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RESEARCH ARTICLE

# Multi-Criteria Measurement of AI Support to Project Management

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**ABSTRACT** This paper aims to measure the level of artificial intelligence (AI) support to project management (PM) in selected service sector activities. The exploratory factor analysis was employed based on the extensive survey on AI in Slovenian companies and the multi-criteria measurement with an emphasis on value functions and pairwise comparisons in the analytic hierarchy process. The synthesis and performance sensitivity analysis results show that in the service sector, concerning all criteria, PM is with the level 0.276 best supported with AI in services of professional, scientific, and technical activities, which also stand out concerning the first-level goals in using AI solutions in a project with the value 0.284, and in successful project implementation using AI with the value 0.301. Although the lowest level of AI support to PM, which is 0.220, is in services of wholesale and retail trade and repair of motor vehicles and motorcycles, these services excel in adopting AI technologies in a project with a value of 0.277. Services of financial and insurance activities, with the level 0.257 second-ranked concerning all criteria, have the highest value of 0.269 concerning the first-level goal of improving the work of project leaders using AI. The paper, therefore, contributes to the comparison of AI support to PM in service sector activities. The results can help AI development policymakers determine which activities need to be supported and which should be set as an example. The presented methodological frame can serve to perform measurements and benchmarking in various research fields.

**INDEX TERMS** Artificial intelligence, factor analysis, multiple criteria, performance sensitivity, project management.

## I. INTRODUCTION

Digitization presents the merging of the digital and real worlds in the future which has important consequences for work, life, and business [1]. A key component of digitization is transforming digitally recorded information into advanced knowledge, which enables the success and efficiency of business processes, as well as broader business functions and models [2]. Digital technology is key in enabling this process. Moreover, digitization is about more than just introducing modern technologies. It is a fundamental change in business models, as the existing models meet the requirements of the digital age less and less [3]. Digitization requires and encourages innovation, agility, and flexibility as technological progress changes rapidly and opens new opportunities. Digital transformation also extends to managerial disciplines, such as project management (PM) [4]. PM must adapt to the new challenges and demands of the digital age. This means redefining and transforming approaches and introducing new tools and methodologies that enable effective project management in the digital environment [5]. The digital transformation of project management also brings new opportunities for the development of the profession, as new areas and challenges that require innovative solutions are opening up [6]. Artificial Intelligence (AI) is rapidly advancing, and its potential impact on our future lives and businesses is becoming more evident. AI encompasses various technologies such as machine learning and large-scale data analysis, commonly known as Big Data [7]. These technologies can revolutionize

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industries and transform how we work, communicate, and solve complex problems. Thus, AI is entering the world of projects and project management, bringing many changes and new opportunities [8]. Companies are faced with the rapid adoption of AI technologies and their integration into various processes, from planning and project management to monitoring progress and analyzing results [9]. One of the key advantages of AI in project management is the ability to automate routine tasks and processes, which enables greater efficiency and productivity [10]. AI can automatically generate reports, analyze data, prepare plans and proposals, and perform other administrative tasks, reducing the workload of project managers and allowing them to focus on strategy and key decisions [11]. In addition, AI brings advanced analytical capabilities that enable a better understanding of data, trends, and patterns in the project environment [12]. Using deep learning and machine learning, UI can identify risks, predict the likelihood of project success, optimize processes, and suggest improvements and alternative solutions [13]. This enables project managers to make more informed decisions and reduce uncertainty in the project process. AI also contributes to greater agility in project management. With the ability to quickly process data and adapt to changes, AI can support agile project management methodologies such as the Scrum method [14]. AI can automatically manage tasks, track progress, facilitate communication between team members, and enable the adaptation of goals and plans based on environmental changes. However, implementing AI into project management also brings some challenges [15]. One of them is related to the human factor. While AI can perform many tasks, the key is for humans to maintain control and take responsibility for the final decisions. It is also necessary to ensure adequate training of employees so that they can effectively use AI tools and take advantage [16]. Thus, integrating AI into project management presents an important milestone that requires adaptability and learning new skills. AI technologies can enhance efficiency, productivity, and decision-making processes. For instance, AI-powered chatbots can improve customer service by providing instant responses and personalized recommendations [17]. AI algorithms can analyze vast amounts of data to identify patterns, predict trends, and optimize business strategies [18].

