneous group of countries, and an extension of the sample could provide additional insights into relevant factors influencing pharmaceutical sales. Furthermore, it could be beneficial to analyse countries separately according to their income level or healthcare system. Furthermore, additional economic and demographic variables at country level could help to better identify differences between pharmaceutical markets. The inclusion of alternative health indicators such as lifestyle measures, which provide additional information, e.g., on the extent of alcohol consumption and smoking, could also add to the field. Finally, analysing the determinants of sales of different groups of pharmaceutical products as opposed to total sales could be a fruitful scientific avenue, especially when it comes to products dealing with mental health issues.

Declarations

Availability of data and materials

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An NLP approach to skill analysis in ICT job advertisements from a gender perspective

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Abstract

Background: The gender gap in the Information and Communication Technology (ICT) sector is strongly pronounced across Europe, including Serbia. Women are underrepresented in ICT education, entry positions, and throughout career trajectory. Although surveys and official statistics are commonly used to study gender disparities and skills in demand, job advertisements remain an underexplored organic data source in these studies. They can provide valuable insights into required hard and soft skills and a basis for measuring the influence of used language in job descriptions on gender distribution of applicants.

Purpose: This paper investigates whether linguistic patterns and the framing of skill requirements in ICT job advertisements correlates with the gender distribution of applicants. The aim is to understand how specific wording or skill emphasis may differently attract male or female candidates.

Study design/methodology/approach: Authors analyse 3,643 ICT job advertisements from Serbia with associated data on self-reported gender of applicants. Using a five-step methodology, the authors apply exploratory text analysis and natural language processing techniques, including n-gram analysis, feature engineering, and co-occurrence networks, to identify hard and soft skills patterns across male- and female-majority job postings.

Findings/conclusions: The results offer insights into the language characteristics used in ICT job descriptions and gender-specific keywords reflecting hard and soft skills. Job advertisements that attract more male candidates use engineering-oriented terminology, such as programming and DevOps tools. In contrast, advertisements drawing more female candidates emphasise collaboration, teamwork, and emotional intelligence. Soft skills are more frequent in female-majority advertisements, while male-majority advertisements focus on narrower technical domains. Empirical findings suggest that how job advertisements frame requirements can reinforce gendered perceptions of role suitability. This has practical implications for human resource management and recruitment strategies in the ICT industry.

Limitations/future research: Limitations include the use of percentage-based gender data and the evolving nature of the ICT labour market. Future research will expand the dataset, improve gender classification, and explore longitudinal trends to track changes over time.

Keywords

ICT labour market, job advertisements, gender gap, NLP, exploratory text analysis, Serbia, soft skills, hard skills

Introduction

Digital transformation has reshaped labour market demands. According to the European Commission (2020) report, 90% of jobs require digital skills or expertise in science, technology, engineering, and mathematics (STEM). Professions reliant on these competencies, particularly in the Information and Communication Technology (ICT) sector, are driving economic development. Women's

participation in the workforce is recognized by the European Commission as a factor that strengthens national economies (European Commission 2020). However, the European ICT sector exhibits a pronounced gender gap. According to the DESI 2022 report, men constitute an average of 80% of ICT specialists in the European Union (European Commission, 2022). Some factors contributing to such disparity are educational barriers and the impact of artificial intelligence (AI) and automation on employment.

In the European Union, women comprise only 18% of ICT students, with 33% of STEM graduates (European Commission, 2022). In general, there are more women graduates in Serbia, but only 27% of them in ICT-related studies (Grljević et al., 2019), leading to missed talent and innovation opportunities (Kukić Đorđević & Čolić Mihajlović, 2023). Women's underrepresentation in ICT and STEM education spans to the workforce and poses a challenge for gender equality (World Economic Forum, 2020). In the EU, women constitute 18.9% of total employed ICT specialists and in Serbia this number is as high as 23.3% (Kukić Đorđević & Čolić Mihajlović, 2023). With career advancement gender gap is further pronounced. Women are underrepresented from entry-level positions to executive roles (Taplett et al., 2018). Research emphasizes low employment rates for women in ICT and higher attrition rates (Quirós, et al., 2018; Scott & Kapor Klein, 2017; Ashcraft et al., 2016). In Serbia, women are rarely present in high-ranking positions and most often apply for internships. Among already employed women, they constitute 55% of junior ICT specialists, 43% mediors, and only 2% seniors (Kukić Đorđević & Čolić Mihajlović, 2023). The same authors point to decrease of the share of women along corporate ladder – 17% of ICT managers are women, while the share of women in directors' positions in the ICT sector in Serbia is below 10%. While automation and digital transformation generate high-paying ICT and AI jobs, they simultaneously jeopardize clerical roles, disproportionally affecting women (Brussevich, et al., 2018), leading to pay gap and economic disparity. An increasing pay gap is present in Serbia, as well. According to Kukić Đorđević and Čolić Mihajlović (2023), general gender pay gap from 9.8% in 2018 reached 14.4% in 2022. Analysing earnings by education levels or occupations reveals an even more pronounced gap in Serbia, with ICT occupations leading.

Studying the gender gap is thus a relevant issue. However, it is insufficient to study how pronounced the gap is, but it is also necessary to deal with the causes, as well as the characteristics of the gender gap itself. Understanding its characteristics is vital for designing policies that address workforce challenges and improve access for women to well-paid careers and leadership opportunities.

The organic nature and easy accessibility contribute to job advertisements becoming the basis for analysis of skill requirements on labour market (Valavosiki et al., 2019). The literature indicates that content analysis of job advertisements provides good insights into required hard and soft skills (Lovaglio et al., 2018; Korbel, 2018; Valavosiki et al., 2019; Ilich & Akilina, 2017; Cosgrove et al., 2024). However, job advertisements are not utilized in the analysis of the relationship between required skills across candidate's genders, instead authors rely on surveys and official statistics (Hossain, et al., 2023; Bradić-Martinović & Banović, 2018; Bradić-Martinović, et al., 2024; Jevtić et al., 2023; Lazarević-Moravčević et al., 2023). Potential of more sophisticated data analysis techniques, such as text mining, natural language processing (NLP) techniques, and machine learning is reflected in their ability to more precisely identify and classify the required skills from advertisements (Jaiswal et al., 2025; Nasir et al., 2020; Pejic-Bach et al., 2020; Bäck et al., 2021), as well as to identify gender language patterns (Hu, et al., 2022). However, these techniques are rarely used to identify gender-specific ICT skills, such as (Simon et al., 2023), given that publicly available job advertisements are not disclosing information on candidate's gender. This leads to researchers rely on statistical data or surveys even though it is restricted to individuals willing to participate, which introduces potential bias. Consequently, there is a lack of studies that integrate these aspects using advanced analytical methods, as well as datasets that simultaneously capture labour market demand, supply, and candidates' socio-demographic characteristics. To the best of our knowledge, Serbia's ICT market has not been analysed and characterized in this manner. This study aims to contribute to bridging this gap.

Given the previously stated, the authors in this paper aim to characterize the gender gap in Serbia's ICT labour market through skill exploration and identification of possible gender-specific competencies. An empirical study addresses the following research questions:

RQ1: How do linguistic patterns and keywords in ICT job advertisements influence the gender distribution of applicants?
RQ2: What required skills in ICT job advertisements differentiate applicants by gender?

To answer these research questions authors utilize a unique dataset – 3,643 organic ICT job advertisements in Serbia with associated data on self-reported gender distribution of applicants – and apply a more comprehensive methodological approach. Self-reported gender data is limited to binary categories (female/male), based on the data provider's platform structure. Methodology comprises five steps, data extraction, data transformation and cleaning, n-gram analysis, feature engineering, and identification and interpretation of salient features. Through these steps, the authors combine content analysis (Krippendorff, 2013; Hsieh & Shannon, 2005), exploratory text analysis (Tukey, 1977; Allen et al., 2018), and natural language processing techniques (Jurafsky & Martin, 2025; Farzindar & Inkpen, 2015). Such combined approach to job advertisement analysis allows for quality text preparation, extraction of useful keywords and skills from texts, and their quantifications in order to identify patterns pertaining to gender distribution of applicants. The results provide insights into the linguistic characteristics of ICT job descriptions, highlighting how certain keywords reflecting hard and soft skills correlate with the gender composition of applicants. Job advertisements that include engineering-oriented terminology tend to receive higher engagement from male candidates, while those emphasising collaboration, teamwork, and emotional intelligence are more often associated with female applicant engagement. These empirical findings have practical implications for human resource management and recruitment strategies in the ICT industry. While this study focuses on gender-based patterns, future research could benefit from adopting an intersectional perspective examining how gender interacts with race, socio-economic status, and other identity dimensions in shaping digital labour market outcomes (Crenshaw, 1989; Noble, 2018).

The paper is structured as follows. Section 1 provides an overview of related literature. Section 2 presents the research methodology. Section 3 presents the results, while in the Section 4, the authors discuss results and reflect on proposed research questions. The last section refers to conclusions with references to practical implications and limitations of the research, as well as the future work.

1. Related literature

The organic nature and easy accessibility (Valavosiki et al., 2019) contribute to job advertisements becoming the basis for analysis of skill requirements and the gender gap in the ICT sector. Contrary to traditional methods to researching skill requirements, such as questionnaires or surveys, job advertisements provide insights into current labour market demands, specific requirements for technical (hard) and soft skills, and reflect dynamic changes in the industry. Author (Vieira da Cunha, 2009) was among the first to identify the analysis of collection of job advertisements can reveal long-term trends and shifts within a profession, which could provide measurable and comparable research insights. When correlated with gender data, analysis of job advertisements help identify gender-specific language patterns in the formulation of requirements for certain positions (Gaucher et al., 2011; Hu, et al., 2022), which influence the candidate's perception of which professions are "suitable" for a particular gender. Related literature is structured into two subsections to reflect on research studying ICT skills in demand from job advertisements and on research on gender disparities from the perspective of digital skills.

1.1. Analysis of ICT skills from job advertisements

Previous research focusing on ICT labour market demands, examined hard (Lovaglio et al., 2018) and soft skills (Korbel, 2018; Valavosiki et al., 2019; Ilich & Akilina, 2017; Pažur Aničić & Arbanas, 2015) separately, with more emphasis on the latter, given their relevance for ICT professionals is recognized early on (Purao & Suen, 2010; Zhang, 2012). Croatian companies sought soft skills almost twice as often as technical skills (Pažur Aničić & Arbanas, 2015). Hungarian and Serbian employees face higher expectations concerning soft skills compared to technical or hard skills (Strugar Jelača et al., 2025). Such findings point to the role educational institutions have in balancing study programmes and equipping students with both technical and non-technical skills, ensuring successful transition from university education to the labour market. A more advanced approach to studying skill gap present in university curricula with respect to AI industry

demands is present in the (Jaiswal et al., 2025) study. They used frequency analysis, machine learning, and NLP. Results indicate well-balanced AI curriculum in technical skills (e.g., programming, machine learning), while gap is present in data science, mathematics, and statistics.

Research points that communication, problem-solving, and team work are most sought for competences in job advertisements among soft skills (Pažur Aničić & Arbanas, 2015; Korbel, 2018; Valavosiki et al., 2019; Ilich & Akilina, 2017). Authors (Valavosiki et al., 2019) associated required soft skills with six ICT job families recognized in the European e-Competence Framework – *Business Management*, *Technical Management*, *Design*, *Development*, *Service and Operations*, *Support*. Their findings indicate that communication, problem-solving, and teamwork are consistently sought in all six job families and that different job families require some specific soft skills, such as *Business or Technical Management* requires analytical and organisational skills, *Design and Support* job families presentation skills, *Development* requires self-motivation and desire to learn, while *Service and Operation* job family emphasize the need for customer orientation and independent work. These findings indicate the necessity for balanced skill development in the ICT sector, both during education and throughout professional development. Authors Cosgrove et al. (2024) mapped DigComp framework, (Vuorikari et al., 2022), to European Skills, Competencies, Qualifications and Occupations skill descriptors used in a database of European online job advertisement (OJA). In this way authors aligned digital skills employers demand from employees with education and training supply. DigComp covered 54.5% of skills mentioned in OJA (2018–2022), however, the coverage is uneven. The greater emphasis is on information and data literacy, content creation, and communication than on safety or problem-solving. The extent to which these skills are explicitly linked to digital environments varies, with information and data literacy more explicitly digital than communication and collaboration.

These studies utilize content analysis and frequencies, while more sophisticated analytical approaches could be used, such as text mining. Text mining is utilized to predict attractiveness of job advertisement based on job descriptions (Yunlu, 2023), to identify skills in demand for particular types of occupation, such as analysts positions (Nasir et al., 2020), or to identify industry specific knowledge, such as the case study of Industry 4.0 (Pejic-Bach et al., 2020), or to study trends, transitions in the job markets and skill demands, such as the case study of Finnish job market and investigation of the emergence of AI-related jobs (Bäck et al., 2021).

2.2. Gender digital divide

Authors rely on official statistics, such as Eurostat data (Martínez-Cantos, 2017) or surveys (Hossain, et al., 2023; Bradić-Martinović & Banović, 2018), if studying digital skills from the gender perspective. Such data provides information on both skill and gender. Global gender gap report by (World Economic Forum, 2020) differs in terms of using LinkedIn data. Based on five-year employment trends on the LinkedIn platform and similarities in required skills, eight job clusters have been defined with a growing employment trend: *People and Culture*, *Content Production*, *Marketing*, *Sales*, *Product Development*, *Data and AI*, *Engineering*, and *Cloud Computing*. This study indicates that women are underrepresented in technical-intense clusters, i.e., *Data and AI* (26%), *Engineering* (15%), and *Cloud computing* (12%). However, *Data and AI* can use the potential from the available talent pool, as women comprise 31% of other professions characterized by skills relevant to data and AI-related positions. Thus, it is possible to increase the proportion of female data scientists.

The issue of the gender gap in the Serbian labour market was studied in general by analysing the gender digital divide (Bradić-Martinović & Banović, 2018), through effects of digitalization and skills on inclusion of women in labour market (Jevtić et al., 2023), or by focusing on a specific sector – the authors Bradić-Martinović et al. (2024) explore gender disparities in Serbian tourism sector, while Lazarević-Moravčević et al. (2023) study gender inequality in science and education. These studies indicate presence of gender divide, such as 62.6% of women have low or no digital skills, contrary to 46.7% of men. Women's digital literacy is prerequisite for reduction of gender gap and potential increase of the number of female entrepreneurs. To the best of our knowledge, the most comprehensive study on the position of women in Serbia's ICT sector is the report published by The United Nations Development Programme. It offers detailed analysis of official statistical data, analysis of causes of gender imbalance pointing to education-related issues, such as stereotypes, lack of female role models,

lack of practical work, support, and motivation, and labour market-related issues, such as lack of female mentors, male-dominated environments and male-culture in companies, imbalance between work-home-family workload, perception gap (Kukić Đorđević & Čolić Mihajlović, 2023).

These studies are based on utilizing and analysing official statistical data. If more sophisticated techniques are used, such as machine learning, natural language processing, or text mining, they are utilized to decipher the language used in ICT job advertisement and link them to gender-based attributes. The pioneering research by Gaucher et al. (2011) reveals that masculine wording, used in male-dominated occupations, are less appealing to women indicating that gendered wording in job advertisements signals a candidate's fit for the position. Gender bias in job advertisements is studied in (Hu, et al., 2022) offering a mitigation approach in order to debias job posting text, while authors (Simon et al., 2023) used a LinkedIn profiles dataset on job candidates fit for IT-related positions to identify presence of gender bias caused by gender differences in textual self-presentation in LinkedIn.

2. Methodology

In an attempt to understand the gender gap present in the Serbia's ICT market, research aims to conduct NLP-based exploratory analysis of ICT job advertisements, with the specific focus on interpreting results in the context of gender distribution among applicants. The primary objective is to identify distinct skills within job advertisements and investigate whether these skills exhibit correlations with the gender distribution of applicants.

Authors use the dataset containing 3,643 ICT job advertisements published on Serbia's largest employment portal, *Poslovi.infostud* – a part of Inspira group and Alma Career. Job advertisement are linked to applicants' self-reported gender, derived from applicants' disclosures regarding their sex and is expressed as the percentage of male and female applicants per job posting, along with the percentage of applicants who did not disclose this information. The data on both job advertisements and applicants' gender data were provided by the company *Poslovi Infostud*, fully respecting data privacy regulations and without exposing any identifiable user information. The authors of this paper deployed named entity recognition as additional mechanism for ensuring anonymity of the data and removed all instances of named entities, such as cities, organisations.

The research presented in this paper is exploratory in nature and the research methodology is rooted in the methodology proposed in (Allen et al., 2018) and adapted to our case study. It comprises the following steps, as illustrated in Figure 1: (1) data extraction enables abbreviation of job advertisements retaining only relevant information, (2) data transformation and cleaning improves text quality enabling drawing more reliable conclusions from graphical representations, (3) n-gram analysis offers direction to frequency-based filtering, domain-dependent stopword detection, and identification of informative n-grams useful for further analysis, (4) feature engineering, and (5) identification and interpretation of salient features. Through these steps authors combine content analysis (Krippendorff, 2013; Hsieh & Shannon, 2005), exploratory text analysis (Tukey, 1977; Allen et al., 2018), and natural language processing techniques (Jurafsky & Martin, 2025; Farzindar & Inkpen, 2015). Such combined approach to job advertisement analysis allows for quality text preparation, extraction of useful keywords and skills from texts, and their quantifications in order to identify patterns pertaining to gender distribution of applicants. Each step is presented in more detail in the subsequent subsections.

