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Path to a Knowledge Society -
Managing Risks and Innovation

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Factors Affecting Adoption of Artificial Intelligence in SMEs and its Impact on Firm's Skills Needs

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Abstract—The paper deals with the problem of artificial intelligence (AI) adoption in companies. It aims to empirically examine factors affecting the adoption of AI. It also identifies factors influencing the potential effects of AI adoption on future infirm skills needs. There is currently an absence of research focused on examining this topic based on empirical data. The research is based on the secondary data from Flash Eurobarometer 537 (2023). More than 19,000 companies from 27 EU countries and 9 non-EU countries have been included in the sample. By examining these data, substantial systematic differences were found between companies with different characteristics. Factors affecting AI adoption and consequences on skills needed have been identified by logistic regression. The results suggest that larger companies with older employees located in cities, as well as those hiring adequate skills without any problems, are often adopting AI. Similar characteristics are also typical for companies that reported a significant effect of AI on their skill needs. However, in this case, the effect of community size and difficulties with hiring skills are not significant. Significant differences were also identified among industries and types of specific skills that a company lacks.

Keywords – artificial intelligence, shortage of skills, factors of AI adoption, skills needs, companies.

I. INTRODUCTION

Artificial intelligence (AI) is one of the very few technologies that have generated as much interest from professional and in the public. Despite the number of research papers focused

on AI is growing there are still many specific areas where research is insufficiently covered. One of them is the issue of companies deciding on the introduction of AI and the subsequent consequences on the skills of the company. This paper aims to cover this gap based on empirical micro-level data. Its main goal is to identify factors affecting the adoption of AI and identify its anticipated effect on the skills needed. The results may help to better understand the decision-making process for AI introduction, provide evidence on factors affecting their choices, and predict its potential consequences for skills. The following three main research questions have been examined in the paper:

RQ1: What factors and firm characteristics are positively correlated with the choice to adopt AI in the company?

RQ2: What factors and firm characteristics are positively correlated with the expected significant effect of AI on skill needs (positive or negative)?

RQ3: Are there any significant differences between both sets of factors?

Our findings attempt to cover the research gap in this field. As far as we are aware, there is no other study focused on examining a similar set of factors for AI adoption based on such extensive micro-level data. Most of the research examining micro-levels deals with the attitudes of individuals, such as, for example, customer perceptions of digitalization [1] or correlations with personal traits [2]. On the other hand,



studies investigating firms' characteristics and factors are mostly based on much smaller samples (such as [3]) or focused on more general problems such as Industry 4.0 (such as [4]).

The following section briefly summarizes the results of previous research focused on similar research problems. However, there are currently only a limited number of studies dealing with the factors affecting AI adoption at companies. The next section describes the methodology and data used in the analysis. Key results are summarized in the fourth section. The final section contains an explanation of the main conclusions resulting from the results.

II. LITERATURE REVIEW

Adoption of artificial intelligence (AI) in company changes its business operations by optimizing existing processes. It enhances automation while interacting with humans [5]. Successful adoption of AI can increase a company's total turnover [6], improve the efficiency and accuracy of logistics [7], improve the safety and security of suppliers [8] and support economic growth [9]. Businesses can take advantage of AI adoption, regardless of their size. While large companies usually employ AI in robotics and resource management, SMEs mostly use it to improve the knowledge management and quality control [10].

The decision on AI adoption is affected by many factors, which we will further examine in more detail. However, the difference between the expected benefits and the costs associated with the adoption is an important criterion. The adoption of any new technology in firm can be theoretically explained by the Innovation diffusion theory [11]. Our research is also based on this theoretical approach, while the focus is on factors affecting AI adoption and role of skills needs.

A. Factors Affecting AI Adoption in Companies

There are many internal and external factors that could influence the willingness and actual decision to adopt AI in the company. Organizational factors such as digital skills, company size, and R&D intensity appear to have the most significant effect on the adoption of AI [3]. Some studies argue that larger companies are more likely to implement AI tools [10,12]. On the contrary, [4] found that firm size does not matter for Industry 4.0 and especially for the adoption of digital technologies. Our paper is

trying to resolve this inconsistency and carefully examine this problem with a larger sample of companies. It is likely that SMEs could struggle with AI adoption due to a lack of sufficient data as well as problems with financial and human resources [13]. The smaller size of the company can be partly compensated by its membership in an industry cluster or any other similar business organization. Membership in the industry cluster provides a conducive environment that supports digitalization [14] and business transformation towards Industry 4.0 [15]. Our analysis takes into account the size of the company as well as its potential membership in an industry cluster or similar organization.