The literature review presented in the next section reflects a large amount of effort in adopting AI technologies and using AI solutions in projects, as well as improving the work of project leaders and successful project implementation using AI. Unlike the AI studies in terms of company size, however, we found little research, with the lack of comparative one, by sector and sector activities, although a quantitative comparison of AI support to project management by sector activities could serve well in making development decisions. This paper intends to fill this gap. We want to measure AI support to PM in several selected service sector activities. The research questions are as follows:

1. What are the levels of AI support to PM in several service sector activities?

2. What are the strengths and weaknesses of AI support to PM in several service sector activities?

The paper continues by presenting the mixed methodology used based on statistical analysis and multi-criteria decision-making methods. In the field of project management, multi-criteria decision-making methods have already been used mainly in project selection – an extensive literature survey can be found in, e.g., [19], in the context of product and service development projects [20], in evaluating the outcomes of projects [21], and in project evaluation – an extensive literature survey can be found in [22]. The exploratory factor analysis was employed based on the extensive survey on AI in Slovenian companies and the multi-criteria measurement with an emphasis on value functions and pairwise comparisons in the analytic hierarchy process. The interpretation of the results obtained follows the methodological part of the paper, and the conclusion with discussion detected limitations, and further research possibilities.

## II. LITERATURE REVIEW

### A. ADOPTING AI TECHNOLOGIES AND USING AI SOLUTIONS IN A PROJECT

The ongoing digital transformation of society and the economy holds disruptive potential for value creation [23], but it also poses a risk to those who fail to participate [24]. AI project management represents a departure from traditional project management methodologies as it incorporates AI technologies to minimize human involvement and streamline project processes [10]. Unlike traditional project management, which heavily relies on human decision-making and manual execution of tasks, AI project management leverages automation and optimization techniques to enhance efficiency and effectiveness [25]. One key aspect of AI project management is automating various processes and administrative tasks. Through the use of AI technologies, routine activities such as budgeting, scheduling, and resource allocation can be automated, freeing up project managers and team members to focus on more strategic and value-added activities [2]. By reducing the time and effort required for these tasks, AI project management allows for faster execution and improved productivity. In addition to automation, AI project management utilizes AI algorithms and machine learning techniques to optimize project performance [11]. AI systems can analyze vast amounts of project data, including historical project information, team performance metrics, and external factors, to generate insights and recommendations. These insights can be used to make data-driven decisions, identify potential risks or bottlenecks, and optimize project plans and strategies [26]. For example, AI algorithms can analyze project schedules and resource availability to identify optimal resource allocation strategies, ensuring that resources are utilized efficiently, and project timelines are met [27]. AI systems can also monitor project progress in real-time, flagging any deviations from the plan

and providing timely alerts to project managers, enabling proactive interventions and course corrections [10]. Furthermore, AI project management can facilitate knowledge transfer and learning within organizations. AI systems can capture and analyze project data and lessons learned, identifying patterns and best practices that can be applied to future projects. This knowledge-sharing capability enables continuous improvement and enhances organizational project management maturity [21]. However, it is important to note that AI project management should not completely replace human involvement. While AI technologies can automate and optimize certain aspects of project management, human expertise, judgment, and creativity remain essential for complex decision-making, stakeholder management, and fostering collaboration within project teams [1], [10], [28].

### B. SUCCESSFUL PROJECT IMPLEMENTATION USING AI

Despite companies acknowledging the tangible business benefits of adopting AI, many struggle to navigate the path toward successful implementation. While the potential of AI is widely recognized, understanding how to effectively harness its power and integrate it into existing operations can be challenging for companies [11]. One of the main reasons for this challenge is the complex and evolving nature of AI technologies. Companies often find it difficult to determine the most suitable AI solutions for their specific needs and develop a clear implementation roadmap [4]. Companies must recognize that the path to AI implementation may not be linear or straightforward. It requires careful planning, continuous learning, and adaptability [16]. By investing time and resources into understanding the potential of AI, addressing organizational challenges, seeking external expertise, and fostering an innovative culture, enterprises can pave the way for successful AI adoption and unlock the full range of benefits it offers [9]. One of the primary challenges lies in the perception that AI projects can be approached like other IT implementations [10], [15]. In such cases, the focus tends to be primarily on selecting an experienced vendor and creating a precisely defined proof of concept (PoC). While these steps are undoubtedly important, they alone are not sufficient for successful AI deployment. Unfortunately, this limited perspective often results in projects becoming stagnant and failing to progress beyond the PoC phase [29]. Companies need to adopt a more comprehensive and holistic approach to AI implementation to overcome this hurdle. This begins with clearly understanding the organization's strategic objectives and how AI can align with and support those goals [11].