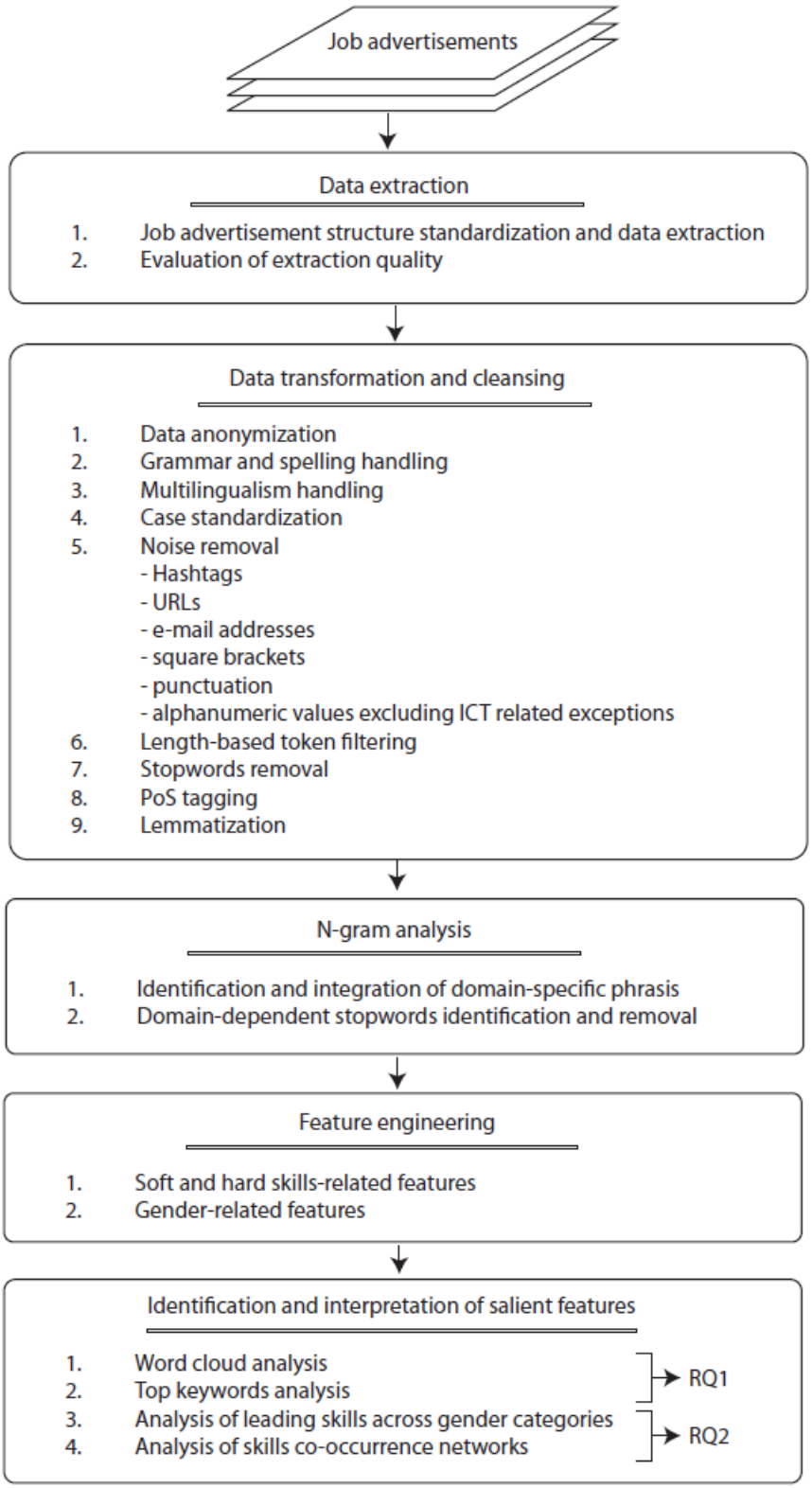


Figure 1 Methodology framework
Source: the authors

2.1. Data extraction

Job advertisements are commonly structured into five segments: a) description of a company, b) description of the position, c) required skills or knowledge, d) conditions a company offers to the future employees, and e) instructions on how to apply for the job. To address research questions, the focus of our analysis is on description of the position and requirements. Extraction of these particular text segments from full texts of job advertisements was challenging due to variations present in the way companies structure job postings. Not all of the job advertisements contained all five of the segments, nor the segments were always structured in the same order. For this reason we automated data extraction using Python, the ChatGPT-3.5 API, and structured prompting, similar to the approach in (Jiang, et al., 2024). This enabled extraction of position-related information into five segments: 1) position naming, 2) the narrative about the role or the job description, 3) responsibilities, 4) required technologies, 5) skills, both soft and hard. We have also anticipated the sixth, optional segment dedicated to non-specific details related to the job function. Figure 2 illustrates the effect of data extraction.

To evaluate the quality of extraction, the authors randomly selected 124 job advertisements for manual evaluation. The first author of the paper along with the expert in the field, marked as annotator A1 and A2, respectfully, independently evaluated each text by comparing original job advertisement text with the extraction, taking into account that only information about job posting, required skills, and responsibilities should remain in the excerpt.

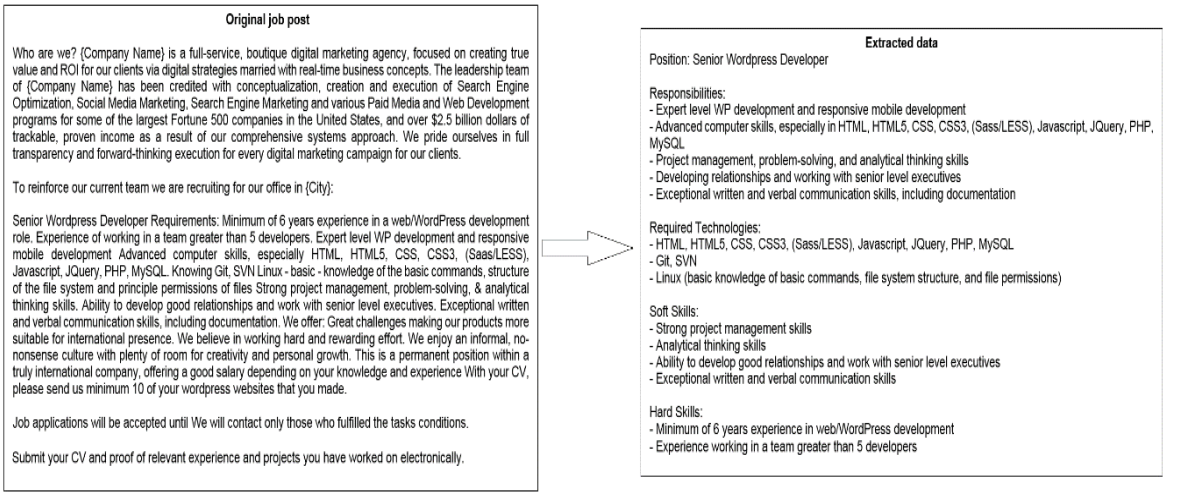


Figure 2 Illustration of data extraction from job advertisement

Source: the authors

Both evaluators rated each extraction with values 1, indicating the extraction was complete and successful, or 0, indicating the extraction was incomplete and unsuccessful. Cohen kappa κ was applied to evaluate the inter-rater agreement (IRA), or the extent to which evaluators make the same judgment on the successfulness of extraction (Rau & Shih, 2021; McHugh, 2012; Tan et al., 2024). "Kappa is a statistical measure of the agreement in assignment of units to categories in excess of what would be expected by chance, based on each rater's tendency to assign units to each category" (Rau & Shih, 2021). It is calculated as:

$$\kappa = \frac{Pr_{(a)} - Pr_{(e)}}{1 - Pr_{(e)}} \quad (1)$$

where $Pr_{(a)}$ and $Pr_{(e)}$ are the actual observed agreement and expected frequencies of agreement, respectively.

Table 1 indicates the number of excerpts assigned to each category by each evaluator: 119 excerpts were judged by both evaluators as successfully extracted text, and 3 excerpts as unsuccessfully extracted, indicating an observed total percent agreement $Pr_{(a)}$ of 98.39% ($Pr_{(a)} = (119+3) / 124$).

As shown in Table 2, based on the evaluators' overall preference for each category, it is expected that 116 excerpts are categorized by both evaluators in category 1 ($(120/124)*(120/124)*124 = 116$), and 0 in category 2 (4/124*4/124*124). An expected

agreement $Pr_{(e)}$ is 93.55% by chance alone ($Pr_{(e)} = (116+0) / 124$).

Table 1 Observed agreement and (disagreement), based on the ratings assigned to each excerpt by evaluators A1 and A2

		Evaluator A2		
	Category	**1**	**0**	**Total**
Evaluator A1	**1**	119	(1)	120
	0	(1)	3	4
	Total	120	4	124

Source: Authors

Table 2 Expected agreement and (disagreement) by chance, based on the proportion of excerpt assigned to each category by each evaluator

		Evaluator A2		
	Category	**1**	**0**	**Total**
Evaluator A1	**1**	116	(4)	120
	0	(4)	0	4
	Total	120	4	124

Source: the authors

Kappa is calculated according to the expression (1) as $\kappa = \frac{0.9839 - 0.9355}{1 - 0.9355} = \mathbf{0.75}$. The value of the IRA indicated by kappa was interpreted using the guidelines given in (Landis & Koch, 1977), according to which there are six categories of agreement: poor (−1–0), slight (0.01–0.2), fair (0.21–0.4), moderate (0.41–0.6), substantial (0.61–0.8) and excellent (0.81–1). Two evaluators achieved substantial agreement ($\boldsymbol{\kappa = 0.75}$) and we conclude that evaluators substantially agree with the automated extraction of key information from the full job advertisement texts and that we can proceed with such automation for the full data set.

2.2. Data transformation and cleansing

Data pre-processing is the most important task in any analytical project, consuming most of the time and effort of the analyst. The goal is to improve data quality and transform data into a suitable format for machine learning (Grljević, 2023). Pre-processing of unstructured data, such as ICT job descriptions, is even more demanding than working with structure data. This is due to the extensive vocabulary used in texts where each unique word, phrase, or a symbol represents a feature. This leads to high dimensionality of data in use. Without adequate pre-processing all of these words would be used to represent text, in this case study job advertisements, regardless of the fact they do not contribute equally to the semantics or meaning of the text. An effective data preparation is key to reducing dimensionality and identifying a simplified set of feature to represent texts (Feldman & Sanger, 2013). In the empirical study, authors applied several procedures pertaining to data anonymization, data transformation, or cleaning the noise from data.

The goal of *data anonymization* is to protect the privacy of companies posting job advertisements. To achieve removal of all mentions of companies we opted for identification and removal of named entities using spaCy open-source Python library for natural language processing and its implementation of entity recognizer for organisations (SpaCy, 2024). While entity recogniser identified certain technologies as organisation, before removing identified named entities the authors implemented manually crafted exceptions referring to the predominant technologies, such as *Microsoft Dynamics 2016*, *Microsoft Azure*, *SAP*, etc. As the main analytical goal is set towards modelling ICT skills on the Serbian job market, we also removed all mentions of geopolitical entities using spaCy library. This aided to pertaining only content referring to the job position, skills, or technologies the company requires for the position.

Job postings officially represent the company and one would expect high standards regarding grammar and spelling. However, the authors of this paper found wide disrespect towards grammar and spelling, particularly in job postings written in the Serbian language. This mostly refers to words containing diacritic marks, which are often written in colloquial style, such as instead of using letter *š* employers used *sh*, or instead of using *č* employers used *ch*. This was corrected manually as it posed limitation for translation of texts to English language in the next step.

Job advertisements are posted in various languages. English written job posts comprise 95.39% of dataset (3.475), Serbian 4.53% (165), and German 0.08% (3). Although non-English advertisements represent a relatively small portion of the dataset (approximately 5%), to ensure full representation of market requirements authors opted for their retainment. The authors decided on language unification as the multilingual strategy. Using Google Translate API the language of the job post is detected and translated to English. In this way, the language is unified. Prevalence of English in the dataset and the availability of the NLP resources for English language motivated this decision. Selected approach is in line with multilingual strategies identified by Laureate et al. (2023) and studies exploring user behaviour (Tang et al., 2022; Marcolin et al., 2021; Kirilenko et al., 2021; Grljević et al., 2025). The authors manually

reviewed and compared original and translated texts to ensure that vocabulary related to skills is preserved, mitigating in this way known limitations of machine translation that might impact technical and context-specific terminology.

The content is thereafter pre-processed in Python using regular expressions or NLTK (natural language toolkit) libraries for the following data cleansing and dimensionality reduction procedures:

1. Case standardization. As different forms of the same word, such as capitalized, uppercased, or lowercased, are considered by algorithms a different feature that increase the dimensionality of the data, the authors standardized the case by lowercasing the text of all job postings.
2. Noise removal. In textual data noise refers to all instances that are not contributing to the meaning or adding new knowledge or information about the text. With respect to noise, we have removed: hashtags, URLs, email addresses, square brackets, punctuation, alphanumeric values excepting technology names (e.g., css3, html5, neo4j), and numbers.
3. Excessive whitespaces and newlines are removed from the job descriptions for this purpose.
4. Length-based token filtering. Words with less than 3 characters are removed from the texts, as they can be considered as stopwords.
5. Stopwords removal. Stopwords refer to frequent words in spoken and written language that do not add new knowledge or attribute to the semantics of the text, such as conjunctions (Grljević et al., 2022), and as such are removed from the texts.
6. Tokenization implies text segmentation on its constituent words (tokens), allowing the further pre-processing on a token level.
7. Authors utilized part-of-word (PoS) tagging as a part of preparation for text normalization. All instances of adjectives, adverbs, verbs, and nouns are tagged, and subsequently lemmatized. Lemmatization is the process of word reduction to their base form, lemma. It is selected as an approach for text normalization since it preserves semantic integrity and retains meaning (Manning et al., 2008).

Figure 3 illustrates job posting prior and after textual data pre-processing.

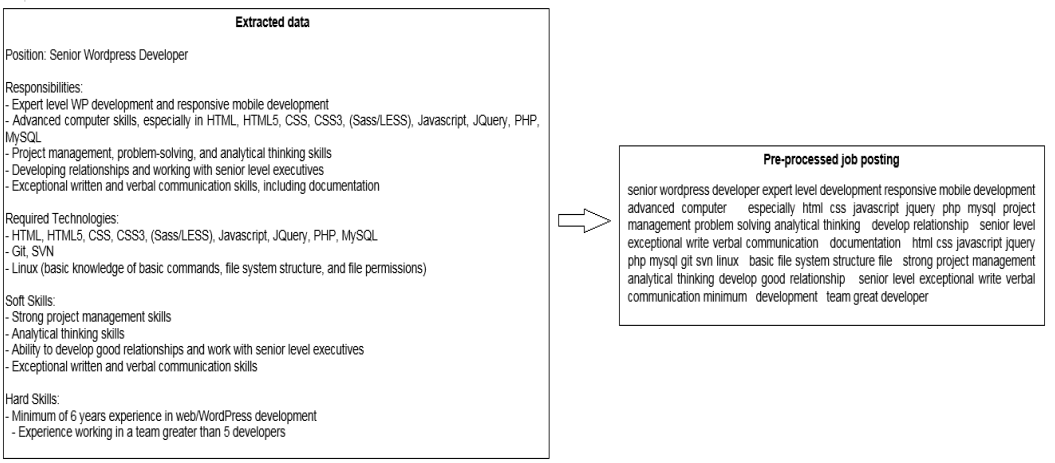


Figure 3 Illustration of pre-processed job advertisements
Source: the authors

2.3. N-gram analysis

An n-gram is a sequence of n tokens or words naturally occurring in text. Single token is referred to as unigram, a sequence of two tokens is called a bigram (e.g., "strong programming", "programming skills"), while a sequence of three tokens is a trigram (e.g., "strong programming skills"), and so forth. To ensure semantical richness of data, we utilize n-grams to identify domain specific phrases that should be observed unified in the further analysis, as well as those that

can be considered as domain-dependent stopwords and should be excluded from the further analysis.

By manually inspecting unigrams, authors were able to identify domain-dependent stopwords, such as *experience, skill, work, knowledge,* or *position*, which were removed from the corpus. Also words occurring 5 or less than five times in the corpus can be considered as uninformative, such as *retirement, water*, *food*. For this reason and with the goal of retaining only words that contribute to modelling soft and hard skills differentiating ICT job advertisements by gender, the authors conducted frequency-based filtering to remove all words occurring 5 or less than 5 times in the corpus. Figure 4 illustrates 20 most frequently used words in ICT job advertisements in the resulting corpus. Prevailing keywords in the corpus are team, development, test, technology, design, software, English, etc. Unigrams offer an initial intuition on common trends in ICT market.

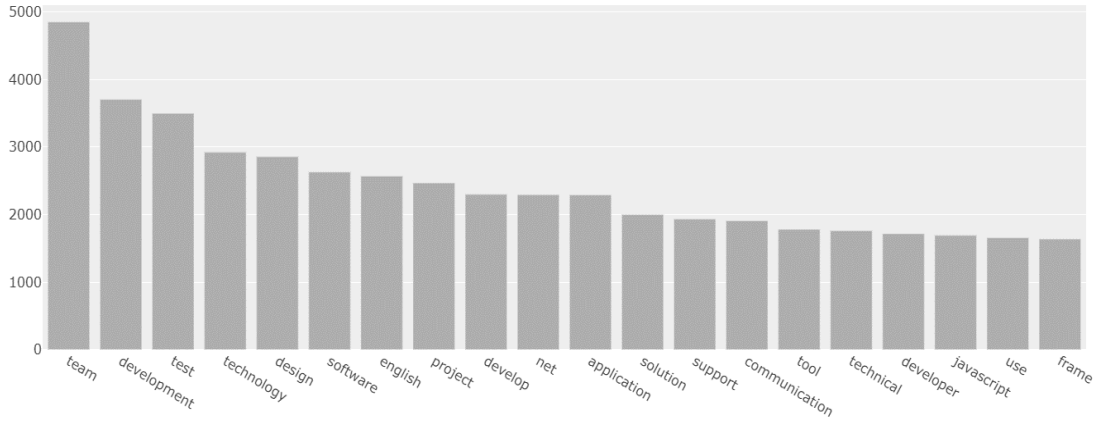


Figure 4 The most frequent unigrams in IT job advertisements
Source: the authors

Bigram analysis allowed for identification of domain-dependent phrases that are not contributing to the context, such as *require technology*, *soft skills*, *hard skills*, which were removed from the corpus, as well as informative phrases that should be retained as features, such as *artificial intelligence, machine learning, SQL server*. Figure 5 illustrates top 20 bigrams according to frequencies, after filtering.