The financial situation of the company is also considered an important factor affecting AI adoption. Especially, the ability to generate significant turnover and profit are both positively related to the adoption of digital technologies [4,16]. Moreover, the growth in total turnover is positively associated with process and product innovation in companies [17].

Besides companies' internal factors, there are certain external factors that are also playing an important role. Country-specific factors such as regulations, labor market specifics, quality of institutions, and cultural differences are affecting the adoption of digital technology or innovation [18,19]. The geographical location of the company in a city or rural area seems to also be important. Considerable heterogeneity among SMEs with respect to the adoption of advanced digital technologies have been found based on their location. [20]. Rural and small-town SMEs are less frequently adopting digital technology in general. In line with these findings, we considered the size of the community where the company is located as an independent variable in regressions.

B. AI Adoption and Skill Needs

Despite several positive effects of AI adoption, there are also some crucial problems resulting from this rather major change. It can mostly lead to significant shifts in the workforce composition [9] and a rising need for highly qualified workers [21]. The usage of digital technologies requires trained professionals who have the competencies and skills to thrive in the new digital environment [22]. Adoption of AI in the company will likely lead to increased demand for soft skills such as critical thinking, problem-solving, communication skills, and creativity

[23,24]. AI can replace some technical skills but increases the need for soft skills in firms [23].

The effect of AI on skill needs after its adoption seems to be more evident. However, the availability of certain skills is also considered a prerequisite for the adoption of digital technology. Several previous studies found that human capital and skills are essential for the adoption of digital technologies [4]. Adoption of new digital technologies such as AI requires employees with specific digital skills [25,26]. Technical skills such as software development, IT design, and complex data analysis, along with the involvement of some soft skills (such as intercultural collaboration or customer handling), are essential for the ability to introduce digitally integrated solutions and technologies [3,27]. Shortages of such skills in the company represent a significant challenge for the process of digital technology adoption.

A firm’s absorptive capacity, which is often proxied by R&D intensity, is considered one of the key determinants for the implementation of new technology [28]. This indicator shows how effectively a company can adopt and use new technology to gain certain benefits. The shortage of R&D skills can therefore represent a barrier to the adoption of AI. Firms with this problem may therefore be less likely to use AI. However, these hypotheses need to be further empirically tested.

It is evident that the relationship between skill needs, and adoption of AI is debatable and needs further empirical investigation based on larger samples of firms. Our paper covers this research gap and examines how shortages of

different types of skills could affect AI adoption. Furthermore, the paper is also focused on examining factors affecting expectations related to the effect of AI on the skills needed.

III. METHODOLOGY AND DATA

The main aim of the paper is to identify factors affecting the adoption of AI in SMEs. Secondly, we also examine companies’ characteristics and potential, affecting their expectations about the effect of AI adoption on future skills needed in their company. Factors affecting both mentioned problems have been compared. This comparison allows us to provide a better discussion and state the implications of our results. The analysis is based on secondary data collected by Flash Eurobarometer Survey No. 537. A questionnaire survey was conducted in Iceland, Norway, Switzerland, the United Kingdom, North Macedonia, Turkey, the United States, Canada, Japan, and all 27 EU countries between September 11 and October 13, 2023. More than 19,000 respondents’ companies were interviewed. More information about the sample can be found in [29]. Fieldwork related to the questionnaire survey has been conducted by Ipsos European Public Affairs. Representative probability sampling methods have been used to select respondent firms- of businesses. The sample data was weighed to marginal population distributions, in terms of company size and NACE sector. We focused our attention on two main questions related to the usage of AI in the company and the expected effects of AI on future skills and needs in the company. These questions

TABLE I. DESCRIPTION OF DEPENDENT VARIABLES INCLUDED IN THE REGRESSIONS.

Name	Question	Coding
Use/Plan AI (using AI or have concrete plans to do so)	Which of the following statements best describes the deployment of Artificial Intelligence Technologies (AI) in your company over the next 5 years? 1. You use AI, or you have concrete plans to do so, and you expect a significant impact on your company's skill needs. 2. You use AI, or you have concrete plans to do so, but you do not expect a significant impact on your company's skill needs.	Use AI, or have concrete plans to do so (answers 1 and 2) coded as 1; Otherwise = 0
AI impacts skills (Expect impact of AI on skills)	3. You have no concrete plans to use AI, but in case you would use it, you expect a significant impact on your company's skill needs. 4. You have no concrete plans to use AI and you expect no significant impact of AI on your company's skill needs.	Expect a significant impact of AI on your company's skill needs (answers 1 and 3) coded as 1; Otherwise = 0

Source: Authors based on the data from Flash Eurobarometer 537 (2023).

were used as dependent variables in logistic regression. They are described in Table I.