### C. IMPROVING THE WORK OF PROJECT LEADERS USING AI

By building rapport and trust, the project leader creates an environment where team members feel comfortable expressing their ideas, concerns, and challenges. Motivating and inspiring team members is another essential aspect of project leadership [5]. Recognizing their efforts, celebrating milestones, and providing constructive feedback are powerful tools for boosting morale and maintaining high motivation levels. When team members feel valued and appreciated, they are likelier to go above and beyond to achieve project goals [30]. Moreover, in today's rapidly evolving world, AI has emerged as a powerful tool across various industries, revolutionizing processes and optimizing outcomes. One area where AI can have a profound impact is in improving the work of leaders within projects [31]. By harnessing the capabilities of AI, project leaders can enhance their decision-making, streamline operations, and drive success with greater efficiency and effectiveness. One of the key challenges project leaders face is managing and making sense of vast amounts of data [13]. AI algorithms can analyze data from multiple sources, extracting valuable insights and identifying patterns that might go unnoticed by human analysis alone [9]. By leveraging AI-powered data analysis tools, project leaders gain a comprehensive understanding of project dynamics, enabling them to make data-driven decisions and optimize resource allocation. AI can provide real-time updates, identify potential risks, and suggest corrective actions, ultimately improving project performance [16]. Additionally, AI can facilitate skill development through interactive training modules and simulations, enabling leaders to stay updated with emerging trends and enhance their capabilities. By fostering continuous learning, AI empowers project leaders to adapt to changing project landscapes and lead their teams more effectively [1], [11].

## III. METHODOLOGY

### A. DATA AND SAMPLE

The survey included a sample of 473 SMEs and large Slovenian companies selected randomly. The sample comprises 53.7% of large companies, while small and medium-sized companies comprise 46.3%. In each company, either the owner or manager participated in our research. Based on gender distribution, the study comprised 59.8% male and 40.2% female respondents. Regarding the standard classification of company activities, the participating companies were operating in various sectors: manufacturing (27.1%), wholesale and retail trade, repair of motor vehicles, and motorcycles (23.5%), financial and insurance activities (16.5%), information and communication activities (13.3%), real estate activities (9.5%), professional, scientific and technical activities (6.8%), human health and social work activities (2.3%), and administrative and support service activities (1.0%).

### B. RESEARCH INSTRUMENT

For data collection, we employed a closed-type questionnaire as our research instrument. The questionnaire consisted of statements, and the respondents were asked to indicate their level of agreement using a 5-point Likert-type scale. The scale ranged from 1, representing ''strongly disagree,'' to 5,

indicating ''strongly agree.'' Items for construct Adopting AI technologies in a project were adopted from Wamba-Taguimdje et al. [1], items for construct Using AI solutions in a project were adopted from Niederman [10], items for construct Successful project implementation using AI were adopted from Wijayati et al. [32] and items for construct Improving the work of project leaders using AI were adopted from Podgórska and Pichlak [33].

### C. STATISTICAL ANALYSIS

The structure of the criteria hierarchy in the multi-criteria measurement of AI support to PM in service sector activities was determined by using factor analysis. Our objective was to determine the suitability of factor analysis, based on the Kaiser-Meyer-Olkin measure of sampling adequacy (KMO $\geq 0.5$) [34] and Bartlett's test of sphericity. Cronbach's alpha coefficient was used to measure the internal consistency, or reliability [35], [36]. The factor analysis results indicated the number and the meaning of factors – the first-level criteria – within each construct. We employed exploratory factor analysis to characterize the relationship between specific variables, to determine the strength of the relationship between each factor and each variable expressed in factor weightings. After examining the results of the factor analysis, we eliminated variables with communalities below 0.40 [35] and thus by using a statistically more sophisticated procedure than simply using correlation coefficients between variables determined the second-level criteria of each first-level criterion. Furthermore, the data analysis involved descriptive statistics. Means as the average levels of agreement with each statement pertaining to a specific construct were used to measure the local alternatives' values in multi-criteria measurement of AI support to PM.