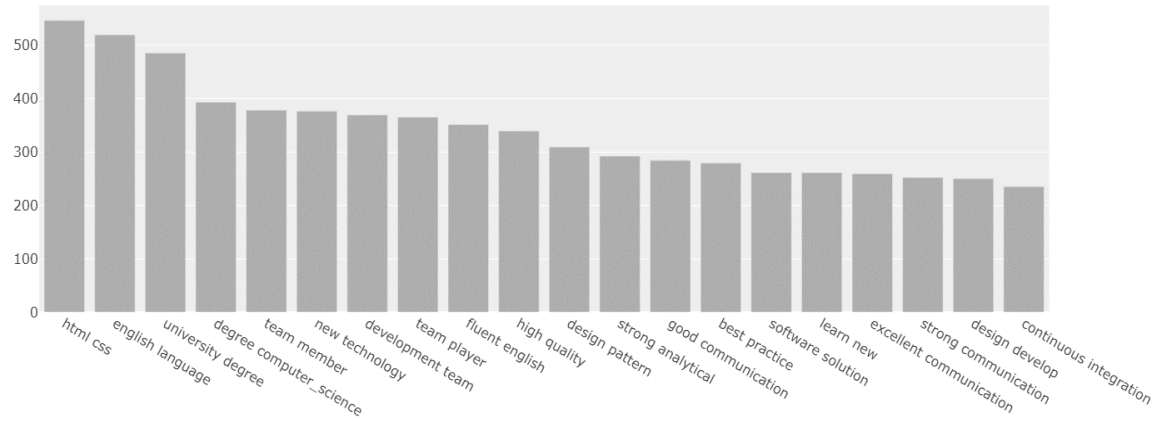


Figure 5 The most frequent bigrams in IT job advertisements
Source: the authors

Bigrams and trigrams, illustrated with Figure 6, also offer the first glimpses into the context of the ICT advertisements. From the most frequent bigrams we can observe that key technologies refer to frontend technologies, HTML and CSS, companies are seeking people with English language skills and university degree, preferably computer science, while most sought soft skills are

ability to work in team, analytical, and communication capabilities. Trigrams are indicating that among other important soft skills employers are valuing learning new technologies, problem solving, and hard skills refer to writing clean, high quality code.

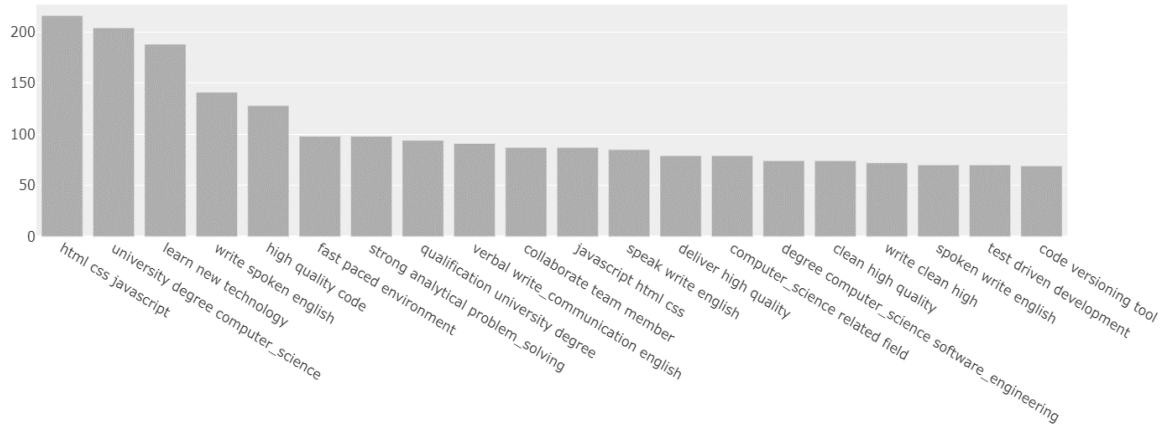


Figure 6 The most frequent trigrams in IT job advertisements
Source: the authors

2.4. Feature engineering

Feature engineering is a crucial step in machine learning, converting pre-processed data into a structured format suitable for automated analysis (Popov, 2022). Three types of features are generated: hard and soft skills sets of features and gender-related feature.

2.4.1. Hard and soft skills features

Unigrams and informative phrases from bigram analysis are used to generate the list of unique words, which were subsequently classified into hard and soft skills through Python code, invoking ChatGPT-3.5 Turbo for AI-driven categorization. Each skill is represented as a separate feature in a column, with values of 0 if the skill is absent and 1 if it is present in the job advertisement. The authors manually inspected resulting skills to filter out instances not strictly related to job skills, such as *three*, *popular*, *accept*, etc., resulting in a 645 keywords reflecting hard skills and 448 keywords reflecting soft skills.

2.4.2. Gender-related features

Data on gender distribution are expressed as percentages of male, female applicants, and applicants whose sex was undisclosed, not as raw counts. Advertisements for which the gender of the candidates is indicated as 100% unknown are removed from the dataset, leaving 3,638 posts for further analysis. Although the percentage data on the gender of candidates provides an overview of gender representation, it limits the granularity of statistical analysis and subgroup comparisons. A discussion of this limitation and its implications is included in the concluding section.

Advertisements are categorized and labelled according to gender ratios. Based on the percentage data, authors derived new attribute *Gender_bins* indicating majority gender of applicants using the following manually crafted rules:

- Female-majority ad – at least 51% of applicants are female.
- Male-majority ad – at least 51% of applicants are male.
- Neutral ad – advertisements where the gender distribution is approximately balanced, with no more than 51% of applicants from either gender.

Table 3 illustrates the gender distribution of ICT job advertisements, indicating severe skewness towards male-majority advertisements. For clarity and brevity, the terms "job advertisements" and "ads" are used interchangeably in the remaining of the paper.

Table 3 ICT job advertisements distribution across gender categories

Male majority ads	Female majority ads	Neutral ads
3465	101	72

Source: the authors

2.5. Identification and interpretation of salient features

This step identifies deviations or variations, i.e., searches for deviations between groups of texts. Using domain knowledge, the authors in the interpretation phase interpret the identified salient

features in the context of the domain from which the texts originate. As suggested in (Allen et al., 2018), for this purpose, we used word clouds, analysis of leading words within the framework of observed phenomenon, as well as co-occurrence networks indicating pairs of skills that often occur together in job advertisements. The results of exploratory analysis are in detail presented in the subsequent sections. Discovered knowledge can help in setting guidelines for potential improvements in hiring strategies.

3. Results

3.1. Word clouds of gender labelled job advertisements

A word cloud is a graphical presentation of the most frequently occurring terms in a corpus. Words closely associated with a specific corpus are emphasized by larger font size. Contrary, less frequent terms appear in smaller font sizes. In this way they extract key information from a corpus and present it visually, enabling prompt comprehension of topics and essential content of the text (Ren et al., 2024). Figures 7-9 illustrate generated word clouds for distinct genre related subsets of IT job advertisements using the WordCloud library in Python. The colours are randomly allocated to distinguish individual words, without conveying any semantic significance.

Prominent words in the word cloud of male majority ads, illustrated in Figure 7, such as *application*, *system*, *development, solution, process, technology,* etc.*,* indicate these ads are more directed towards technical aspects and greater emphasis is on software development, platforms, and engineering-oriented terminology. Female majority ads, illustrated in Figure 8, are characterized by words such as *project*, *team*, *product*, *data*, *design,* etc., indicating the focus is more on teamwork, collaboration, coordination, product-related and analytics-oriented roles. In neutral ads, Figure 9, software testing and user-oriented roles are more in focus compared to other two groups of advertisements.

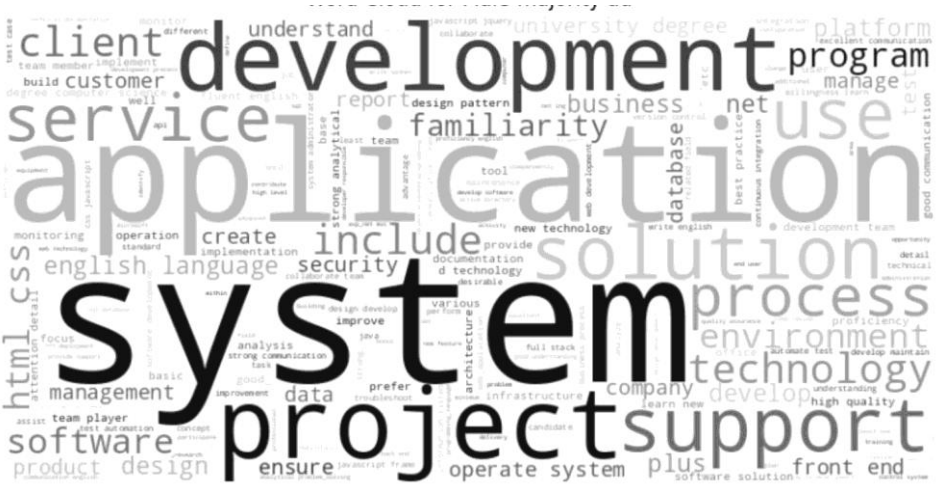


Figure 7 Word cloud of male-majority job advertisements
Source: the authors

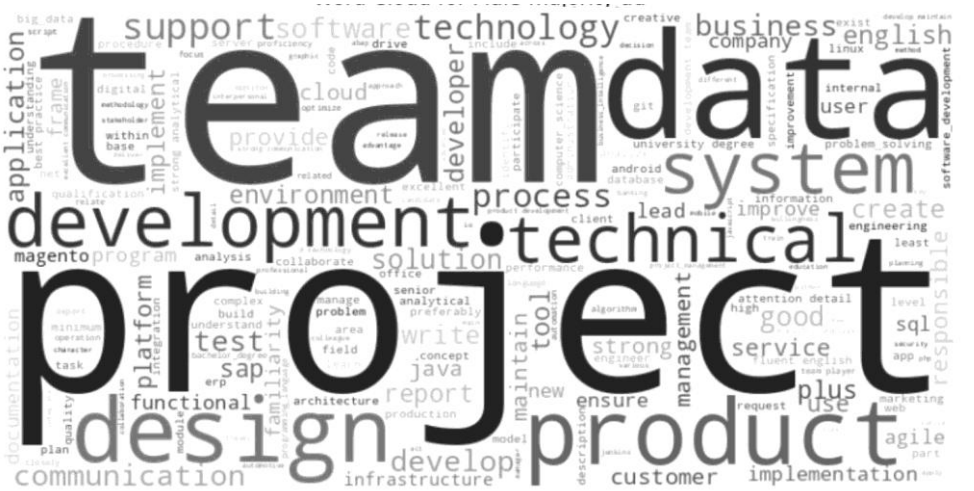


Figure 8 Word cloud of female-majority job advertisements
Source: the authors

Figure 9 Word cloud of neutral job advertisements
Source: the authors

3.2. Distinguished words in gender labelled job advertisements

Keywords that contribute more to advertisement content are derived using the Term Frequency-Inverse Document Frequency (TF-IDF) measure. This is a weighted value that indicates relative importance of a term to a document compared to the relevance it has to all documents in the corpus (Grljević, 2023; Zhou et al., 2024). TF-IDF improves semantic clarity by downweighing commonly occurring words with low distinguishing power while highlighting less frequent terms that carry greater discriminatory significance (Luo et al., 2021). This measure is constituted of two measures Term Frequency (TF) and Inverse Document Frequency (IDF), (Markov & Larose, 2007; Grljević, 2023). TF measures term frequency within a document and is defined as:

$$TF_{t,d} = \begin{cases} 1 + \log\big(count(t,d)\big), & if\ count(t,d) > 0 \\ 0, & else \end{cases} \quad (2)$$

Here, t denotes the term, and d the document. In the research presented in this paper d refers to a single job ad. The logarithmic adjustment mitigates the overemphasis on frequently appearing terms. IDF, emphasizing terms that occur in fewer documents, is computed as:

$$IDF_t = \log\left(\frac{N}{df_t}\right) \quad (3)$$

where N represents the total number of documents in the corpus, and df_t the count of documents

containing term *t*. Terms appearing in fewer documents receive higher IDF values, while universally present terms are assigned the lowest weight (1). Logarithmic scaling smoothens the measure for large corpora.

The significance of a term *t* in a document *d* is determined by combining TF and IDF:

$$TF\text{-}IDF_{(t,d)} = TF_{t,d} \; x \; IDF_t \quad (4)$$

Table 4 illustrates 10 top distinguishing words in job advertisements according to gender categories, based on their TF-IDF scores. Emphasized words indicate unique words that are particularly indicative of respective gender categories. Male majority advertisements are particularly characterized by .NET application and software development. Female majority advertisements are focused on data, product, SAP, and technical background, while neutral advertisements are user-centred.

Table 4 Top distinguishing words in job advertisements according to gender categories

Male-majority	Female-majority	Neutral
test	**data**	team
team	team	test
development	**product**	software
net	development	development
design	project	technology
software	**sap**	develop
project	design	design
technology	test	**developer**
application	**technical**	**customer**
develop	**strong**	**solution**

Source: the authors

3.3. Skills across gender labelled job advertisements

The total number of job postings is imbalanced and skewed toward the male-majority category and using raw skill frequencies as a sole measure could mislead conclusions. The authors applied a normalization procedure to raw skill frequencies to facilitate a comparison of skills prevailing in male-majority and female-majority job advertisements and indicate disparities in skills across gender categories.

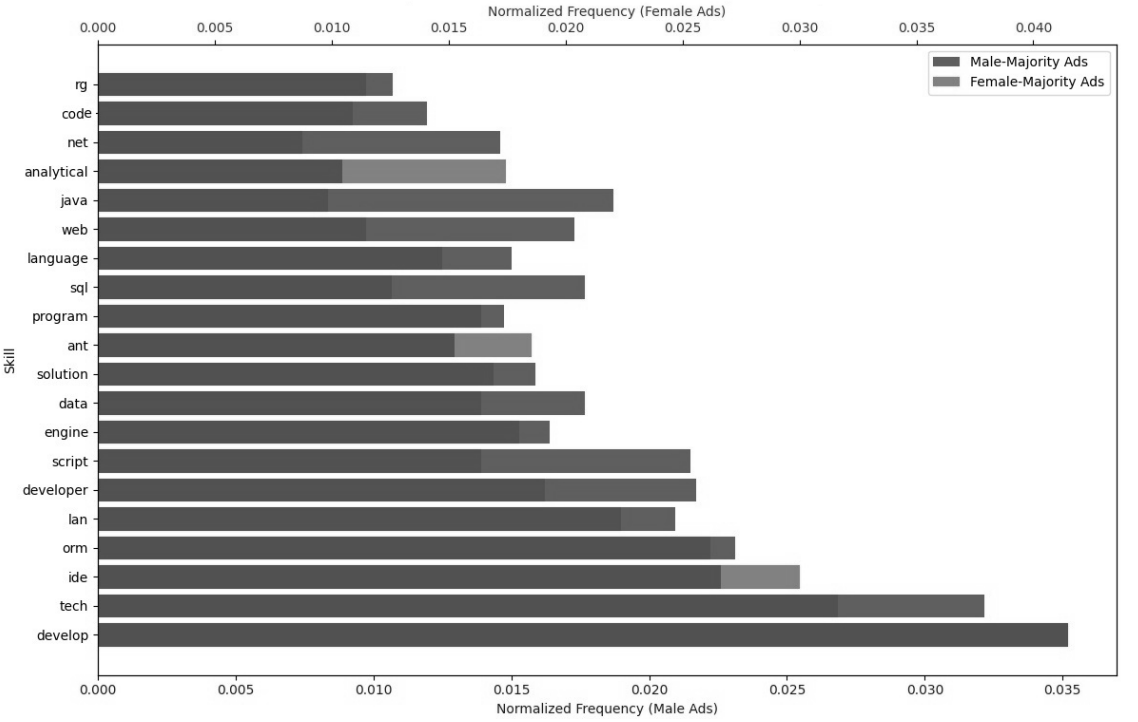
The frequency of each skill within male-majority and female-majority job advertisements was normalized by dividing the raw frequency of each skill by the total frequency of all skills in the respective category. Such a normalization approach transforms absolute skill frequencies into relative proportions, making the relative importance of specific skills within each gender category comparative and not dependent on differences in the total volume of job advertisements. Both hard and soft skills are normalized. The mathematical representation of the normalization process is as follows:

$$Male\_Normalized_i = \frac{Male\_Frequency_i}{\sum_{j=1}^{n} Male\_Frequencies_j} \quad (5)$$

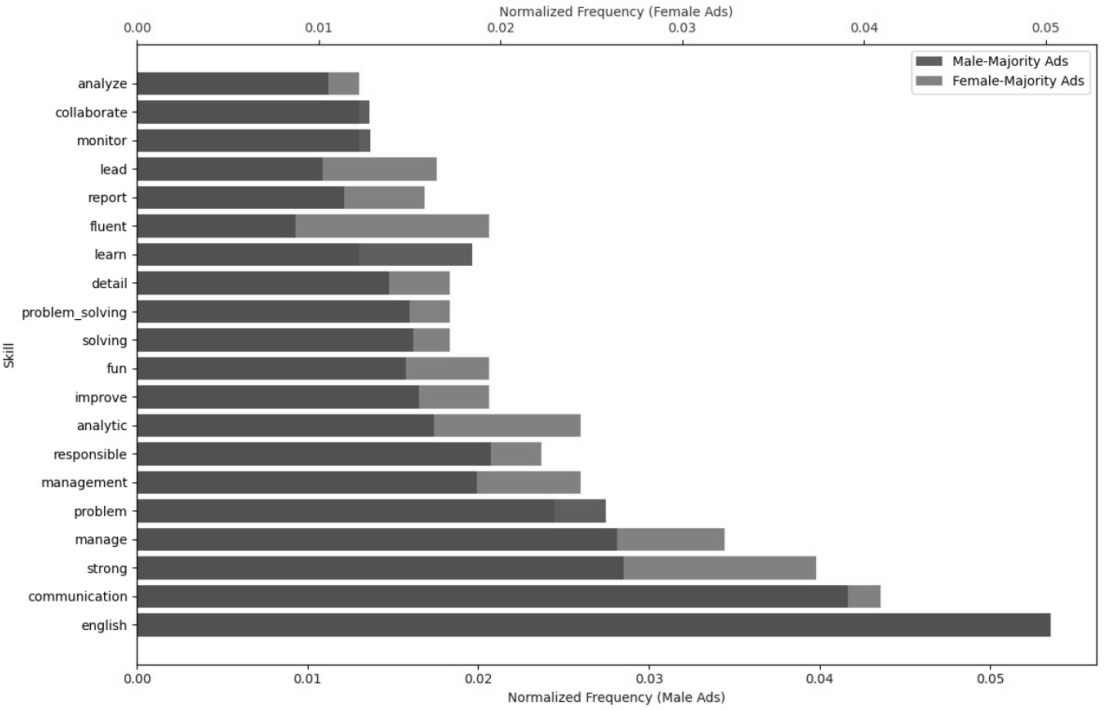
$$Female\_Normalized_i = \frac{Female\_Frequency_i}{\sum_{j=1}^{n} Female\_Frequencies_j} \quad (6)$$

where, $Male\_Normalized_i$ and $Female\_Normalized_i$ represent the proportion of job advertisements within male-majority and female-majority categories, respectively, that mention skill *i*. $Male\_Frequency_i$ and $Female\_Frequency_i$ denote raw frequencies of skill *i* appearing in each gender category. $\sum_{j=1}^{n} Male\_Frequencies_j$ and $\sum_{j=1}^{n} Female\_Frequencies_j$ represent the sum of all skill mentions in each of the gender categories, serving as denominators ensuring proportional scaling within this category. The total number of distinct skills in the dataset is denoted as *n*.