Both dependent variables are binary variables created based on the answers of respondent companies. Descriptive statistics of the variables capturing the answers on the main question are shown in Table II.

More than 56% of companies in the sample reported that they have no concrete plans to use AI, and they also do not expect a significant impact of AI on a company's skill needs. More than 11% are either already using AI or at least have concrete plans to do so soon and expect a significant impact on company's skill needs. On the other hand, approximately 9.4% of the sample is using AI or plans to use it and does not expect an effect on skill needs. Hence, the subsample of those firms using AI or planning to use AI is divided into two almost equally represented groups concerning their expectations towards the effect of AI on skills needed. We will further examine factors affecting their attitudes, represented by independent variables shown in in Table III. They have been chosen based on the theoretical background and expected potential effects. The choice was also limited by data availability. Hence, only the variables capturing the questions in the questionnaire can be used in

TABLE II. DESCRIPTION OF INDEPENDENT VARIABLES INCLUDED IN THE REGRESSIONS.

Variables/Answers	Proportion/ Std. Error	95% Conf. Interval
Use AI, or have concrete plans to do so, and expect a significant impact on company's skill needs	0.1121/ 0.0023	0.108-0.117
Use AI, or have concrete plans to do so, and do not expect a significant impact on company's skill needs	0.0935/ 0.0022	0.089-0.098
You have no concrete plans to use AI, but in case you would use it, you expect a significant impact on your company's skill needs	0.1681/ 0.0028	0.163-0.174
You have no concrete plans to use AI and you expect no significant impact of AI on your company's skill needs	0.5648/ 0.0037	0.558-0.572
Dont know/No answer (excluded in regressions)	0.0615/ 0.0018	0.058-0.065

Source: Authors based on the data from Flash Eurobarometer 537 (2023).

TABLE III. DESCRIPTION OF INDEPENDENT VARIABLES INCLUDED IN THE REGRESSIONS.

Name	Question	Coding
Employees	What is the size of your company in terms of number of employees?	1 to 4 employees = 1; 5 to 9= 2; 10 to 49= 3; 50 to 249 = 4; 250 to 499 = 5; 500 or more = 6
Employees' age	What is the average age of your employees?	Under 20 years = 1; 20-29 = 2; 30-39 = 3; 40-49 = 4; 50 or above = 5
Increased annual turnover	Over the past 2years, has your company's annual turnover increased/decreased/ remained unchanged?	Increased = 1; Decreased/remain unchanged = 0
Community size	Which of the following best describes the area where your company is located	A rural area = 1; less than 20000 inhabitants = 2; 20000-100000 inhabitants = 3; 100000-500000 inhabitants = 4; Over 500000 = 5
Industry cluster	Are you a member of an industry cluster or another SME business support organisation?	Yes = 1; No = 0
Difficult to hire skills	Over the past 24 months, how difficult was it for your company to find and hire staff with the right skills?	Very difficult = 4; Slightly difficult = 3 Not difficult at all = 2; Not relevant. We did not need to hire anyone in the past 24 months = 1
IT shortage	Does your company face skill shortage for any of these job roles? ...	Yes = 1 (IT experts skill shortage) No = 0
Administrative shortage		Yes = 1; No = 0
HR shortage		Yes = 1; No = 0
Technician shortage		Yes = 1; No = 0
Customer care shortage		Yes = 1; No = 0
R&D shortage		Yes = 1; No = 0
Marketing shortage		Yes = 1; No = 0
Other shortage	Yes = 1 (Other job roles skill shortage); No = 0	
Industry (dummy)	What is the main activity of your company?	11 dummy variables created based on NACE categories.

Source: Authors based on the data from Flash Eurobarometer 537 (2023).

the regression. The company's size was represented by the number of employees in intervals, coded from 1 to 6. Variables such as employees' average age, recent changes in turnover, type of industry, community size, and membership in the industry cluster have also been used. Moreover, we introduced independent variables capturing the skills shortage for a specific type of job (IT, administrative jobs, HR, technician, customer care, R&D, marketing).