### D. MULTI-CRITERIA PROCEDURE AND METHODS

For measuring the level of AI support to PM, the frame procedure of the multi-criteria decision-making with the methods, based on assigning weights, was applied [37]: from problem definition, elimination of unacceptable alternatives, problem structuring, measuring local alternatives' values, criteria weighting, synthesis, ranking and sensitivity analysis. The criteria were structured in the criteria hierarchy top-down: from the global goal, through the first-level criteria to the second-level criteria. The local values of alternatives – selected service sector activities were measured by using increasing value functions considering the arithmetic means as the data. Using the analytic hierarchy process (AHP) method [38], pairwise comparisons determined weights by using the following scale [39], [40]: 1 means that the two criteria are equally important; 3 means that the criterion is moderately more important than the compared one; the verbal description of importance strength 5 is strong, of 7 very strong, and of 9 – extreme. Using the above descriptions of importance, intermediate values can also be described: e.g., 8 means that the criterion is very strongly to extremely (or very, very strongly) more important than the compared one; the verbal description of 6 is strong to very strong (or strong plus), of 4 is moderate to strong (or moderate plus), and 2 equal to moderate (or weak or slight). When the criterion is less important than the compared one, the numerical values of judgments are written as reciprocal values. The acceptable consistency of the obtained matrix of expressed judgments was measured with the consistency ratio (CR $\leq 0.1$) [41]. In this survey, three experts from the key areas of expertise crucial for this research, namely AI, project management, and decision-making, expressed their judgments on the criteria's importance concerning the upper criterion (i.e., hierarchically) by pairwise comparisons. Geometric mean was used to gather the weights of individual experts on the criteria's importance. The additive model [42], [43] was used in synthesis to obtain the aggregate alternatives' values. Performance sensitivity supported the benchmarking, and gradient sensitivity helped analyze the sensitivity of the obtained ranks concerning changes in criteria weights.

A diagram of the methodology and the sequence of work is presented in Figure 1.

## IV. RESULTS

The results of factor analysis showed that factor analysis is justified in the criteria determination: all values of KMO were higher than 0.5, and the results of Bartlett's test of sphericity were significant ($p < 0.001$). As only one component was extracted from each construct, the first level criteria are as follows: 'adopting AI technologies in a project' (ATP), 'using AI solutions in a project' (UAIP), 'successful project implementation using AI' (SPI), and 'improving the work of project leaders using AI' (IWPL). The results of the exploratory factor analysis regarding the relationship between specific variables resulted in the structure of the second-level criteria, as well. Because of the communality value, lower than 0.4, the statement 'We use Resource Scheduling software (it helps allocate resources like equipment rooms, staff, and other resources) to improve the work on the project' was not included as the second-level criterion of UAIP. For the same reason, the statements 'AI allows a leader to work effectively on a project' and 'AI allows a leader can work remotely' were not included as the second-level criteria of IWPL. The results of the final exploratory factor analysis are presented in Table 1. Our study's high Cronbach's alpha values reflect a high degree of internal consistency of items within individual constructs. This is due to carefully selecting and formulating items that closely and consistently measure the relevant aspects of AI project management.

Based on the results of factor analysis in Table 1, the criteria structure for measuring the level of AI support to PM in selected service sector activities is presented in Figure 2.

In the multi-criteria model, the following service sector activities were included as alternatives: Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles (G),