Figure 10 illustrates resulting top 20 hard (10a) and soft skills (10b) across gender categories. Figure 10a indicates higher rates in male-majority postings for hard skills, such as *develop*, *developer*, *tech*, *script*, *java, .net, sql*, that indicate male category is dominated by technological skills. On the contrary, female-majority advertisements put emphasis on *analytical*, *ant*, and IDE, indicating potential differences in how job advertisements for different gender-majority roles are structured. Figure 10b indicates that soft skills are present with higher frequencies in female majority job advertisements, except for skills associated to identification and resolutions of problems, willingness to learn, monitoring, and collaboration, while all other most frequently occurring skills are linked to female-majority advertisements.



a) Hard skills



b) Soft skills

Figure 10 Prevailing skills in male-majority vs. female-majority job advertisements
Source: the authors

3.4. Skill co-occurrence networks

Co-occurrence networks represent text mining technique that analyses joint occurrence of pair of keywords in the documents (van Eck & Waltman, 2014). In the case study keywords are hard or soft skills extracted from job advertisements. The assumption is that keywords which frequently appear together in the same documents have a relationship to one another (Narong & Hallinger, 2023). Co-occurrence network is derived based on the skills frequencies using Pearson correlation coefficients. In this way it is quantified how often skills are mentioned together in job advertisements and facilitated identification of dependencies between skill sets. To extract only strong correlations among skill sets, a threshold is set to 0.75 and identified skill pairs are visualized using Python's implementation of network graph. Nodes represent individual skills, while edges represent co-occurrence relationships indicating which skills are often required together. The following of the section is structured into subsections to separately present hard and soft skills co-occurrence networks. The corresponding network visualizations are provided as supplementary material to the paper (Grljević & Kecojević, 2025).

3.4.1. Hard skills co-occurrence network

Three types of co-occurrence networks are created. The first refers to hard skill co-occurrence network regardless of genders providing an insights about general patterns present in job descriptions (Supplementary material – (Grljević & Kecojević, 2025) – Figure 1). The results suggest presence of five distinct clusters of skills. Authors have associated names according to technical domains clusters represent:

- *Programming and development* is represented with skills, such as Java, JavaScript, jQuery, Python, and MongoDB, which suggest strong co-occurrence in software development and data-related roles.
- *Networking* cluster groups skills, such as ASP.NET, WebSphere, GlassFish. These skills are associated with infrastructure and networking roles.
- *Database and cloud* cluster comprises skills such as PostgreSQL, Unix, and diagnostics that might indicate relevance in cloud computing, system administration, and database management.
- *Software testing and automation* cluster. The co-occurring skills, such as TestLink, Testrail, and Robot Framework, indicate group of ICT roles related to software testing and automated tests.
- *Embedded systems and IoT* cluster links skills such as Autosar, WinCC, and CPU.

We also observe separately hard skill co-occurrence patterns in job advertisements that are male majority (Supplementary material – (Grljević & Kecojević, 2025) – Figure 2) and female majority (Supplementary material – (Grljević & Kecojević, 2025) – Figure 3). Male majority hard skill co-occurrence network is sparser compared to female majority network. This is reflected in fewer connections with many isolated clusters compared to denser co-occurrence network in female majority advertisements indicating multiple hard skills appear in more co-occurring pairs. Advertisements male candidates are more interested in put emphasis on skills with technical and infrastructure focus or software engineering and testing focus. Technical and infrastructure focused skills are reflected in the presence of skills related to programming languages and database (e.g., Java, Python, PostgreSQL, MongoDB), networking and security related skills (e.g., IPsec, HTTPS, TCP, proxy), DevOps and automation skills (e.g., CI/CD, WebLogic, Robot Framework, Docker), or embedded and hardware oriented skills (e.g., microcontrollers, controller, GPS). Software engineering and testing focus is reflected in mentions of related tools, such as TestRail, TestLink, PHPUnit, Cordova. Such co-occurrence network indicates that ICT job postings drawing more attention among male candidates are more specialised in various domains, such as security, embedded systems, DevOps, testing, which formed separate clusters in the co-occurrence network.

High connectivity, observed in hard skill co-occurrence network of female majority job advertisements indicates that certain skills frequently co-occur in job advertisements associated with higher female applicant engagement. This pattern may reflect a broader or versatile skill set expected in these roles. Job advertisements linked to female-majority application profiles appear to span a wide range of subdisciplines, including software development (e.g., JavaScript, AngularJS,

Node.js, GraphQL, frontend development with Bootstrap or React), data and cloud infrastructure (e.g., Azure, Kubernetes, RabbitMQ, Ansible, virtual machines, PostgreSQL, Hive), project management (e.g., product owner, scrum, Bitbucket, Subversion), business analytics (e.g., business analysts, visualisations, regression), as well as security and compliance (e.g., authentication, authorisation, secure configurations).

3.4.2. Soft skills co-occurrence network

The resulting co-occurrence network was extremely sparse when threshold is set at 0.75. This indicates that small number of skills in ICT job advertisements frequently appear together with correlation above 0.75, meaning they tend to be mentioned independently instead in strong pairs. Such sparsity limits the interpretability and usefulness of the network. To obtain a more informative graph with meaningful soft skill clusters, i.e., groups of skills that might be relevant for both job seekers and HR managers, and to achieve improved interpretability of the graph we varied the threshold. A threshold of 0.5 was selected as it provided a balance between including meaningful co-occurrence patterns and maintaining a readable network structure. Using this threshold we observed soft skills co-occurrence network for the overall dataset of job advertisements to gain insights into the general patterns present in job descriptions (Supplementary material – (Grljević & Kecojević, 2025) – Figure 4). The results suggest presence of four distinct groups of soft skills. Authors have attributed names according to prevailing keywords used in job descriptions:

- *Communication and collaboration* are represented with keywords, such as *communicativeness, communicate, discuss, open-minded, trustworthy, teammate,* etc. It represents an important personal threads for ICT roles where effective communication, teamwork, and interpersonal skills often have a crucial role for successful completion of projects, or collaborations across teams or departments.
- *Leadership and organisational skills* are represented with keywords, such as *management*, *training*, *organise, motivate, guide*, etc. They emphasise importance of such skill set in managing projects, teams, and ensuring undisturbed workflow.
- *Problem-solving and analytical thinking* are referred to with keywords such as *problem solving, suggest, anticipate, analytical thinking, estimating*, etc. This set of skills is closely related to critical thinking that is necessary for resolving complex problems and working with data.
- *Adaptability and performance under pressure* are represented with keywords like *stressful, stress, rapid, immediate,* etc. The co-occurring skills indicate that ICT needs professionals who can handle high pressure and adapt to changes.

We also observe separately soft skill co-occurrence patterns in job advertisements that are male majority (Supplementary material – (Grljević & Kecojević, 2025) – Figure 5) and female majority (Supplementary material – (Grljević & Kecojević, 2025) – Figure 6). Similar to hard skills co-occurrence networks, male majority soft skill co-occurrence network is sparser than female, which is reflected in fewer connections. Also we can observe less overlaps in co-occurrence network suggesting well-defined sets of expected competences. The results indicate that job advertisements male candidates are more interested in put emphasis on soft skills linked with autonomy and independence (e.g., *independent*, *autonomous*, *problem solving*, *trustworthiness*), analytical thinking (e.g., *statistics*, *methodical*, *intelligent*, *analytical thinking*), leadership (e.g., *manage*, *teammate*, *guide*, *conscientious*), efficiency and performance (e.g., *consistency*, *monitoring*, *improvement*, *rapid*). Such co-occurrence network indicates that ICT job postings drawing more attention among male candidates are emphasizing problem-solving, leadership, independent decision making which align with technical ICT roles and managing technical teams.

The soft skill co-occurrence network in female majority advertisements reveals a pattern similar to that of hard skills, with a high degree of interconnectivity suggesting a diverse and multi-dimensional skill set. Job advertisements associated with higher female applicant engagement more frequently emphasise competencies such as communication and teamwork (e.g., *communicativeness*, *coach*, *growth*, *community*), management (e.g., *manage*, *milestone*, *willingness*), emotional intelligence (e.g., *zeal*, *care*, *friendly*), critical thinking (e.g., *problem-solving*, *investigate*, *insight*), and adaptability (e.g., *adjustable*, *compatible*).

3. Discussion

Word clouds and distinguishing words across gender categories indicate potential gendered language patterns in job descriptions and skills and responsibilities that may attract different applicant pools, such as the use of engineering-oriented terminology in male dominated job advertisements contrary to collaboration-oriented and product-related terminology in female dominated advertisements. Natural language pre-processing techniques enabled extraction of hard and soft skills from job descriptions. On the basis of these skills, labour market demands were analysed and skills that differentiate applicants' interests by gender are identified. Frequency analysis revealed that soft skills are present with higher frequencies in female majority and hard skills in male majority job advertisements, while co-occurrence networks offered insights into common skill groupings indicating how different hard and soft skills are used in job descriptions. Table 5 comparatively presents key hard skills related findings. Job advertisements male candidates prefer favour specialised skills and are more focused on security, networking, and DevOps. The female majority advertisements are more focused on business tools and agile methodologies. High connectivity in the co-occurrence network suggests that job advertisements associated with higher female applicant engagement tend to describe multidisciplinary roles requiring a broader set of skills.

Table 5 Comparative insights from hard skills analysis

Aspect	Male-majority ads	Female-majority ads
Skill specialisation	Specialised clusters	General clusters
Key fields	Security Embedded systems Databases DevOps	Frontend development Agile Business analysis
Technical focus	Infrastructure-heavy skills System-level skills	Application oriented Business focus

Source: the authors

Table 6 comparatively presents key findings related to soft skills. Job advertisements male candidates prefer are more focused on structured leadership, independent decision making, autonomy in work, and efficiency. The female majority advertisements are more focused on collaborative problem solving, teamwork, high adaptability, mentorship, and emotional intelligence. These differences in prevalent soft skills suggest that job advertisements associated with male-majority applications tend to describe technical or managerial roles, while those linked to female-majority applications more often emphasise customer-centric or HR-related responsibilities.

Table 6 Comparative insights from soft skills analysis

Aspect	Male-majority ads	Female-majority ads
Key skills	Autonomy Independence Structure	Communication Teamwork Emotional intelligence Adaptability
Focus	Efficiency driven Goal-oriented Hierarchical	People-oriented Mentorship driven Collaborative

Source: the authors

Conclusion

Proposed methodology, based on NLP techniques and exploratory text analysis, offers a promising direction in job advertisement analysis. NLP enables a scalable and unbiased way to uncover patterns in job advertisements' language that might otherwise go unnoticed. By analysing linguistic patterns and skill requirements in 3,643 job advertisements in Serbia, the authors found that role descriptions and the gender composition of applicants correlate. Job advertisements more appealing to male candidates are more specialised, putting an emphasis on technical and infrastructure-heavy skills, such as microcontrollers, GPS, robotics. This reflects a higher demand for engineering-oriented roles. According to the results, female candidates are more prone to business-oriented positions, which highlight team collaboration, teamwork, emotional intelligence, and data-related tasks. These roles suggest integration of coordination skills with technical knowledge and more prominent demand for agile methodologies. Differences suggest that even a subtle shifts in framing can influence the future candidate's perception of their fitness for a role.

Resulting insights contribute to broader efforts aimed at creating more equitable and diverse digital labour markets and have a practical implications for human resource managements and recruitment strategies in the ICT sector. They can support diversity-aware recruitment practices, as results align with a growing body of research

recommending inclusive recruitment practices, such as the use of gender-neutral language in job advertisements or software able to detect bias. A more inclusive recruitment strategies could be supported by understanding the influence language used in job descriptions has on application behaviour. Such knowledge enables employees to refine the job descriptions and ensure a more inclusive appeal, particularly for roles where female representation is historically low, thus, contributing to reducing the gender imbalance in ICT. Beyond recruitment, discovered patterns in formulation of job descriptions may guide career planning and professional development efforts, by informing the design of training programmes, mentorship pathways, and curriculum development in ICT education. This could encourage a more balanced development of technical and interpersonal competences across all genders and contribute to a more equitable and resilient ICT workforce.

Although proposed methodology offers valuable insights into gender-related patterns in job advertisements, limitations should be acknowledged. Given the ICT labour market is highly dynamic and technologies are evolving changing the skills in demand, dataset should be regularly updated to ensure the relevance of the findings over time and enable tracking of evolvement of gendered patterns over time. Another limitation stems from the way gender data is obtained, as percentages instead of raw frequencies. This restricts the granularity of the analysis and restricts opportunities for more extensive analyses. Future data collection should aim to include actual counts to enhance precision. Lastly, diversity observed in female-majority category in both soft and hard skills may be due to the limited data availability. This reinforces the importance of strengthening the dataset, ensuring the data representation is of more quality and balancing the representation of each category. This will improve analytical robustness.

As part of our future research, we aim to explore more advanced NLP techniques, including embedding-based and transformer models, alongside methods, such as market-basket analysis and community detection for identification of clusters of skills and enhance the depth and breadth of our analysis. Future research could also include more dimensions, such as educational background of candidates, socio-economic status, location. This will enable improved understanding of how multiple factors shape access to ICT employment opportunities.

Declarations

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Identifying segments of consumers willing to buy an electric car using Choice Based Conjoint method

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Abstract

Background: Whatever product we buy today, we should all take sustainability into account. This applies to everyday consumer goods, the use of environmentally friendly materials, and the field of transportation. A wide range of mobility options is available to meet modern transportation demands, and the steady increase in the number of vehicles used for daily travel has become clear in recent years. The increasing diversification of mobility needs has made car ownership – typically at least one vehicle per household – nearly indispensable. Increased traffic and the ever-increasing number of vehicles are also a threat to our environment. In addition to noise pollution, air pollution has worsened in recent decades largely because of the continuous emission of carbon dioxide from transportation. If all transport vehicles were electrically powered, urban noise and air pollution would be significantly reduced, thereby contributing to sustainability and enhancing the overall liveability of cities. However, the uptake of electric cars remains challenging due to the trade-offs involved, and there is ongoing debate regarding the extent to which they contribute to cleaner transportation.

Purpose: This paper aims to examine consumer segments from the dataset of a previously conducted online survey, based on their attribute preferences related to electric vehicle purchasing decisions.

Study design/methodology/approach: In an online questionnaire survey conducted in February 2023, we collected responses from 206 participants. Their answers enabled us to apply conjoint analysis to determine the characteristics of the ideal electric vehicle. The present study aims to identify which electric vehicle attributes are considered most important in the purchase decision-making process across different consumer groups. To achieve this, we segmented the respondents into well-defined groups, examined their preferences, and estimated the utility values associated with each sub-attribute level.

Findings/conclusions: During the segmentation process, three distinct consumer groups were identified: “City Comforters”, “Long Haul Luxers” and “Eco Hatch Explorers”. Although their preferences vary in relative weight, all three segments prioritize price, driving range, and vehicle design when considering the purchase of an electric vehicle. The analysis also presents the relative importance of attribute levels within each group.

Limitations/future research: The vast majority of respondents to the online questionnaire underlying this study were individuals with a pre-existing interest in automobiles and driving. While this target group provided valuable insights, more robust and generalizable findings could be obtained through a larger and more demographically diverse sample. Additionally, analyzing the demographic background of the identified segments could yield further meaningful insights and is therefore recommended as a promising avenue for future research. A further methodological limitation is that the applied model does not account for noncompensatory decision rules – situations in which a respondent considers one attribute so essential that it overrides all other considerations. In such cases, a respondent will consistently choose the same attribute level regardless of the trade-offs. To better accommodate this type of decision-making behavior, future studies may benefit from applying the Adaptive Choice Based Conjoint method.