Specific types of skills that are missing in the company can potentially affect the decision on AI adoption. Some skills are more likely to be substituted by AI, while others are less replaceable. The overall difficulty of hiring adequate skills can also affect AI adoption. On one hand, companies with lower skill availability in the labor market could consider introducing AI more often. On the other hand, the adoption of AI itself also requires highly skilled employees.

The effects of factors represented by independent variables on both binary dependent variables have been identified by logistic regression. We used robust standard errors to avoid problems with heteroscedasticity. Standard errors are also clustered by countries to reduce potential problems with sampling design while interpreting the results. This method is widely used in economic and social research. However, there are certain limitations to our approach. Despite our best efforts to identify casual relationships, we are not able to rule out potential endogeneity problems. Hence, most of the relationships found in the regression can be interpreted more as correlations than causation.

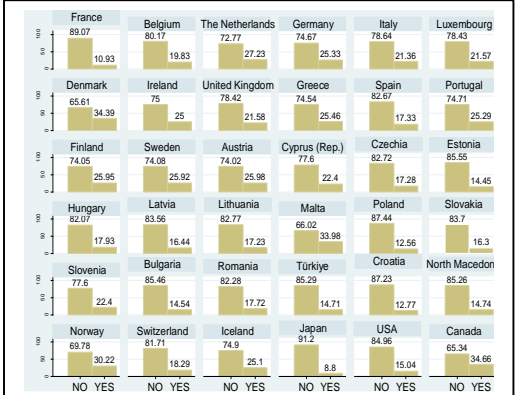


Figure 1. Share of companies using AI or have concrete plan to do so (YES – second column). Source: Authors based on the data from Flash Eurobarometer 537 (2023).

IV. RESULTS AND DISSCUSION

Firstly, we examine the share of companies that are using or planning to use AI soon. Fig. 1 explores differences among the countries where the respondent firms are located. This is one of the most interesting classifications from our perspective. The differences among countries are notable.

The proportion of firms that do not even plan to introduce AI appears to be highest in Japan, followed by France and Poland. On the other hand, companies from Canada, Denmark, and Malta are the leaders in AI adoption. Comparing the situation in EU countries, the differences between the top and bottom countries are more than 20 percentage points.

Turning to the potential impact of AI on a company's skill needs, we explore the differences in the firm's size. We assume that bigger companies with more employees will likely experience less impact on skill needs than smaller ones. Surprisingly, the results show us the opposite (Fig. 2). Companies with fewer employees are usually reported to perceive the effect of AI adoption on skills as irrelevant.

This could be since smaller companies are often not considering using AI, and even if they did, the extent of its application in day-to-day business would be smaller. However, these interesting findings need to be investigated in future research. The following part of research is focused on more detail examining the potential effect of individual factors on adoption of AI and its expected affects on skills need in company.

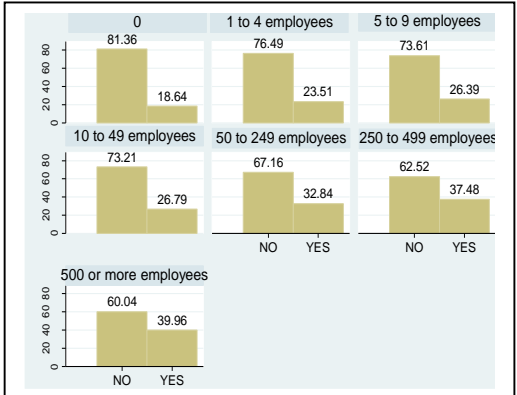


Figure 2. AI impacts skill needs in companies (YES we expect a significant impact on company's skill needs). Source: Authors based on the data from Flash Eurobarometer 537 (2023).

The results of logistic regression are shown in the Table IV. There are several companies' characteristics that appear to play a significant role. The probability that the company will introduce AI as well as this adoption will lead to changes in skills need increases with the number of employees and decreases with the average age of the employees. Hence, the results suggest that the size of the company is positively linked with the probability of AI adoption. Although this finding is contrary to the findings provided by [4], similar results were achieved by [10,12].

Furthermore, the increasing turnover of the company in recent years is positively correlated with the adoption of AI as well as with its effect on skill needs. This is in line with the results of previous studies such as [4], and [17] which found a similar positive correlation between turnover and innovation. However, the exact direction of this should be further examined. Difficulties with hiring staff are negatively correlated with AI usage, which can also be the cause as well as the result of AI adoption. Hence, companies with more problems acquiring adequate skills tend to use AI less. Interestingly, this variable has no significant effect on the expected effect of AI on skill needs.