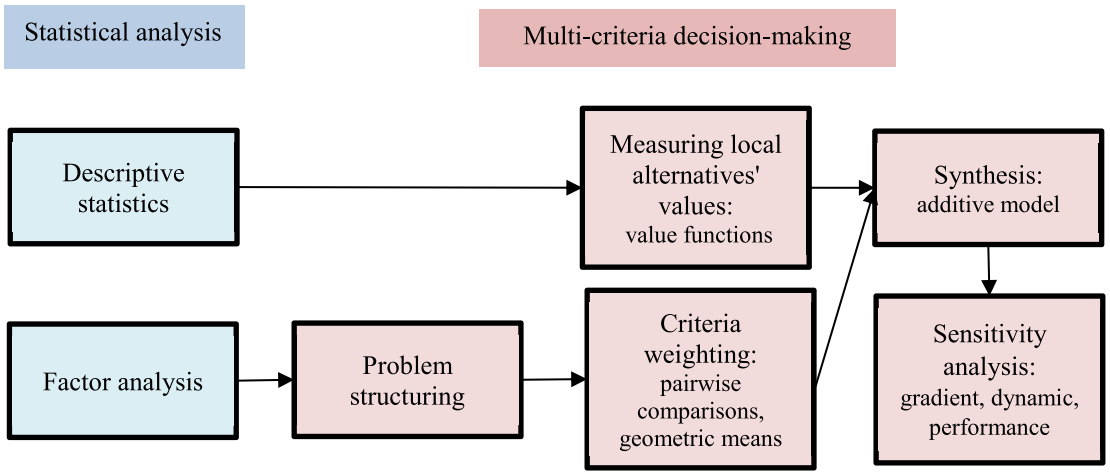


**FIGURE 1.** Research methodology with the sequence of work.

**TABLE 1.** Results of exploratory factor analysis for AI support to PM.

| Construct | Cronbach alpha | Statement | Communality | Factor loading |
|---|---|---|---|---|
| ATP. Adopting AI technologies in a project. | 0.956 | ATP1. Our company uses program and portfolio structures for managing projects. | 0.746 | 0.864 |
| | | ATP2. Our company has a digital transformation strategy, including AI adoption. | 0.885 | 0.941 |
| | | ATP3. Our company uses AI technologies in projects for work design. | 0.886 | 0.941 |
| | | ATP4. Our company uses AI technologies in projects to plan new tasks. | 0.883 | 0.940 |
| | | ATP5. Our company uses AI technologies in projects to create teams. | 0.859 | 0.927 |
| Kaiser-Meyer-Olkin measure of sampling adequacy: 0.884, total variance explained – cumulative %: 85.206 | | | | |
| UAIP. Using AI solutions in a project. | 0.823 | UAIP1. We use ChatBots (Digital Assistants) to improve the work on the project. | 0.568 | 0.754 |
| | | UAIP2. We use Predictive Analytics Tools to improve the work on the project. | 0.529 | 0.728 |
| | | UAIP3. We use Robotic Process Automation to improve the work on the project. | 0.751 | 0.867 |
| | | UAIP4. We use Project scheduling software (it helps in planning, tracking, and analysis of projects) to improve the work on the project. | 0.854 | 0.924 |
| Kaiser-Meyer-Olkin measure of sampling adequacy: 0.744, total variance explained – cumulative %: 67.553 | | | | |
| SPI. Successful project implementation using AI. | 0.954 | SPI1. AI technologies improve communication with stakeholders. | 0.633 | 0.795 |
| | | SPI2. AI technologies improve compliance, security, and project risk management. | 0.458 | 0.677 |
| | | SPI3. AI technologies improve project performance and reporting. | 0.838 | 0.915 |
| | | SPI4. AI technologies improve decision-making regarding project work/tasks. | 0.917 | 0.957 |
| | | SPI5. AI technologies improve resource utilization. | 0.884 | 0.940 |
| | | SPI6. AI technologies provide accurate data and information related to project work. | 0.866 | 0.931 |
| | | SPI7. AI technologies increase productivity by freeing up project managers to focus on more important decisions. | 0.659 | 0.812 |
| | | SPI8. AI technologies reduce costs and delivery time. | 0.909 | 0.953 |
| Kaiser-Meyer-Olkin measure of sampling adequacy: 0.939, total variance explained – cumulative %: 77.051 | | | | |
| IWPL. Improving the work of project leaders using AI. | 0.947 | IWPL1. AI allows the leader to be released from routine managerial tasks. | 0.721 | 0.849 |
| | | IWPL2. AI allows the leader can allocate more time to leading the project team. | 0.751 | 0.866 |
| | | IWPL3. AI allows the leader can focus on complex managerial tasks. | 0.746 | 0.863 |
| | | IWPL4. AI allows the leader can run more projects. | 0.420 | 0.648 |
| Kaiser-Meyer-Olkin measure of sampling adequacy: 0.777, total variance explained – cumulative %: 65.942 | | | | |