Keywords

electric car, consumer behavior, sustainability, segmentation, Choice Based Conjoint

Introduction

As sustainability has evolved beyond a mere buzzword (Gyurácz-Németh et al., 2021), virtually no domain is untouched by it today. According to the Brundtland Report on sustainable development, resources should be utilized in a manner that ensures their availability and usability for future generations (Lele, 2013). Although the need to reframe our patterns of consumption is increasingly recognized (Hofmeister-Tóth et al., 2010), achieving more conscious consumer behavior is difficult in a socio-economic context where continuous growth is not only the norm but often an expectation. At the same time, products that support sustainable lifestyles are gaining prominence (Brewer, 2019), and various industries – some more decisively than others – are being compelled to develop sustainable solutions (Sodiq et al., 2019; Glass & Newig, 2019). These developments collectively enable consumers to pursue more sustainable everyday practices (Brand, 2016). Since transportation is one of the sectors that contributes most significantly to greenhouse gas emissions (Han et al., 2017), the search for alternatives in this area has also become necessary. Consumers express a desire for sustainable products (Wunderman Thompson Intelligence, 2021), a trend that has also emerged in the field of transportation. However, the use of sustainability-promoting products that involve certain compromises appears to be problematic (Verma, 2020), as they may somewhat limit the accustomed, carefree lifestyle (Avram, 2014). A similar situation can be observed in the case of electric vehicles (EVs). When it comes to everyday mobility, electric driving represents a relatively new, yet increasingly prominent topic that garners considerable interest. Our research indicates that over the years, public awareness and opinion regarding the use of EVs have grown steadily, alongside a rising number of both domestic and international studies addressing the subject (Tóth, 2017; Németh & Kovács, 2022; Pónusz & Klinszky, 2024). While many consider EVs a sustainable solution for transportation, others argue that they may, in fact, contribute to environmental harm, raising various concerns about their actual impact (Gelmanova et al., 2018). One frequently cited issue is the questionable recyclability of EV batteries (Blomgren, 2016), and the fact that electricity generation for charging often still relies on fossil fuels such as oil (Ortar & Ryghaug, 2019). Nevertheless, it is indisputable that EVs, lacking internal combustion engines, produce no emissions, thereby eliminating direct air pollutants from urban environments (Martins et al., 2021). The battery systems used in EVs store energy to power electric motors, allowing for noise-free operation (Sendek-Matysiak, 2018) and emission-free driving during use (Sobol & Dyjakon, 2020). While the electric vehicle has emerged in public awareness as a sustainable transportation alternative, consumers are not adopting it at the pace manufacturers had anticipated (Prakhar et al., 2024). Ongoing uncertainty regarding the environmental benefits of electric vehicles continues to hinder consumers from replacing their traditional vehicles (Xue et al., 2024).

1. Electric cars in transition: From technological promise to consumer reality

There are many arguments for and against the use of electric cars. The most important advantage, besides greener transport, is that it is cheaper to maintain, both in terms of maintenance and running costs (Scorrano et al., 2020). A petrol or diesel car, due to its technology, has a lot of rotating and wearing parts that age, wear out and need to be replaced over time (Cotterman et al., 2024). In addition to these parts, there is of course the regular periodic service, which means, for example, changing the engine oil. Since electric vehicles contain significantly fewer rotating and wearing parts (Cotterman et al., 2024) and do not require engine oil at all, their service needs – and associated costs – are considerably lower (Metso et al., 2020), with maintenance expenses potentially reduced by up to 40% (Albatayneh, 2024). Also, cheaper operation is ensured by the number plates available in many countries that distinguish electric cars from conventional cars (Li et al., 2023). While in Germany, for example, an extra "E" character appears on the official registration plate (Ferner, 2024), in Hungary the basic color of the number plate is green (Villanyautosok, 2024). There are differences in which countries offer discounts to e-car drivers (Zhuge et al., 2020). For instance, in Hungary e-car users are exempted from paying registration tax, vehicle tax and property acquisition tax (Katona, 2016). Moreover, although the number of such cities is decreasing, there are still many cities – including the capital, Budapest – where they can park for free in pay

zones (Bukovics, 2021). In addition to public incentives (Breetz & Salon, 2018) and cheaper maintenance costs, electric cars promise a whole new way of travelling for drivers, as they imply a more conscious and enjoyable (comfortable, unique, dynamic) way of travelling compared to conventional cars. However, while there are many advantages to be gained from electric cars, there are also some factors that make the adoption slower. One of these is price (Vilchez et al., 2019). Despite the low maintenance costs, car manufacturers want to recover the development costs of e-cars as quickly as possible, so the purchase price of electric cars is particularly high. Car manufacturers justify the high purchase price with the cost of producing the batteries, but these costs are steadily decreasing (Soulopoulos, 2017), even if this is not reflected in the price tag of the new cars (Larson et al., 2014). For example, looking at Hyundai's Hungarian website, their Kona model would cost approximately EUR 24,000 with a conventional petrol engine, approximately EUR 28,000 with a hybrid system (combustion engine plus electric drive), and approximately EUR 33,300 for a pure electric model in early 2025 (Hyundai, 2025). However, a growing number of electric vehicles are now available on the second-hand market, where more cost-effective options can be found. Another drawback is that even today's most advanced electric cars have a shorter driving range (Albatayneh et al., 2020) and slower charging compared to any conventional petrol or diesel car. We are used to being able to travel 700-800 or even 1000 kilometers on one single fuel tank, while even the most advanced electric cars can only travel 400-500 kilometers on a single electric charge (Philipsen et al., 2018). We have also become accustomed to the fact that it typically takes no more than 10 minutes to fill up a conventional car, while e-cars can only "fill up" a fraction of the total range in that time. In return, however, we can charge our e-car at home during the night, which we cannot do with a conventional car (Baresch & Moser, 2019). Home charging – particularly when sourced from solar panels – is not only emission-free (Adeh et al., 2019), but also incurs no ongoing energy costs, aside from the initial investment in the solar infrastructure. Consequently, electric vehicles charged this way enable virtually cost-free driving on a per-kilometer basis.

Clearly, there are many arguments for and against electric cars. However, it is also worth considering that mass-produced electric technology has only been available to consumers for the last 20 years (Roberts, 2022), and that the most advanced petrol or diesel cars of today were not always so advanced either. Although the range of e-cars is unlikely to increase significantly (Ruffo, 2021), battery charging times are expected to become much faster, as the trend shows, and the development of charging networks to facilitate charging is ongoing. Despite the financial incentives, the above-mentioned drawbacks and counterarguments are slowing down the rapid spread of electric cars. At the same time, the number of e-cars is growing worldwide year by year. In Hungary, for instance, 5 years ago, there were 7,700 electric cars on Hungary's roads at the beginning of 2020, then 22,000 electric cars by the beginning of 2022, with their number already exceeding 70,000 by 2025, with 74,456 pure electric cars on the roads in February 2025 (Szűcs, 2024). As traditional petrol or diesel cars have been in our daily lives for so long, the transition to e-cars is causing complications at all levels, from manufacturers, infrastructure developers to consumers. To achieve zero emissions in transportation, the European Union has set a target to ban the distribution of cars with internal combustion engines from 2035 (European Commission, 2022). This decision will challenge European car manufacturers to adapt their production lines and completely rethink their portfolio in a relatively short time. They will also face difficulties in developing the charging infrastructure for e-cars. As indicated above, charging electric cars can be done at home or at work, but public charging stations are also needed, for example for those who cannot charge their cars at home (Jochem et al., 2022). However, the development of charging infrastructure is a long process, and the number of charging stations does not follow the growth in the number of electric cars (Szabó, 2023). The standardization of charger connectors and the widespread implementation of charging hubs are developments that have yet to be fully realized (Matjaz et al., 2019; Vereckei-Poór, 2023). Finally, the transition to e-cars will bring a big change to the lives of consumers. In a survey of 1,000 people representative of the Hungarian population in 2022, in which attitudinal statements were formulated (Vereckei-Poór & Törőcsik, 2023), 53.0% of consumers agreed that e-cars are beneficial for the environment, while 46.5% also thought that the spread of e-cars will not stop global warming. 48.7% indicated that they were sympathetic to this means of transport and only

26.0% agreed that it would keep the limitless travel within bounds. Although operating an e-car is generally more straightforward than using a conventional car, its shorter driving range – and the associated limited driving range – necessitate a more deliberate and well-planned approach to travel. It is therefore evident that while numerous arguments support electric vehicles (EVs), there are also several counterarguments that contribute to consumers' uncertainty regarding their willingness to purchase EVs. Among the many factors, government incentives (Pamidimukkala et al., 2023), purchase price (Pamidimukkala et al., 2024), infrastructure development (Zhang et al., 2024), technological innovation and related challenges (Dwipayana, 2023) or even demographic factors (Tao et al., 2024) play a crucial role in shaping consumer demand for electric vehicles. Incentives such as tax exemptions, purchase subsidies, and free parking directly influence the perceived value and cost-benefit ratio of EVs from the buyer's perspective. Meanwhile, the availability and accessibility of charging infrastructure affect the convenience of daily usage and long-distance travel, which are often major concerns among prospective EV buyers. Technological advancements – particularly in battery range, charging speed, and smart vehicle functions – also contribute to shaping consumer expectations. These factors do not operate in isolation: they interact with consumer preferences, shaping both the perceived usefulness and ease of use of EVs and therefore align closely with the key constructs of the Technology Acceptance Model. Numerous studies have investigated EV adoption through the lens of the Technology Acceptance Model (TAM) developed by Fred Davis (Davis, 1989). The TAM comprises two core components: perceived usefulness (PU) and perceived ease of use (PEOU), which are key predictors of consumer attitudes and purchase intentions. In the context of EVs, PU reflects the extent to which consumers view the use of the vehicle as beneficial – for instance, due to lower operational costs, environmental benefits, or innovative features – while PEOU encompasses factors such as infrastructure availability, charging convenience, and ease of user interaction. Empirical evidence suggests that both PU and PEOU significantly influence EV purchase intentions. For example, a Malaysian study found that both factors are strongly correlated with EV purchase willingness (Poon et al., 2024). A Chinese study demonstrated that environmental knowledge, PU, PEOU, and perceived risk (PR) all significantly affect purchase intention, where perceived risk has a negative effect, while environmental knowledge positively enhances both PU and PEOU (Jaiswal et al., 2022). Furthermore, a 2024 study conducted in Brazil using structural equation modelling confirmed that infrastructure readiness, PEOU, and Green Utility (i.e., the perception of the technology's environmental benefits) positively influence the intention to adopt EV technology. Interestingly, environmental concern did not show a direct effect on behavioral intention in this sample (Oliveira et al., 2024). Overall, in the EV context, the TAM can be extended by incorporating variables such as PU and PEOU, perceived risk, knowledge level, infrastructure accessibility, and optionally, social and psychological factors (e.g., attitudes and subjective norms), which together offer a more comprehensive explanation of both purchase and acceptance intentions.

2. Research background

The segmentation presented in this study is based on an online survey conducted in February 2023 with 206 respondents. The survey employed the Choice Based Conjoint (CBC) method to identify the characteristics of the ideal electric car as perceived by participants (Vereckei-Poór & Ujházi, 2023). This method was selected due to the relatively limited variety of electric vehicles currently available on the market, especially when compared to the broader range of conventional petrol and diesel vehicles. Conjoint techniques are well suited for product development to create products that meet market needs (Wittink et al., 1994). In CBC analyses, consumers are forced to forego other attributes in order to obtain one attribute in their decision making, and the attributes that are most useful are selected on this basis (Bernáth & Szabó, 2019). Each product can be described in terms of its attributes, which can have multiple attribute levels. Based on these, we create fictitious products, represent them on cards (Malhotra, 2005), and ask respondents to rate them depending on the type of conjoint analysis. The CBC method involves creating hundreds of cards and showing at least 3 but no more than 5 cards to the research subjects and asking them to choose the one that best matches their expectations from the cards they have just seen. From the resulting data, we can calculate the relative importance of attributes, the part-worth utilities of attribute levels, and individual utility values, which can be used as segmentation criteria even with relatively

small sample sizes (Mahajan et al., 1982). While the study provides valuable insights into consumer preferences, it is important to note that the sample used was non-representative and relatively small (n=206), which may limit the generalizability of the findings to the broader population. However, the use of the Choice Based Conjoint (CBC) method in combination with the Latent Class Multinomial Logit (LCMNL) modelling allows for meaningful segment-level preference estimation even with limited sample sizes (Mahajan et al., 1982). The segmentation and insights presented here should therefore be interpreted as indicative and exploratory, offering a basis for future research with more diverse and representative samples.

Our non-representative online survey asked participants to imagine what their ideal electric car would be. Based on the above, we created fictitious electric cars with the following attributes (CBC attribute levels): condition (new or used), design (cabriolet, sedan hatchback, station wagon, sport, minivan, SUV, pickup), range (from 150 km to 950 km), equipment (1: basic, 2: comfort, 3: full extra), price (from €12,500 to more than €125,000) which can be seen in Table 1. The attributes were developed in line with the dilemmas associated with electric vehicle usage, as identified in our earlier research, the findings of which have been previously published (Vereckei-Poór, 2025). To define the attribute levels, we relied on professional automotive websites and the search filters of used car portals. By randomly combining the attribute levels, 300 cards were created, each representing a fictitious electric car. Respondents were presented with 4 cards each time (Figure 1 as an example), from which they had to choose the option they liked best, and if they could not decide, they could indicate that they would not choose any of them. The decision situation was asked to be repeated 12 times, during which the respondents were always presented with new cards and thus a new decision situation. The result of our research is that the most important factor for an imagined electric car purchase is the price, followed by the car's design, its range, then its equipment and condition.

During our research, we identified several studies that segmented consumer groups based on their electric vehicle usage. The objective of these studies is to develop value-based, targeted marketing and business strategies tailored to specific segments. A 2022 study used the RFM model, two-stage clustering, and the Entropy Weight Method to cluster EV owners, thereby identifying various EV user groups, characteristic consumer value categories, and consumer preferences (Hu et al., 2022). In a study from 2024 involving Filipino electric vehicle owners, K-means clustering was applied, with a specific focus on demographic, income, and lifestyle data. The study defined segments that reflect the varying purchasing capacities for electric vehicles across different demographic backgrounds (Uy et al., 2024).

Based on the results of our previous research, we think it is worthwhile to examine the sample of our research conducted in February 2023 to identify which consumer segments could be created among those who would buy an electric car. Once the segments have been defined, we thought it would be interesting to compare these groups, to see which of the attributes identified are considered most important. By defining the segments, we can also find out which factors help or hinder the purchase of a pure electric car. On this basis we can make recommendations to car manufacturers on which attributes they should improve. Our segmentation procedure, the Latent Class Multinomial Logit (LCMNL) model, divides respondents into segments with similar preferences based on which card they chose in each decision situation in the previous CBC questionnaire (Ogawa, 1987; Vriens et al., 1996). It simultaneously estimates the segmental utilities, and the probability of which segment respondents belong to (DeSarbo et al., 1995; Lenk et al., 1996).

Table 1 Product attributes used for CBC analysis and their attribute levels

UTAUT variable	Expected Performance			Hedonistic motivation	Price-value perception
CBC attributes	**Condition**	**Design**	**Range**	**Equipment**	**Price (EUR/€)**
CBC attribute levels	new	cabriolet	150 km	1 – basic	€12,500
	used	sedan	300 km	2 – comfort	€25,000
		hatchback	450 km	3 – full extra	€37,500
		station wagon	600 km		€50,000

CBC attribute levels		sport	950 km		€62,500
		minivan			€75,000
		SUV			€100,000
		pickup			€125,000
					> €125,000

Source: the authors

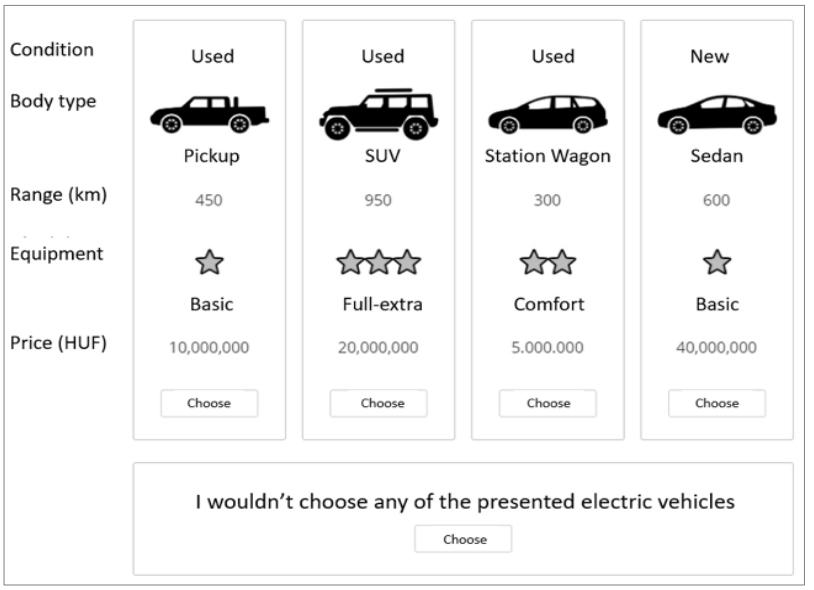

Figure 1 One of the decision scenarios used in the process of data collection
Source: Ujházi & Vereckei-Poór, 2023

2.1. The subject of the research

We reached 206 people with the help of social media to respond to our non-representative online questionnaire in February 2023. We shared the survey in several groups involved in car and/or e-car use, as shown by the relatively high proportion of people in the sample who own a car or e-car. 97% of respondents have a driving license, 87% said they own a car or have a car in their environment that they can use on a daily basis. The vast majority own 1 or 2 cars, 60% of which are petrol, 38% diesel, 27% pure electric and 5% plug-in hybrid. 70% of respondents were male, 29% female and 1% selected the other option. 41% of the sample were aged between 29 and 43, 31% between 44 and 62, 25% between 18 and 28 and 3% between 63 and 77. 59% of the sample live in urban areas, 31% in agglomerations and 9% in other places. 54% of respondents have a university degree of some kind, 19% are still studying. 55% of the sample are in full-time employment, 15% own a business and 14% work in a managerial position.

3. Results

Through LCMNL segmentation, we were able to gain a deeper understanding of our respondents' preferences. After performing the segmentation, we could identify three groups that were significantly different from each other. The first group included 39.7% of respondents, the second 27.8% and the third 32.5%. The segments created are characterized by the relative importance of the attributes (Table 2) and the part-worth utilities of the attribute levels (Table 3).

Looking at the relative importance of the attributes, Table 2 shows that for **Segment 1**, the most important attribute is the purchase price (40.7%), followed by the design (30.13%), then the range of the car on a single charge (16.02%). The level of equipment (7.92%) is less important, and the condition (5.23%) is the least important for **Segment 1**. For **Segment 2**, the purchase price (79.76%) is the most important aspect, with range (8.92%) being only slightly more important than the design (8.04%), and the least important attributes being the equipment level (1.80%) and the condition of the car (1.48%). **Segment 3**, unlike the previous two, did not consider the purchase

price to be the most important attribute, but the car's design (45.89%), followed by the purchase price (21.44%), the range (20.78%) and the equipment level (11.75%). As in the previous segments, the condition of the car was not an important attribute for them either.