Similarly, the community size where the company is located is affecting the usage of AI but not its potential effect on skills needs. This is fully in line with our expectations as well as the results of previous studies [20]. The agglomeration forces should play a role in the adoption of new digital technology and innovation in general. Nevertheless, the effect of AI on skills should not directly depend on the geographic location of the company.

On the other hand, membership in the industry cluster seems to be positively correlated with both dependent variables. This could be due to a suitable environment and better access to knowledge, as previously reported by [14,15].

Missing skills in the company and their exact type also appear to be linked with AI usage and its effects on skills. Companies that have a problem with the availability of IT skills are opting for AI usage more often. A similar correlation can be found for customer care skills, R&D job-related skills, and marketing-related skills. On the other hand, there is no evident link

between the shortage of administrative and technician jobs' related skills.

TABLE IV. RESULTS OF LOGISTIC REGRESSION.

	(1)	(2)
VARIABLES	USE or PLAN AI	AI IMPACTS SKILLS
Employees	0.0782*** (0.0281)	0.122*** (0.0206)
Employees' age	-0.133*** (0.0399)	-0.118*** (0.0272)
Increased annual turnover	0.265*** (0.0576)	0.180*** (0.0367)
Difficult to hire skills	-0.0537** (0.0241)	-0.00546 (0.0241)
Community size	0.0514** (0.0228)	0.0204 (0.0167)
Industry cluster	0.334*** (0.0607)	0.219*** (0.0486)
IT shortage	0.439*** (0.0879)	0.563*** (0.0775)
Administrative shortage	0.0454 (0.0792)	0.101 (0.0651)
HR shortage	-0.210* (0.113)	0.0786 (0.149)
Technician shortage	0.0262 (0.0628)	0.0780 (0.0479)
Customer care shortage	0.167** (0.0750)	0.238*** (0.0677)
R&D shortage	0.432*** (0.127)	0.0435 (0.129)
Marketing shortage	0.440*** (0.133)	0.396*** (0.0831)
Other shortage	-0.0759 (0.0577)	-0.0798 (0.0552)
Industry dummy variables (reference category ICT sector) – selected variables:		
Manufacturing	-1.090*** (0.118)	-0.547*** (0.0873)
Energy	-1.156*** (0.211)	-0.471* (0.242)
Construction	-1.399*** (0.166)	-0.778*** (0.106)
Financial	-0.367** (0.143)	-0.191 (0.128)
Constant	-0.399** (0.183)	-0.593*** (0.156)
Observations	15870	15870

Notes: Robust standard errors clustered by countries.

*** p<0.01, ** p<0.05, * p<0.1

Source: Authors based on the data from Flash Eurobarometer 537 (2023).

We also found some significant effects of industry on both dependent variables. All industries except for the ICT industry (as the baseline category), appear to have a negative correlation with AI adoption. These results are not surprising because the ICT sector is the one that is very closely linked with AI. Moreover, the construction sector appears to be significantly lagging. This is in line with previous findings such as [30], who argue that AI technology is gaining ground only very slowly in construction due to several industry-specific challenges. Adoption of digital technology is slower due to the specific nature of the construction industry as well as financial and managerial problems in the field [31].

However, the differences among industries should be examined in more detail in future research. There are also several external factors that could potentially influence the probability of AI adoption in companies. This includes financial and non-financial external support from the government or other institutions. Here we also see a potential path for future research.

Despite the best efforts to use relevant and sound methodology, it is also important to mention some limitations of this research. The results of regression cannot be directly interpreted as causal effects due to potential problems with endogeneity, which cannot be ruled out. However, the results are still valid for explaining associations. Problems related to omitted variables have been minimized by the inclusion of control variables. However, the research is not able to identify the possible effect of other potential factors that cannot be captured within the available data or through proxy variables.

V. CONCLUSIONS

Our findings shed light on factors potentially affecting AI adoption as well as those affecting its effect on skill needs in companies. The results achieved helped us answer the three research hypotheses stated in the introduction. Several significant factors related to AI adoption have been found. These factors include the size of the company, employees' ages, turnover growth, and community size. Moreover, problems with hiring skills and shortages of certain skills, such as IT skills and customer care skills, also play a crucial role in the adoption of AI.

To some extent, similar factors were found to be associated with the expected effect of AI on infirm skill needs. However, there are also some crucial differences. Community size and difficulties with hiring skills are not considered significant factors affecting the expected consequences of AI adoption on skills needed in companies.

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