**TABLE 2. Local alternatives' values.**

| Second-level criterion | Alternative | | | |
|---|---|---|---|---|
| | G | J | K | M |
| Using program and portfolio structures for managing projects in the company | 0.285 | 0.237 | 0.241 | 0.237 |
| Having a digital transformation strategy, including AI adoption in the company | 0.270 | 0.238 | 0.248 | 0.244 |
| Using AI technologies in projects for work design in the company | 0.259 | 0.222 | 0.297 | 0.222 |
| Using AI technologies in projects to plan new tasks in the company. | 0.286 | 0.241 | 0.248 | 0.225 |
| Using AI technologies in projects to create teams in the company | 0.297 | 0.231 | 0.253 | 0.218 |
| Using ChatBots (Digital Assistants) to improve the work on the project | 0.200 | 0.237 | 0.265 | 0.299 |
| Using Predictive Analytics Tools to improve the work on the project | 0.234 | 0.259 | 0.231 | 0.276 |
| Using Robotic Process Automation to improve the work on the project | 0.177 | 0.258 | 0.278 | 0.287 |
| Using Project scheduling software to improve the work on the project | 0.197 | 0.258 | 0.258 | 0.286 |
| Improving communication with stakeholders | 0.190 | 0.239 | 0.281 | 0291 |
| Improving compliance, security, and project risk management | 0.185 | 0.253 | 0.303 | 0.258 |
| Improving project performance and reporting | 0.197 | 0.248 | 0.248 | 0.307 |
| Improving decision-making regarding project work/tasks | 0.187 | 0.257 | 0.262 | 0.294 |
| Improving resource utilization | 0.202 | 0.262 | 0.251 | 0.284 |
| Providing accurate data and information related to project work | 0.198 | 0.254 | 0.249 | 0.299 |
| Increasing productivity by freeing up project managers to focus on more important decisions | 0.201 | 0.223 | 0.237 | 0.339 |
| Reducing costs and delivery time | 0.185 | 0.261 | 0.245 | 0.308 |
| Allowing the leader to be released from routine managerial tasks | 0.226 | 0.247 | 0.274 | 0.253 |
| Allowing the leader can allocate more time to leading the project team | 0.257 | 0.249 | 0.270 | 0.224 |
| Allowing the leader can focus on complex managerial tasks | 0.224 | 0.240 | 0.266 | 0.271 |
| Allowing the leader can run more projects | 0.260 | 0.225 | 0.279 | 0.236 |

Symbols: G – Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles, J – Information and Communication Activities, K – Financial and Insurance Activities, M – Professional, Scientific, and Technical Activities.

Information and Communication Activities (J), Financial and Insurance Activities (K), and Professional, Scientific and Technical Activities (M). The local alternatives' values concerning each second-level criterion were obtained with increasing linear value functions where arithmetic means for the entire sector were used as data (Table 6 in Appendix A). As all means were in the interval between 3 – neither agree nor disagree and 5 – strongly agree (Table 6 in Appendix A), the lower bound was set to 3 and the upper bound to 5, to better differentiate between alternatives. The resulting local values of alternatives are presented in Table 2.

For each expert, the results of the pairwise comparisons of the criteria importance by the AHP method are presented in Table 6 in Appendix B, together with the values of the consistency ratio. Table 3 presents the geometric means of the individual weights of the artificial intelligence, project management, and decision-making experts, together with the normalized values of geometric means that were then used as the local weights, i.e., the weights concerning the upper criterion, of the first and second-level criteria in the multi-criteria model for measuring the level of AI support to PM. Table 3 also presents the global weights, i.e., the weights concerning the global goal. The global weight of each second-level criterion is calculated as the product of its first-level criterion's weight and local weight.

Table 3 shows that the most important first-level criterion is 'successful project implementation using AI', followed by 'improving the work of project leaders using AI', 'using AI solutions in a project', and 'adopting AI technologies in a project'. Concerning 'adopting AI technologies in a project,' the most important is having a digital transformation strategy, including AI adoption. Concerning 'using AI solutions in a project,' the most important is the use of Project scheduling software to improve the work on the project. Concerning 'successful project implementation using AI,' the most important is that AI technologies reduce costs and delivery time, and concerning 'improving the work of the project leaders using AI,' the most important is that AI allows the leader can focus on complex managerial tasks. Table 4 shows the aggregate alternatives' values concerning the first-level criteria and the global goal.

Table 4 shows that concerning all criteria, the highest level of AI support to PM is achieved by alternative M, i.e., in professional, scientific, and technical activities, which also stands out in using AI solutions in a project, and in successful project implementation using AI. Although alternative G, i.e., wholesale and retail trade, and repair of motor vehicles and motorcycles has the lowest level of AI support to PM, it excels in adopting AI technologies in a project. Alternative K, i.e., financial and insurance activities, which is second-ranked concerning the global goal, has the highest value concerning improving the work of project leaders using AI. The results for ranking the alternatives are verified by gradient and dynamic sensitivity analysis. The result is considered stable if a criterion weight changes less than or equal to 0.1 and the selected alternative is preserved. The results of gradient and dynamic sensitivity analysis that was performed for each first- and second-level criterion let us