Table 2 Relative importance of attributes by group expressed as a percentage

Attributes	Segment 1	Segment 2	Segment 3
Condition	5,23%	1,48%	0,13%
Design	30,13%	8,04%	45,89%
Range	16,02%	8,92%	20,78%
Equipment	7,92%	1,80%	11,75%
Price	40,7%	79,76%	21,44%

Source: the authors

The partial utilities of the attribute levels for the three segments are shown in Table 3. **Segment 1** considers the lowest price range (EUR 12,500) to be the most attractive in terms of purchase price but would be willing to pay up to EUR 50,000 for the car. In terms of design, they would prefer to buy a hatchback, or a sedan, maybe a station wagon or a minivan, but certainly not a cabriolet or a pickup. In terms of range on a single charge, 600 km is the most attractive for them, followed by 950 km, then 450 km, and they would certainly not buy an e-car with a range of 150 km. Those in this segment would buy the highest equipped car in new condition. **Segment 1** would therefore buy a comfortable hatchback with a range of 600 km for EUR 12,500 in new condition. We label this group the "City Comforters".

Those in **Segment 2** also prefer the lowest purchase price but would be willing to pay EUR 100,000 for an e-car but would not pay EUR 125,000 or more. In terms of range, they would prefer the highest (950 km) but would be happy with a range of 450 km as well but would not accept anything below that. The second segment would prefer a sedan e-car, but would buy a station wagon, a pickup truck or even a minivan. They would not choose a cabriolet, sports car or SUV. This segment would also choose the highest equipment level and buy a new car in new condition. **Segment 2** would therefore buy a comfortable, new sedan with a 950 km range for EUR 12,500. We label this group the "Long Haul Luxers".

Segment 3 would mainly buy a hatchback, possibly a station wagon, sedan or minivan. They would prefer a price tag of EUR 12,500 but would be prepared to pay up to EUR 75,000 for a car but are not willing to spend more than that. In terms of range on a single charge, they would also prefer 950 km, followed by 450 km and 600 km. They would not buy a car with a range of 300 km or less. In terms of equipment, they prefer a high level, the condition of the car is not very important to them, and they would be satisfied with a used car. **Segment 3** would therefore prefer a comfortable used hatchback with a 950 km range for EUR 12,500. We label this group the "Eco Hatch Explorers".

In summary, the results show that all three groups prefer the lowest purchase price of EUR 12,500, but while **Segment 1** is the most price-sensitive, **Segment 2** would be willing to pay the most (up to EUR 100,000) for an e-car, and **Segment 3** is also willing to pay a high price. Looking at the design of car, it seems that sedans, station wagons, minivans and hatchbacks are the most popular among the 3 segments, but **Segment 2** would prefer a pickup instead of the latter. In terms of range on a single charge, **Segment 2** and **Segment 3** prefer 950 km, while **Segment 1** prefers 600 km, but all three groups are willing to compromise and would be happy with 450 km. In terms of equipment level, all groups prefer the highest of the three available categories. **Segment 1** and **Segment 2** would buy a new car, while **Segment 3** would prefer a used car.

Table 3 Part-worth utilities by Segments

	Segment 1	Segment 2	Segment 3
Condition			
new	13,07092	3,69778	-0,33326
used	-13,07092	-3,69778	0,33326
Design			
cabriolet	-74,88240	-25,66597	-43,94963
sedan	72,27767	14,51105	35,79475
hatchback	75,78175	1,53372	83,85207
station wagon	42,53039	12,07417	61,26645
sport	-24,81328	-9,90371	-15,05971
minivan	20,33980	3,26067	25,81116
SUV	-38,51162	-1,83136	-2,13305
pickup	-72,72232	6,02143	-145,58204
Range (in km)			
150 km	-51,85170	-24,99902	-60,78264
300 km	-20,86336	-13,49409	-6,29427
450 km	16,76699	7,08851	14,56479
600 km	28,24042	11,79991	9,37804
950 km	27,70764	19,60469	43,13408

Equipment			
1 - basic	-21,95107	-5,32042	-38,06924
2 - comfort	4,31615	1,64094	17,37595
3 full extra	17,63492	3,67948	20,69329
Price (in EUR/€)			
€12,500	95,09932	112,69172	38,74721
€25,000	61,60379	97,97445	22,58130
€37,500	65,93439	90,26022	18,38615
€50,000	6,60670	71,05176	23,41474
€62,500	-16,06729	56,89742	17,11556
€75,000	-40,78351	40,80935	16,18790
€100,000	-4,52590	16,01570	-19,16607
€125,000	-59,45094	-199,56853	-48,79389
> €125,000	-108,41656	-286,13210	-68,47290

Source: the authors

Conclusions

Despite the growing interest in electric vehicles, their widespread adoption remains limited by several factors. One key barrier is the lack of diversity in the current portfolios of EV manufacturers: electric models are not yet available across all vehicle segments and body types. A non-representative online survey conducted in 2023 (n=206), using the Choice Based Conjoint method aimed to identify the characteristics of an ideal electric vehicle from the perspective of Hungarian consumers (Ujházi & Vereckei-Poór, 2023). While the findings provide meaningful insights into consumer preferences, the limited and non-representative nature of the sample restricts the generalizability of the results to the broader population. The present study draws upon this dataset. The primary objective was to determine whether distinct consumer segments could be identified, and to explore their specific preferences. Applying the Latent Class Multinomial Logit (LCMNL) model, we identified three clearly differentiated segments. Based on the relative importance of various vehicle attributes and the partial utilities of specific attribute levels, we labelled the segments as follows: (1) “City Comforters”, (2) “Long Haul Luxers”, (3) “Eco Hatch Explorers”. Although a demographic background analysis could have provided deeper insight into each segment’s characteristics, this was beyond the scope of the current research. Nevertheless, we consider it a promising direction for future investigation. Segment preferences revealed that price, driving range, and design were the most critical factors influencing potential purchase decisions. These three elements also reflect broader structural limitations that hinder mass adoption of EVs. In particular, electric vehicles tend to have significantly higher purchase prices compared to internal combustion engine vehicles, and they are often associated with limited driving range and underdeveloped charging infrastructure, which together create substantial constraints for prospective buyers. While the SUV trend continues to dominate the automotive market, and the electrification of this segment is progressing rapidly, our findings suggest that there is also substantial latent demand for affordable, fully electric sedans, station wagons, and compact city hatchbacks. The decline of these previously popular body styles has made it increasingly difficult for consumers to find suitable EV alternatives within current offerings. Considering these results, we recommend that automotive manufacturers adopt a more consumer-oriented approach to product development. Expanding EV portfolios to include a broader range of affordable and practical models could enhance consumer interest and accelerate the European Union’s transition toward zero-emission mobility by 2035. We encourage industry stakeholders to reconsider investing in vehicle types that were once popular, and according to our findings, remain in demand. Alongside vehicle design, affordability and driving range must remain central areas of improvement. Addressing these dimensions is not only essential to increasing EV marketability but may also promote broader technological acceptance among consumers.

Declarations

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Influence of insurance on entrepreneurship: sector-specific evidence

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Abstract

Background: Numerous authors have researched the impact of insurance on entrepreneurship and focused primarily on different aspects of health and social insurance, and their alternatives to private insurance. This paper investigates the importance of various lines of insurance on entrepreneurial performance.

Purpose: The aim of the research is to analyse how insurance affects entrepreneurship in certain sectors of activity.

Study design/methodology/approach: A linear regression model was applied on data collected through the questionnaire, which consisted of 12 questions embodying the variables included in the regression analysis. The survey was conducted on a sample of 460 entrepreneurs, which provided a confidence interval of 4.5 at a confidence level of 95%. The questionnaire was submitted to entrepreneurs in person, and it was filled in accountancy agencies that provide them accounting services, thus avoiding initial mistrust of entrepreneurs as respondents.

Findings/conclusions: The main findings included the positive impact of premium paid on business results. By using variance analysis, the existence of sectoral differences regarding the impact of entrepreneurship on insurance was also confirmed. It was found that sectoral differences exist not only in the purchase of insurance, but also in the level of realized income, whereby the highest revenues were realized in the activities of information and communication and accommodation, and food service, while the smallest revenues were realized in the manufacturing industry. These results are also crucial for directing the government's economic policies to stimulate entrepreneurship and economic growth.

Limitations/future research: Future research will be directed toward comparisons of results obtained in a developing country, with the sector specific evidence in developed countries.

Keywords

Entrepreneurship, income, insurance, premium, risk

Introduction

The grand opus of theoretical literature points to various aspects of the contribution of insurance on entrepreneurship development (e.g., Rejda, 2005; Skipper & Kwon, 2007; Dorfman, 2008) in the context of making the insurance of entrepreneurial activity safer and more certain. A lot of literature on insurance indicate insurance enables entrepreneurs to take over more business risks and make higher profits. Entrepreneurship includes creativity, innovation and willingness to accept risk. Given that the risk is inherent in entrepreneurial ventures and that

entrepreneurship in Serbia, as a developing country, is burdened with problems of financing, Njegomir (2020) researched how insurance contributes to the advancement of entrepreneurship in terms of risk management and financing.

Some authors researched the link between social security and entrepreneurship (e.g., Holly & Wadhwa, 2013; Hambert et al., 2014). Only Masci (2013) researched the impact of the availability of private insurance on entrepreneurship development. In the research, the author pointed out the interdependence of insurance and entrepreneurship availability, and the relation between social security and entrepreneurship in Brazil and the countries of South America. In developing countries like Serbia, there are various sources of incentives for entrepreneurship and economic development. Research of the impact of insurance on entrepreneurship can contribute to the advancement of entrepreneurship and lay the foundations for further empirical research into the impact of private insurance and entrepreneurship. Njegomir (2015) pointed out the double potential of insurance for the development of entrepreneurship, by two functions of insurance - risk management and institutional investment on financial markets.

The study's significance is that it presents an overview of the impact of insurance on entrepreneurship, including the analysis of the impact of insurance on entrepreneurship by individual sectors of activity. The aim of the study is to enable the systematization of the impact or quantification of certain sectors' elasticities, depending on the impact of insurance.

The remainder of this article is organized as follows. The second section reviews the prior literature. The third section presents the study's theoretical framework, while the fourth section presents the data and methodology applied in the analysis. The fifth section encompasses the presentation of the empirical results and the sixth section discussion. The sixth section concludes.

1. Literature review

Papers that investigate the impact of insurance on entrepreneurship in the literature focus primarily on different aspects of health and social insurance and their alternatives to private insurance.

For example, DeCicca (2010) investigated the link between the availability of health insurance and entrepreneurship. The paper examined the impact of the individual health insurance plan in New Jersey on self-employment. Interestingly, the emergence of this plan had a positive effect on the self-employment of New Jersey citizens. A stronger relationship existed among unmarried, elderly, and individuals with poorer health.

Aggarwal et al. (2013) proved that the lack of health insurance has a significant negative impact on entrepreneurship. Also, they documented the importance of health insurance for self-financed entrepreneurs, who are married, have children who originate from poor socio-economic conditions, and who are older. The research of Fossen et al. (2021) also suggested that lower health insurance costs in the HIX (Health Insurance Exchange) would have the additional effect of stimulating entrepreneurship.

Kwapisz (2020) investigated the decision of self-employed to purchase health insurance, as well as the source of financial information for making such decision. The finding was that self-employed women are less likely than men to be insured, the opposite of what is seen in general population. Also, self-employed women who rely on family and friends as the main source of financial information are significantly less likely to purchase health insurance, an effect that is not true for self-employed men.

The results of research of Wolfe and Patel (2019) pointed out that individuals who have their own health insurance are less likely to exit self-employment. Among them, males, relative to females, are more likely to exit self-employment. Additionally, their results suggested that for older individuals, having one's own health insurance does not have a significant relationship with self-employment exit. Individuals who have own health insurance, for whom health does not limit work, are more likely to exit self-employment relative to those who have health problems.

Similar results were obtained in the study of Leopold et al. (2020) conducted in Vietnam. They pointed out that health insurance has a strong association with self-employment (SE) entry. Those insured under the compulsory membership category are less likely to enter SE, than those insured under the voluntary membership category. Regarding self-employment exit, people with compulsory insurance are more likely to exit self-employment compared with those covered by voluntary insurance.

Knut & Skogstrøm (2014) researched how unemployment insurance, an element of social insurance, affects the labor market and entrepreneurship. Their research indicated that entrepreneurial activities are strengthening with

the reduction or exhaustion of unemployment insurance.

Deloitte (2022) surveyed 5,300 SMEs (defined as companies with 5 to 75 full-time employees) including 400 in Switzerland, to gain deeper insight into their views on insurance and translate them into specific recommendations for insurers. The sample consisted of SMEs from 14 countries. Deloitte disclosed the following findings based on the survey: 1) SMEs increasingly see the value of insurance; 2) SMEs want a trusted advisor and digital engagement; 3) SMEs want advice and a holistic service offering more than just insurance. Unexpected, COVID has strengthened trust in insurers. In total, 99% of Swiss SMEs trust their insurer or intermediary as much or more than before the pandemic. Insurers should use these findings regarding SME segment, as opportunities to grow and provide them additional protection or advisory services.

Chatterjee and Wehrhahn (2017) pointed out that reducing the credit gap and improving access to finance are crucial, especially for MSMEs (micro, small and medium entreprises). Availability of collateral and credit risk assessment considerably contribute to the access to the needed and scarce capital. Improvement of MSME risk management system is very important for getting higher credit rating and positive credit decision by lender. Insurers as risk management experts contribute to assessment of existing risk management systems and better pricing of credit risk. Including insurers as creditors to MSMEs would increase competition and supply of credit, and contribute overcome the credit gap.

Brown et al. (2022) researched access of innovative SMEs to external funds and found that SMEs undertaking pure product and joint product and process innovation have a significantly higher incidence of borrower discouragement than non-innovative SMEs. Additionally, radical and incremental product innovators are more likely to be discouraged relative to non-innovative counterparts. It indicates that innovative SMEs should become visible for insurers as special segment to support them in managing risks that SMEs face.

Moric Milovanovic (2022) researched relation between entrepreneurial orientation (EO) and performances of small firms in an open, small, transitional economy and found that firms should take into account changes in their environment, to invest more in environmental scanning activities, to set up risk controls, to focus on limited number of opportunities, in order to allocate their limited resources with the highest possible performances and returns. Providing insurance coverage could be one of the risk taking strategies, especially important for small firms and entrepreneurs that are considerably exposed to business and environmental risks.

Hambert et al. (2014) researched the impact of the reform in France that led to the reduction of unemployment insurance for individuals starting a business venture. The research results indicated that the reform had contributed to the improvement of the entrepreneurs' productivity, and created relatively smaller companies in relation to those created before the reform.

Unlike the above-mentioned research, this research focused on the analysis of the influence of private insurance on entrepreneurship development, as well as on the impact of insurance on entrepreneurship in certain sectors of activity.

In previous research, total revenue was used as an entrepreneurship measure (Foley & Green, 1989; Perren, 2000; Amit et al., 2000). Giannetti & Simonov (2004) explored how social norms, economic environment, and individual characteristics influence entrepreneurs' income, while Swindall (2010) explored how personal characteristics, availability of resources, and economic structure influence the income of entrepreneurs.

Typical explanatory variables that describe the income of entrepreneurs include education, activity structure, gender, marital status, age, mortgage, health insurance, type of activity, urbanization, unemployment, business environment, immigration, social protection, available labor and capital, level of income per capita, wealth tax per capita, unemployment rate, competition, specialization, public employment rate, degree of aversion, or risk tolerance, level of self-confidence and other variables (Verheul et al., 2003; Giannetti & Simonov, 2004; Arenius & Minniti, 2005; Freytag & Thurik, 2007; Swindall, 2010; Wennekers et al., 2010). In some studies that consider entrepreneurship as a dependent variable over the measure of total income, the usual effect of age (younger), gender (male), marital status (married), education (higher education), the number of employees (higher number), the amount of gross domestic product measured by different measures (higher gross domestic product) have a positive impact on entrepreneurial income.

As independent variables whose influence on entrepreneurship is determined, this paper uses the

type of activity, the level of education of entrepreneurs, the gender of entrepreneurs, the age of entrepreneurs, the number of employees, purchase of insurance, the types of insurance, and total premium according to the amount of total revenues per entrepreneur.

The question about the affiliation of entrepreneurs to different sectors of activity was taken in order to determine the existence of differences in the impact of the protection function against the risk that insurance performs by activities. Henriquez et al. (2002) indicated that in France and in general, the largest entrepreneurial presence was realized in service activities. The diversity of insurance impacts depending on the sector was examined by analysing variance. Also, the answers about the affiliation of entrepreneurs to certain types of activities were used in the regression analysis to obtain a response to differences in activity in the amount of annual business revenues per entrepreneur.

The level of education is usually observed in the context of population education and the impact on entrepreneurship (Web, Grace & Skipper, 2002; Davidsson & Honig, 2003; Aidis, Estrin & Mickiewicz, 2012). Warneryd et al. (1987), using data for Sweden, found that better-educated individuals are more likely to start an entrepreneurial venture, while Johansson (2000) came to the contrary data in Finland, where less educated individuals are more prone to start a business venture. Lazear (2005) indicated that individuals who completed diversified master studies of business administration have a greater probability of engaging in entrepreneurship.

Numerous studies analysed gender differences in the creation of entrepreneurial ventures and performances. In most studies, it was confirmed that men are more likely to become entrepreneurs than women (Reynolds et al., 2002; Verheul et al., 2006; Aidis, Estrin & Mickiewicz, 2012; Kelley et al., 2015). The most important results were obtained by examining gender differences in entrepreneurship performance, primarily on revenue and profitability. Watson (2002) provided an overview of various studies that have explored gender differences in the context of the impact on entrepreneurship profitability. Coleman (2007) suggested that human capital, including their education and experience, has a positive impact on profitability among women entrepreneurs, while the availability of capital has a greater impact on male entrepreneurs' profitability.