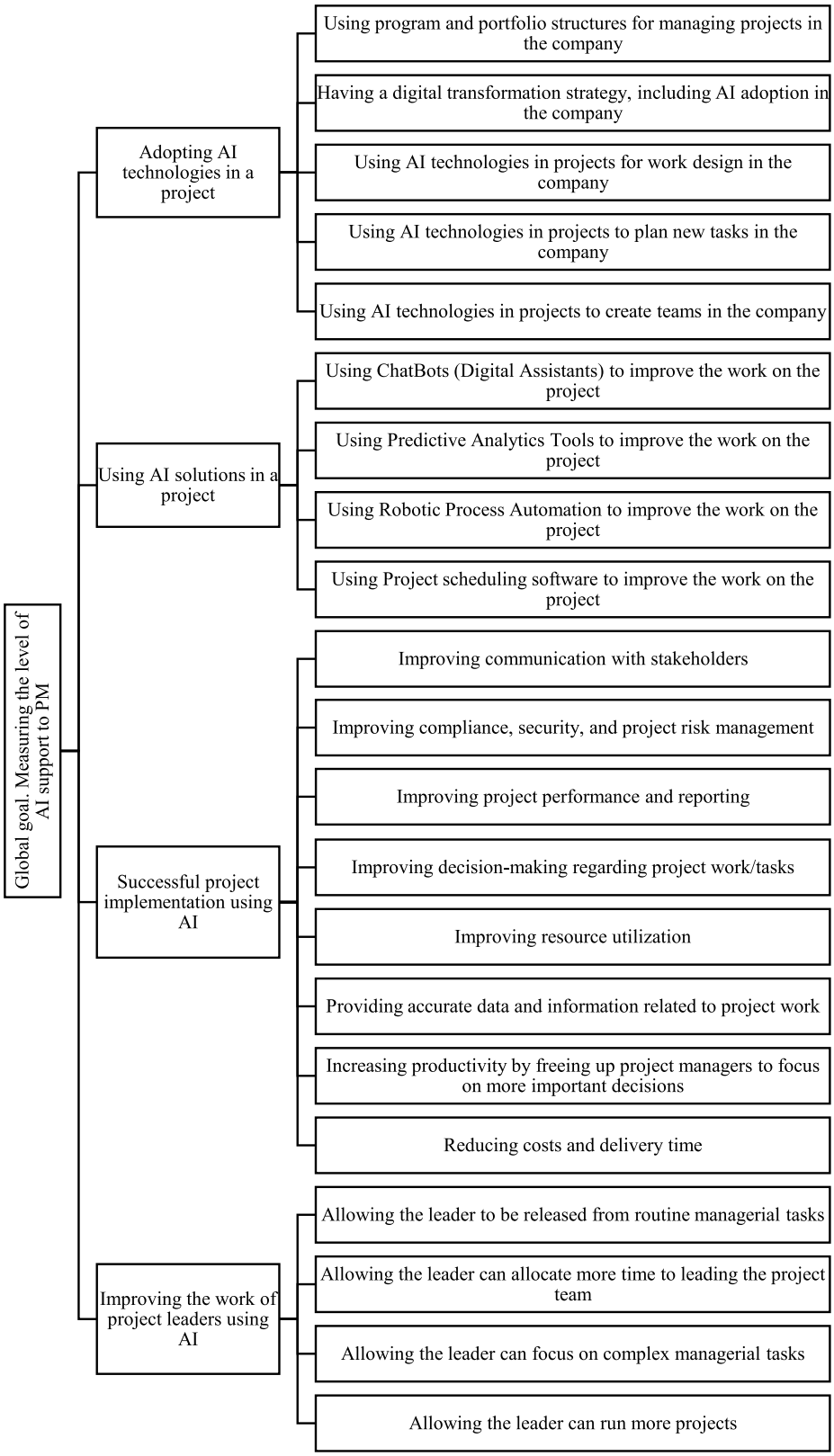


**FIGURE 2.** Criteria structure.

report that concerning the global goal, the weight of 'adopting AI technologies in a project' should be increased by 0.351 and the weight of 'improving the work of project leaders using AI' by 0.441 to replace the first-ranked alternative M with