Most studies indicate that younger people, or people under 35, are most likely to become entrepreneurs (Levesque & Minniti, 2006; Aidis, Estrin & Mickiewicz, 2012). Evans & Leighton (1989) found empirically that individuals are more inclined to enter into entrepreneurial ventures before the age of 40, while after 40, they are less willing to start entrepreneurial activities. Even though young entrepreneurs have higher education and lack sufficient entrepreneurial training compared to the elderly, they could not build enough wealth due to the global financial crisis (Kauffman Foundation, 2015) and have fewer personal business relationships (Robinson & Stubberud, 2014). The largest number of studies confirm the thesis that entrepreneurs between the age of 35 and 55 are the most successful (Brüderl & Preisendörfer, 2000; Henley, 2005; Alam, Jani, & Omar, 2011). Starting from the previous studies' results, we expected middle-age entrepreneurs to earn the highest income in our research.

The type of insurance variable was established to test the relationship between the entrepreneurs' income and the types of insurance they use. The basic starting point was that insurance affects the increase in entrepreneurs' income, and therefore the assumption that each type of insurance, except life insurance, affects the increase of income. Three types of insurance were offered in questionnaire: property insurance, liability insurance, and life insurance. Entrepreneurs usually provide life insurance for their own needs. This option was given to determine if there is a relation between purchasing life insurance and income level. It was expected that the impact of life insurance on income per entrepreneur is neutral, or the purchase of life insurance would not have an impact on the income of entrepreneurs, since this type of insurance is deductible cost (Verdon, 2010), but not improving the business. Property and liability insurance is in the business's function, and their acquisition provides potential benefits if the harmful event covered by the insurance occurs. There are no previous studies of non-life insurance's impact, except for the health insurance impacts mentioned in the opening statement. According to the authors' knowledge, only Masci (2013) analysed the impact of private insurance in general on entrepreneurship, but not individually, the impact of the property, liability, and life insurance. The expected effect of property and liability insurance on incomes per entrepreneur is positive, and the expected effect of the life insurance is neutral.

The research's key explanatory variable was the amount of the total insurance premium by income per entrepreneur. By survey research, the amount of insurance premium per entrepreneur was compared with the amount of total revenues per entrepreneur, in order to determine the interdependence by regression analysis.

Research on the number of employees in entrepreneurial firms included research on wages (Bengtsson & Hand, 2013), the position of the union (Batt & Welbourne, 2002), and productivity (Garmaise, 2008). Creating new jobs is one of the three key impacts of entrepreneurship, with the other two being economic growth and poverty reduction (Ahmad & Hoffman, 2007; Haltiwanger, Jarmin & Miranda, 2013; OECD, 2014; Fairlie & Miranda, 2016). Bearing in mind that the number of employees directly affects the performance of entrepreneurship, the number of employees was also taken as the measure of the performance of entrepreneurs (Ahmad & Hoffman, 2007). Based on the above, positive impact of number of employees to the success of entrepreneurs was expected.

Entrepreneurship has been historically linked to risk (Cramer et al., 2002). Knight (1921) and Marshall (1961) pointed out the importance of the ability to handle uncertainty, identifying, and carrying risks. Numerous studies have empirically confirmed that successful entrepreneurs have a lower risk aversion (Kihlstrom & Laffont, 1979; Cramer et al., 2002; Memill et al., 2010) or loss (Koudstaal, Sloof & van Praag, 2015) relative to the rest of the population. Entrepreneurial attitudes about the business risk as an approximation of risk perception were used. Using previous studies' results, it was expected that the identified higher risk in business implies no correlation with the entrepreneur's annual operating income.

In the survey research, the individual risks presented to entrepreneurs as the most important were: price, credit, operational, risks of claim collection, fire risks, floods, earthquakes, and others that can be transferred into insurance and the risks of interruption of work, also insurable risks. By introducing a framework for the regulation of solvency of banks - Basel III (2011), as well as with the application of the European Union Directive regulating solvency issues of insurance companies - Solvency II (2009) not only in banking and insurance, but in all other sectors, the importance of holistic risk management and therefore recognizing the risks that were not previously covered, have been emphasized.

For further analysis, the most significant were the risks of fire, floods, earthquakes, and others that can be transferred into insurance. In particular, the risks of work termination to determine the extent to which these risks are identified were added. It was expected that those entrepreneurs who choose the most important insurance risks, or the risks of fire, floods, earthquakes, and others that can be transferred into insurance, will more often choose insurance as a form of risk management. The total insurance premium will be higher in relation to entrepreneurs who choose other types of risk as the most important.

2. Research methodology

The questionnaire consists of 12 questions embodying the variables included in the regression analysis. The authors have created the questionnaire (attached in the Appendix 1) to gather the data on company level. The research presents a 'snapshot' at a certain moment and hence no macro variables were included due to their constant value for each respondent. The survey was conducted in the period from June 1, 2019, until September 10, 2019, and data are related to 2019. The survey was conducted on a sample of 460 entrepreneurs, which provides a confidence interval of 4.5 at a confidence level of 95%. The entrepreneurs come from northern Serbian province of Vojvodina. The questionnaire was submitted to entrepreneurs in person, and it was filled in in accountancy agencies that provide them accounting services, thus avoiding initial mistrust of entrepreneurs as respondents. Thanks to trust in the agencies, anonymity of the questionnaire, precision, and clarity, the percentage of answers received is extremely high and exceeds 90%.

In the design of the questionnaire, two open questions were included regarding the size of the realized annual incomes of the participating entrepreneurs and the size of the total insurance premium for all types of insurance. These two open questions were necessary, as only in this way could the annual income of the entrepreneurs be ascertained. Furthermore, data on the amount of the insurance premium per entrepreneur or on the annual income of the entrepreneur could only be obtained by survey research.

The set of explanatory variables was limited by the availability of data collected through the survey. Variables used in the regression are both numerical and categorical, i.e., qualitative in nature. The problem with qualitative variables is

that they cannot be directly included in the regression equation. In general, a categorical variable with a k level must be transformed into a k-1 binary variable to avoid linear dependency among the variables. Binary variables can be entered directly into the model. The level of the category that is omitted becomes the "reference variable", and all others in the same category are compared with it. In this case, the regression model's estimated coefficients that stand with the binary variables are interpreted as the difference (positive or negative) of the influence on the dependent variable relative to the influence that has the reference variable.

A linear regression model which includes m continuous explanation variables and n categorical variables is given by:

$$y_h = \alpha x_0 + \sum_{k=1}^{m} \beta_k x_{kh} + \sum_{k=1}^{n} \sum_{d=1}^{D_k} \gamma_{dk} x_{kdh} + \varepsilon_h, \qquad h = 1, 2, \ldots N \quad (1)$$

where the y_h is the dependent variable, the variable intersection with y-axis x0 is identically equal to 1, continuous explanatory variables x_{kh}, k = 1, ..., m, and the set of indicator variables x_{kd}, d = 1, ..., D_k defines a categorical variable x_k with D_k level, where k = 1, ..., n.

The parameters α,β_k, γ_{dk} are the regression coefficients evaluated by the analysis. The presented model is the so-called main effect model that does not contain interaction effects among the variables. Since the assumption of iid is unrealistic, feasible generalized least square (FGLS) approach was applied instead of OLS method, which is widely used to correct for heteroscedasticity as well as autocorrelation (Powers, D), and it is suitable when the dependent variable is continuous.

3. Results and discussion

The first hypothesis tested by the variance analysis was the hypothesis of equal premiums for all entrepreneurs. The following hypothesis were tested:

H0: Insurance premiums are the same for all entrepreneurs, regardless of which risks are indicated as the most important ones.

The application of the software package in the application of the variance analysis is presented in Tables 1 and 2.

Table 1 Descriptive statistics for the variance analysis of the premium size depending on the most important risks

Groups	Count	Sum	Average	Variance
Other risks	305	1.56E+08	510023	4,54E+11
Insurable risks	155	1.09E+08	702477	8,33E+11

Source: the authors' calculations

Table 2 The variance analysis of the premium size depending on the most important risks

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	3.81E+12	1	3.81E+12	6.541	0.011	3.862
Within Groups	2.67E+14	458	5.82E+11			
Total	2.70E+14	459				

Source: Eviews 7; the authors' calculations

Using the variance analysis on the data collected by survey research, the results were obtained, which reject the hypothesis (F = 6,541 > Fcrit) on equal insurance premiums for all entrepreneurs. This rejection of the hypothesis means that premium insurance varies depending on whether entrepreneurs chose insurance risks or the risks of fire, flood, earthquakes, and others that can be transferred to insurance or other risks.

The second tested hypothesis was:

H0: More formal education has a beneficial effect on the purchase of insurance.

The results of the variance analysis are shown in Table 3 and Table 4.

Table 3 Descriptive statistics for the variance analysis of insurance purchase depending on the level of formal education

Groups	Count	Sum	Average	Variance
Faculty	137	96745000	706168	6.81E+11
Secondary school	308	1.58E+08	512162	5.45E+11
Primary school	15	9950000	663333	4.87E+11

Source: the authors' calculations

Table 4 The variance analysis in the purchase of insurance depending on the level of formal education

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	3.69E+12	2	1.85E+12	3.163	0.043	3.0154
Within Groups	2.67E+14	457	5.83E+11			
Total	2.70E+14	459				

Source: the authors' calculations

By applying the variance analysis, we get $\alpha = 0.05$. It was necessary to test the least significant differences and determine which level of formal education most favorably affects the purchase of insurance. Tukey's test confirms a significant difference in the amount of premiums between highly educated entrepreneurs and entrepreneurs who have secondary education. Entrepreneurs with a university degree, on average, pay higher insurance premiums.

Finally, the existence of sectoral differences in the amount of insurance premiums was tested using variance analysis. The following hypothesis was set up:

H0: There are sectoral differences in the amount of insurance premiums.

The software package application results in the application of the variance analysis are shown in Tables 5 and 6.

Table 5 The variance analysis in the purchase of insurance depending on the level of formal education

Sectors	Count	Sum	Average	Variance
a	85	27931000	328600	1.45E+11
b	77	84488000	1097247	1.07E+12
c	43	32018000	744605	7.32E+11
d	42	24124000	574381	3.43E+11
e	72	58348000	810389	8.50E+11
f	5	7000000	1400000	8.95E+11
h	5	1570000	314000	4.13E+09
j	69	11535000	167174	5.22E+10
k	61	16937000	277656	2.08E+11

Source: the authors' calculations

Table 6 The variance analysis of the premium amount depending on the sector of activity

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	5.20E+13	8	6.50E+12	13.399	1.95E-17	1.959
Within Groups	2.18E+14	450	4.85E+11			
Total	2.70E+14	458				

Source: the authors' calculations

There are significant differences in the average premium depending on the sectors to which the enterprises belong. T-test, Tukey test, and LSD (least significant differences) lead to the formation of three professional clusters:

The first cluster: The highest average insurance premiums were collected in the agriculture, forestry, and fisheries sectors and the accommodation and food service sector.

The second cluster: Insurance premiums that are among the largest and the smallest have been collected in the manufacturing and construction sectors and in the sector of transport and storage.

The third cluster: The smallest average insurance premiums were collected in the wholesale and retail sector, repair of motor vehicles and motorcycles, the real estate sector, sector of professional, scientific, innovative, and technical activities, and other service activities.

Next, the regression analysis results or estimated the equation parameters were analyzed (1). The explanations of the variables are shown in Table 7, and the results of the regression analysis are shown in Table 8.

Table 8 shows the regression analysis results obtained by using the software statistical data processing package Eviews 7. The dependent variable in the regression analysis, which is being considered, is the entrepreneur's total income realized in the previous year (in the logarithmic form).

Table 7 Explanation of variable labels for regression analysis

Label	Explanation
C***	Independent variable. The realized annual income in dinars in the previous year per entrepreneur.
A11*	Property insurance (answer to the question about the type of insurance)
A3**	Wholesale and retail trade; repair of motor vehicles and motorcycles (answer to the question about the type of activity)
A4	Faculty (answer to the question about completed formal education)
A9	Insurance (the answer to the question of which forms of risk management are used)
AB11**	Property and liability insurance (answer to the question about the type of insurance)
AB9	Insurance and prevention (the answer to the question of which forms of risk management are used)
ABC11***	Property, liability, and life insurance (answer to the question about the type of insurance)
ABD9	Insurance, prevention, and reduction (answer to the question of which forms of risk management are used)
AC11**	Property and life insurance (answer to the question about the type of insurance)
AD9	Insurance and risk retention (answer to the question about the type of insurance)
B11**	Liability insurance (answer to the question about the type of insurance)
B3	Agriculture, forestry, and fisheries (answer to the question about the type of activity)
B4	Secondary school (answer to the question on completed formal education)
B6*	36-55 (age of entrepreneur)
B9**	Prevention (answer to the question of which forms of risk management are used)
C11	Life insurance (answer to the question about the type of insurance)
C3***	Manufacturing (response to the question about the type of activity)
C6	over 55 (the age of the entrepreneur)
D3*	Construction (answer to the question about the type of activity)
D9	Risk reduction (answer to the question of which forms of risk management are used)
E3	Transport and storage (response to the question about the type of activity)
EMPLOYEE***	Number of employees
F3*	Accommodation and food services (answer to the question about the type of activity)
G3*	Information and communication (answer to the question about the type of activity)
H3	Real estate (answer to the question about the type of business)
J3**	Administrative and support service activities (answer to the question about the type of activity)
POL***	Gender
TOTPREM***	Total insurance premium

Source: the authors' abbreviations for regression analysis

Table 8 Results of regression analysis

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C***	15.061	0.207	72.809	0.000
A11*	0.,314	0.186	1.687	0.092
A3**	-0.179	0.086	-2.082	0.038
A4	-0.007	0.147	-0.047	0.962
A9	-0.144	0.209	-0.685	0.493
AB11**	0.389	0.193	2.019	0.044
AB9	-0.191	0.220	-0.863	0.388
ABC11***	0.367	0.148	2.482	0.006
ABD9	0.292	0.273	1.068	0.286
AC11**	0.369	0.198	1.858	0.063
AD9	0.075	0.217	0.343	0.731
B11**	0.485	0.218	2.218	0.027
B3	-0.105	0.093	-1.124	0.262
B4	0.013	0.142	0.090	0.928
B6*	-0.152	0.085	-1.784	0.075
B9**	-0.345	0.145	-2.368	0.018
C11	0.344	0.216	1,589	0.112
C3***	-0.299	0.107	-2,777	0.005
C6	0.041	0.104	0,395	0.692
D3*	-0.204	0.107	-1.890	0.059
D9	-0.154	0.132	-1.165	0.244
E3	-0.078	0.100	-0.780	0.435
EMPLOYEE***	0.103	0.008	12.669	0.000
F3*	0.429	0.242	1.771	0.077
G3*	0.899	0.485	1.851	0.064
H3	-0.090	0.263	-0.348	0.733
J3**	-0.179	0.094	-1.897	0.058
POL***	0.257	0.070	3.663	0.000
TOTPREM***	4.07E-07	4.28E-08	9.499	0.000
R-squared	0.754	Mean dependent var		15.879
Adjusted R-squared	0.738	S.D. dependent var		0.926
S.E. of regression	0.474	Akaike info criterion		1.406
Sum squared resid	96.884	Schwarz criterion		1.666
Log likelihood	-294.438	Hannan-Quinn criteria.		1.508
F-statistic	47.203	Durbin-Watson stat		1.898
Prob(F-statistic)	0.000			

Note: ***, **, * indicate the significance of coefficient at levels of 1%, 5% and 10% respectively.
Source: the authors' calculations
Dependent variable: LOG(TOTREV) - total revenues
Method: Least Squares
Sample: 1460
Included observations: 460

First, sectoral differences were pointed out. The sectoral impact is a categorical variable, and the sector k (other service activities) was taken for the base size. Coefficients of the variables B3, E3, and H3 (binary variables that indicate affiliation, or non-affiliation to the sectors B, E, and H,

respectively, or to the following sectors: agriculture, forestry and fisheries (B), transport and storage (E) and real estate (H)) are not significantly different from zero, which implies that the average total income in each of these sectors is at the level of income in the sector of other service activities.

The coefficient of the variable A3 (-0.1794) is statistically significantly different from zero and shows that average revenue in sector A is 83.58% (e-0.1794) of revenue in the sector K, or average income in sector A, wholesale and retail trade; repair of motor vehicles and motorcycles is about 16.5% lower than in the sector of other service activities (K), ceteris paribus.

The situation in sector C (manufacturing) is even more unfavorable. The C3-variable coefficient has a value of -0.299, which represents a lower average income compared to the sector of other service activities (K), almost 26%.

The situation in sector D (construction) is unfavorable given that the coefficient with the variable D3 (-0.2038) represents a lower average income compared to the sector of other service activities (K) by about 18.5%.

For the variable E3, the coefficient is negative (-0.0785). This coefficient explains that there is a notable lower income in the sector of transport and storage activities, or sector E, compared to the sector of the service activities (K) by about 7.5%.

In the accommodation and food service sector, the situation is favorable given the positive coefficient of the variable F3 (0.4292). In the accommodation and food service sector, higher income was recorded by 53.6% in relation to the service sector (K).

In sector G, the information and communication sector, the situation is the most favorable since the coefficient of the variable G3 is 0.8992. This coefficient shows that the revenue is higher by 145.7% in the information and communication sector compared to the service sector (K). This result, however, has to be taken cautiously given that only one entrepreneur from the information and communication sector participated in the questionnaire, which is not a representative indicator.

In sector J, the sector of professional, scientific, innovation, and technical activities, a lower income of about 16.5% was achieved in relation to the service sector (K).

3.1. The impact of formal education

The basic variable is the elementary education of the entrepreneur. Coefficients of the variables that measure the additional impact of middle and high levels of formal education are not statistically different from zero, and it was concluded that on the observed sample of entrepreneurs, the level of their formal education does not affect the total annual income or that the annual income of entrepreneurs does not increase with the increase in years of formal education. The result is the highest share of entrepreneurs with secondary education in the structure of entrepreneurs, and the data indicate that for success in entrepreneurship, there are no differences in the level of education. Most of the literature deals with the impact of education on entrepreneurship in terms of willingness to engage with entrepreneurial activities and in those cases there is a positive impact of educational level towards entrepreneurship (Aladejebi, 2018; Hessels et al 2020).

3.2. Gender structure

The auxiliary explanatory variable POL is a binary variable with a value of 0 if it is a female entrepreneur and 1 if the entrepreneur is a man. The coefficient for this variable is significantly different from zero. The coefficient with POL is positive (0.2568), indicating that male entrepreneurs on average earn higher incomes than female entrepreneurs by 29.28%. This means that male entrepreneurs have better conditions for the business in relation to female entrepreneurs. This result is in line with the multitude of research which proves that female entrepreneurs earn less and have more fear of failure in starting a business (Hung & Tuan, 2020; Khalife & Chalouhi, 2013).

3.3. Age structure

Young entrepreneurs (18-35 years) are taken as the base variable. The values of the auxiliary variable B6 (middle-age entrepreneurs) and C6 (older entrepreneurs) indicate that older entrepreneurs earn on average the same income as the young (C6 is not significantly different from 0), while middle-aged entrepreneurs, on average, earn less than young entrepreneurs by 14%. This is due to the fact that young entrepreneurs have a greater initiative, as well as the fact of the differences in association with certain activities, and these differences are expressed in the amount of an annual income of young, old, and middle age entrepreneurs. This is in line with Zhao et al (2021), who also performed a meta analysis on age and entrepreneurial success and concluded that it exhibit signs of a U-shaped relationship.

3.4. Insurance purchase

The impact of different risk management methods (insurance, prevention, risk retention, risk reduction on total income) in relation to the annual income of entrepreneurs who do not use any of these methods is not significant. Entrepreneurs who use only insurance (alone or in combination with risk prevention or reduction) receive on average the same amount of annual income as entrepreneurs who do not use any of these methods. Coefficients of the variables A9 (insurance), AB9 (insurance and prevention), ABD9 (insurance, prevention, and risk reduction), AD9 (insurance and risk reduction), and D9 (risk reduction) are not significantly different from zero. The entrepreneurs who control risk by prevention are an exception; they have an average income of less than 29% compared to the control group. The obtained results related to prevention do not have a direct connection with theoretical bases. When it comes to other forms of risk management, the obtained results do not interpret the difference between their use or non-use.

3.5. Types of insurance

In relation to entrepreneurs who do not use any insurance (base variable), entrepreneurs who are insured on average earn higher incomes. Let us suppose that entrepreneurs only use property insurance, property and liability insurance, property insurance, liability and life insurance, property and life insurance, or only liability insurance. In that case, they earn more income by 37%, 47.6%, 44.3%, 44.7%, and 62.4%, respectively, in relation to entrepreneurs that are not insured.

The purchase of only life insurance does not affect the increase in income in relation to non-insured entrepreneurs. These relations confirm the positive influence of insurance on entrepreneurship, or the hypothesis that the primary insurance function of protection against the harmful consequences is to promote the development of entrepreneurship, making entrepreneurial activities safer and more certain.

3.6. Total premium

The TOTPREM variable's coefficient that describes the total premium per entrepreneur is positive and significantly different from 0 (α <0.01). The coefficient's value indicates that when 100,000 monetary units increase the total premium, the total revenue is increased by about 4%. As the amount of insurance premium per entrepreneur represents an approximation for the protection function that insurance provides, the relation confirms the positive impact of insurance on entrepreneurship, or the hypothesis that the primary function of protection against the harmful consequences that insurance provides improves the development of entrepreneurship, making entrepreneurial activities safer and more certain.

Finally, **the number of employees** in entrepreneurial firms has a significant positive impact on total income. Each additional employee increases income on average by 10.8%, ceteris paribus.

The survey research was conducted in order to supplement the research on the interdependence of insurance and entrepreneurship that was applied on secondary data. The most important result is the confirmation of the interdependence of insurance and entrepreneurship. The premium amount per entrepreneur has a positive impact on business income. The value of the coefficient of the variable of the total premium per entrepreneur indicates that when the total premium is increased by 100,000 units, the total revenue is increased by 4%. The obtained result is in accordance with the expected theoretical assumptions and previous empirical studies (Masci, 2013). It was also confirmed the existence of sectoral differences in the impact of entrepreneurship on insurance. By analysing the variance, the existence of sectoral differences in the average premium per entrepreneur was established, whereby the largest insurance premiums were allocated in the agriculture, forestry and fisheries, and accommodation and food services, and the least in wholesale and retail trade; repair of motor vehicles and motorcycles, real estate, administrative and auxiliary service activities, and other service activities.

Besides the key results in the analysis of the results of the research, additional results were obtained. It was found that sectoral differences exist not only in the purchase of insurance but also in the level of realized income. The largest revenues were achieved in information and communication activities and accommodation, and food services, while the smallest revenues were achieved in the manufacturing industry.

Regarding the age structure, the results of the survey indicated that older entrepreneurs, over 55, earn, on average, the same as young people, up to 35, while middle-aged entrepreneurs earn, on average, 14% less. The obtained results were incompatible with previous research in the field,

which indicates that middle-aged entrepreneurs are among the most successful (Brüderl & Preisendörfer, 2000; Henley, 2005; Alam, Jani, & Omar, 2011). These results are explained by the fact that young entrepreneurs are more innovative, with fresh ideas, using advanced technologies. Quicker accepting changes, participate in entrepreneurial activities that are most propulsive, and are most often assisted by parents and their business and friendship relationships. In contrast, older entrepreneurs are well governed by business issues, have a business reputation, do business more carefully, and successfully use their business contacts.

Based on risk theory and risk management, it was anticipated that all entrepreneurs who have chosen any or more risk management approaches would receive higher returns than those who do not apply a single measure. However, the results denied the expectations. The results empirically confirmed that the choice of any risk management measure does not affect the realization of higher revenues, or the revenues of those entrepreneurs are not higher than revenues of entrepreneurs who have not chosen a single risk management measure. The entrepreneurs who have chosen risk prevention are an exception, which means that they have an average income of 29% less than entrepreneurs who did not apply a single risk management measure. This result is interpreted with the specificity of the economic environment, economic activities, and a relatively small volume of business activities in order to have the risk management impact absolutely evident.

In the regression model, the impact of insurance types that entrepreneurs use on annual operating incomes was examined. The obtained results were in accordance with the expectations given that entrepreneurs who have purchased property insurance and liability insurance, in combination with life insurance, earned higher incomes than entrepreneurs who did not have any insurance. The acquisition of life insurance alone had a neutral impact in relation to non-insured entrepreneurs. The obtained results were interpreted as the interconnection of property insurance and liability insurance with the business of entrepreneurs, while life insurance was associated with an entrepreneur, but not with his business.

The impact of the number of employees on the annual operating income of entrepreneurs was also examined and it was found that the number of employees in entrepreneurial companies has a significant positive impact on total income. Each additional employee increases income on average by 10.8%. The obtained result is in accordance with previous empirical studies (Ahmad & Hoffman, 2007; Haltiwanger, Jarmin & Miranda, 2013; OECD, 2014; Fairlie & Miranda, 2017).

Conclusion

The positive impact of insurance on entrepreneurship is confirmed. The amount of premium per entrepreneur has a positive impact on operating income. The value of the coefficient with the variable of the total premium per entrepreneur indicates that when 100,000 units increase the total premium, the total revenue is increased by about 4%. The above confirms the hypothesis that the primary function of protection against the harmful consequences of insurance is to promote the development of entrepreneurship, making entrepreneurial activities safer and more certain. The obtained result is in line with the expected theoretical assumptions and previous empirical studies of Masci (2013). The variance analysis of the existence of sectoral differences in the impact of entrepreneurship on insurance is confirmed. The sectoral differences exist not only in the purchase of insurance, but also in the level of realized income, whereby the highest revenues were realized in the activity of information and communication, and accommodation and food services, while the smallest revenues were realized in the manufacturing industry. The level of entrepreneurs' formal education does not affect the entrepreneur's total income, but influences purchase of insurance coverage. Unlike similar research in the world, middle-aged entrepreneurs in Serbia earn on average by 14% less, compared to younger and older entrepreneurs. Higher risk perception identified by the entrepreneur, has a positive impact on entrepreneurial income, but does not have an impact on the purchase of insurance. Entrepreneurs who have chosen the risks of fire, flood, earthquake and other risks that can be transferred into insurance, as well as those who have a positive attitude towards insurance, and those who consider insurance as the investment, and not the cost, pay a higher amount of insurance premium.

The obtained results are relevant for entrepreneurs since the theoretical premise has been confirmed that they can achieve higher income with higher insurance premiums. These results are also important for steering the government's economic policies in order to stimulate entrepreneurship, and thus economic

growth. In addition, they represent the basis for conducting future research in developed countries and comparisons with the results obtained in a developing country.

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> Ljubojević, T.K. (1998). Ljubojević, T.K. (2000a). Ljubojević, T.K. (2000b). Ljubojević, T.K., & Dimitrijević, N.N. (1994).

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> Author, A. A., Author, B. B., & Author, C. C. (Year). Title of article. *Title of Periodical, volume number* (issue number), pages.

➲ **Journal article, one author, paginated by issue.**

Journals paginated by issue begin with page 1 in every issue, so that the issue number is indicated in parentheses after the
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> Seliverstova, Y. (2021). Workforce diversity management: A systematic literature review. *Strategic Management*, *26*(2), 3–11. https://doi.org/10.5937/StraMan2102003S

➲ **Journal article, one author, paginated by volume.**

Journals paginated by volume begin with page 1 in issue 1, and continue page numbering in issue 2 where issue 1 ended, e.g.

> Perić, O. (2006). Bridging the gap: Complex adaptive knowledge management. *Strategic Management, 14*, 654–668.

➲ **Journal article, two authors, paginated by issue.**

Dakić, S., & Mijić, K. (2020). Regression analysis of the impact of internal factors on return on assets: A case of meat processing enterprises in Serbia. *Strategic Management*, *25*(1), 29–34. https://doi.org/10.5937/StraMan2001029D

➲ **Journal article, two authors, paginated by volume.**

Ljubojević, K., & Dimitrijević, M. (2007). Choosing your CRM strategy. *Strategic Management, 15*, 333-349.

➲ **Journal article, three to six authors, paginated by issue.**

Marić, S., Uzelac, O., & Strugar-Jelača, M. (2019). Ownership structure as a measure of corporate performance. *Strategic Management*, *24*(4), 28–37. https://doi.org/10.5937/StraMan1904028M

➲ **Journal article, three to six authors, paginated by volume.**

Boškov, T., Ljubojević, K., & Tanasijević, V. (2005). A new approach to CRM. *Strategic Management, 13*, 300-310.

➲ **Journal article, more than six authors, paginated by issue.**

Ljubojević, K., Dimitrijević, M., Mirković, D., Tanasijević, V., Perić, O., Jovanov, N., et al. (2005). Putting the user at the center of software testing activity. *Management Information Systems, 3*(1), 99-106.

➲ **Journal article, more than six authors, paginated by volume.**

Strakić, F., Mirković, D., Boškov, T., Ljubojević, K., Tanasijević, V., Dimitrijević, M., et al. (2003). Metadata in data warehouse. *Strategic Management, 11*, 122-132.

➲ **Magazine article.**

Strakić, F. (2005, October 15). Remembering users with cookies. *IT Review*, *130*, 20-21.

➲ **Newsletter article with author.**

Dimitrijević, M. (2009, September). MySql server, writing library files. *Computing News, 57,* 10-12.

➲ **Newsletter article without author.**

VBScript with active server pages. (2009, September). *Computing News,57,* 21-22.

B. BOOKS, BROCHURES, BOOK CHAPTERS, ENCYCLOPEDIA ENTRIES, AND BOOK REVIEWS

Basic format for books

Author, A. A. (Year of publication). *Title of work: Capital letter also for subtitle*. Publisher.

➲ **Book, one author.**

Ljubojević, K. (2005). *Prototyping the interface design*. Faculty of Economics in Subotica.

➲ **Book, one author, new edition**

Dimitrijević, M. (2007). *Customer relationship management* (6th ed.). Faculty of Economics in Subotica.

➲ **Book, two authors.**

Ljubojević, K., Dimitrijević, M. (2007). *The enterprise knowledge portal and its architecture*. Faculty of Economics in Subotica.

➲ **Book, three to six authors.**

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➲ **Book, more than six authors.**

Mirković, D., Tanasijević, V., Perić, O., Jovanov, N., Boškov, T., Strakić, F., et al. (2007). *Supply chain management*. Faculty of Economics in Subotica.

➲ **Book, no author or editor.**

Web user interface (10th ed.). (2003). Faculty of Economics.

➲ **Group, corporate, or government author.**

Statistical office of the Republic of Serbia. (1978). *Statistical abstract of the Republic of Serbia.* Ministry of community and social services.

➲ **Edited book.**

Dimitrijević, M., & Tanasijević, V. (Eds.). (2004). *Data warehouse architecture*. Faculty of Economics.

➲ **Chapter in an edited book.**

Repa, V. (2019). Deriving Key Performance Indicators from Business Process Model. In M. Pańkowska & K. Sandkuhl (Eds.), *Perspectives in Business Informatics Research. BIR 2019. Lecture Notes in Business Information Processing, vol 365.* (pp. 148–162). Springer. https://doi.org/10.1007/978-3-030-31143-8_11

➲ **Encyclopedia entry.**

Mirković, D. (2006). History and the world of mathematicians. In *The new mathematics encyclopedia* (Vol. 56, pp. 23-45). Faculty of Economics.

C. UNPUBLISHED WORKS

➲ **Paper presented at a meeting or a conference.**

Ljubojević, K., Tanasijević, V., Dimitrijević, M. (2003). *Designing a web form without tables*. Paper presented at the annual meeting of the Serbian computer alliance, Beograd.

➲ **Paper or manuscript.**

Boškov, T., Strakić, F., Ljubojević, K., Dimitrijević, M., & Perić, O. (2007. May). *First steps in visual basic for applications*. Unpublished paper, Faculty of Economics Subotica, Subotica.

➲ **Doctoral dissertation.**

Strakić, F. (2000). *Managing network services: Managing DNS servers*. Unpublished doctoral dissertation, Faculty of Economics Subotica.

➲ **Master's thesis.**

Dimitrijević, M. (2003). *Structural modeling: Class and object diagrams.* Unpublished master's thesis, Faculty of Economics Subotica.

D. ELECTRONIC MEDIA

The same guidelines apply for online articles as for printed articles. All the information that the online host makes available must be listed, including an issue number in parentheses:

Author, A. A., & Author, B. B. (Publication date). Title of article. *Title of Online Periodical, volume number* (issue number if available). https://www.anyaddress.com/full/url/

➲ **Article in an internet-only journal**

Tanasijević, V. (2003, March). Putting the user at the center of software testing activity. *Strategic Management*, *8* (4). https://www.ef.uns.ac.rs/sm2024

➲ **Document from an organization**

Faculty of Economics. (2008, March 5). *A new approach to CRM*. https://www.ef.uns.ac.rs/papers/acrm.html

➲ **Article from an online periodical with DOI assigned.**

Jovanov, N., & Boškov, T. A PHP project test-driven end to end. *Management Information Systems*, 2 (2), 45-54. https://doi.org/10.5937/StraMan213302003S

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If a work is directly quoted from, then the author, year of publication and the page reference (preceded by "p.") must be included. The quotation is introduced with an introductory phrase including the author's last name followed by publication date in parentheses.

According to Mirković (2001, p. 201), "The use of data warehouses may be limited, especially if they contain confidential data".

Mirković (2001, p. 201), found that "the use of data warehouses may be limited". What unexpected impact does this have on the range of availability?

If the author is not named in the introductory phrase, the author's last name, publication year, and the page number in parentheses must be placed at the end of the quotation, e.g.

He stated, "The use of data warehouses may be limited," but he did not fully explain the possible impact (Mirković, 2001, p. 201).

➲ **Summary or paraphrase**

According to Mirković (1991, p. 201), limitations on the use of databases can be external and software-based, or temporary and even discretion-based.

Limitations on the use of databases can be external and software-based, or temporary and even discretion-based (Mirković, 1991, p. 201).

➲ **One author**

Boškov (2005) compared the access range…

In an early study of access range (Boškov, 2005), it was found...

➲ When there are **two authors**, both names are always cited:

Another study (Mirković & Boškov, 2006) concluded that…

➲ If there are **three or more authors** the abbreviation "et al." (Latin for "and others") is employed in APA in-text citations when referencing works with three or more authors. The format is to include only the first author's last name, followed by "et al.," a comma, and the year of publication. For instance, (Dakic et al., 2024) would be used as an example.

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If the work does not have an author, the source is cited by its title in the introductory phrase, or the first 1-2 words are placed in the parentheses. Book and report titles must be italicized or underlined, while titles of articles and chapters are placed in quotation marks:

A similar survey was conducted on a number of organizations employing database managers (Limiting database access, 2005).

If work (such as a newspaper editorial) has no author, the first few words of the title are cited, followed by the year: (The Objectives of Access Delegation, 2007)

Note: In the rare cases when the word "Anonymous" is used for the author, it is treated as the author's name (Anonymous, 2008). The name Anonymous must then be used as the author in the reference list.

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According to the Statistical Office of the Republic of Serbia (1978), …

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The overview is limited to towns with 10,000 inhabitants and up (Statistical Office of the Republic of Serbia [SORS], 1978).

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(Bezjak, 1999; Griffith, 2004)

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Survey results published in Theissen (2004a) show that…

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Bergson's research (as cited in Mirković & Boškov, 2006)…

Here, Mirković & Boškov (2006) will appear in the reference list, while Bergson will not.

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(Britten, 2001; Sturlasson, 2002; Wasserwandt, 1997)

➲ When there is **no publication date**: (Hessenberg, n.d.)

➲ **Page numbers must always be given for quotations**:

(Mirković & Boškov, 2006, p.12)

Mirković & Boškov (2006, p. 12) propose the approach by which "the initial viewpoint…

➲ **Referring to a specific part of a work**:

(Theissen, 2004a, chap. 3) (Keaton, 1997, pp. 85-94)

➲ **Personal communications, including interviews, letters, memos, e-mails, and telephone conversations**, are cited as below. (These are *not* included in the reference list.)

(K. Ljubojević, personal communication, May 5, 2008).

FOOTNOTES AND ENDNOTES

A few footnotes may be necessary when elaborating on an issue raised in the text, adding something that is in indirect connection, or providing supplementary technical information. Footnotes and endnotes are numbered with superscript Arabic numerals at the end of the sentence, like this.1 Endnotes begin on a separate page, after the end of the text. However, *Strategic Management* **does not recommend the use of footnotes or endnotes.**

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