**TABLE 3.** Criteria weights.

| Global goal. Measuring the level of AI support to PM | | | | |
|---|---|---|---|---|
| Level | Criterion | Geometric mean | Local weight | Global weight |
| 1 | Adopting AI technologies in a project | 0.113 | 0.156 | 0.156 |
| 2 | Using program and portfolio structures for managing projects in the company | 0.143 | 0.168 | 0.026 |
| 2 | Having a digital transformation strategy, including AI adoption in the company | 0.282 | 0.331 | 0.052 |
| 2 | Using AI technologies in projects for work design in the company | 0.181 | 0.212 | 0.033 |
| 2 | Using AI technologies in projects to plan new tasks in the company | 0.088 | 0.104 | 0.016 |
| 2 | Using AI technologies in projects to create teams in the company | 0.157 | 0.185 | 0.029 |
| 1 | Using AI solutions in a project | 0.163 | 0.224 | 0.224 |
| 2 | Using ChatBots (Digital Assistants) to improve the work on the project | 0.111 | 0.122 | 0.027 |
| 2 | Using Predictive Analytics Tools to improve the work on the project | 0.336 | 0.370 | 0.083 |
| 2 | Using Robotic Process Automation to improve the work on the project | 0.068 | 0.075 | 0.017 |
| 2 | Using Project scheduling software to improve the work on the project | 0.393 | 0.433 | 0.097 |
| 1 | Successful project implementation using AI | 0.286 | 0.393 | 0.393 |
| 2 | Improving communication with stakeholders | 0.037 | 0.040 | 0.016 |
| 2 | Improving compliance, security, and project risk management | 0.082 | 0.089 | 0.035 |
| 2 | Improving project performance and reporting | 0.093 | 0.102 | 0.040 |
| 2 | Improving decision-making regarding project work/tasks | 0.093 | 0.102 | 0.040 |
| 2 | Improving resource utilization | 0.188 | 0.205 | 0.080 |
| 2 | Providing accurate data and information related to project work | 0.058 | 0.063 | 0.025 |
| 2 | Increasing productivity by freeing up project managers to focus on more important decisions | 0.149 | 0.162 | 0.064 |
| 2 | Reducing costs and delivery time | 0.217 | 0.237 | 0.093 |
| 1 | Improving the work of project leaders using AI | 0.165 | 0.227 | 0.227 |
| 2 | Allowing the leader to be released from routine managerial tasks | 0.116 | 0.125 | 0.028 |
| 2 | Allowing the leader can allocate more time to leading the project team | 0.196 | 0.211 | 0.048 |
| 2 | Allowing the leader can focus on complex managerial tasks | 0.490 | 0.527 | 0.120 |
| 2 | Allowing the leader can run more projects | 0.128 | 0.137 | 0.031 |

**TABLE 4.** Aggregate values and ranking of alternatives.

| | Alternative | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | G | | J | | K | | M | |
| | Value | Rank | Value | Rank | Value | Rank | Value | Rank |
| Adopting AI technologies in a project | 0.277 | 1. | 0.234 | 3. | 0.258 | 2. | 0.231 | 4. |
| Using AI solutions in a project | 0.210 | 4. | 0.256 | 2. | 0.250 | 3. | 0.284 | 1. |
| Successful project implementation using AI | 0.194 | 4. | 0.251 | 3. | 0.254 | 2. | 0.301 | 1. |
| Improving the work of project leaders using AI | 0.236 | 4. | 0.241 | 3. | 0.269 | 1. | 0.254 | 2. |
| Global goal. Measuring the level of AI support to PM | 0.220 | 4. | 0.247 | 3. | 0.257 | 2. | 0.276 | 1. |

Symbols: G – Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles, J – Information and Communication Activities, K – Financial and Insurance Activities, M – Professional, Scientific, and Technical Activities.

alternative K. Considering that such weight changes are too great for a competent assessor and that the ranking of alternatives is not changed concerning changes in the weights of 'using AI solutions in a project' and 'successful project implementation using AI', we can conclude that the solution is stable given the changes in the weights of the first-level criteria. Furthermore, changes in the second-level weights of 'adopting AI technologies in a project,' 'using AI solutions in a project' and 'improving the work of project leaders using AI' do not affect the order of alternatives concerning the global goal. Except for the weight of 'improving compliance, security and project risks management', which would need to be increased by as much as 0.485 to replace the alternative M with alternative K in the first place concerning the global goal, changes to the weights of the second-level criteria weights of 'successful project implementation using AI' do not affect the order of alternatives concerning the global goal. We can therefore conclude that the solution is stable given the change in the weights of the criteria at the second level, too.

## V. CONCLUSION

### A. ANSWERS TO RESEARCH QUESTIONS AND DISCUSSION

Comparing the aggregate alternatives' values concerning the global goal, presented in Table 4, let us answer the first research question: the level of AI support to PM in

professional, scientific, and technical activities is 0.276, which is the highest value in the observed service sector activities. It is followed by financial and insurance activities, with a level of 0.257, and information and communication activities, the level of which is 0.247 – these two service sector activities have therefore very similar levels of AI support to PM. The level of AI support to PM in wholesale and retail trade, together with repair of motor vehicles and motorcycles is 0.220, which is 11 % less than the third-placed alternative, 14 % less than the second-placed one, and 20 % less than the first-placed alternative. From a professional and scientific point of view, rapidly developing technologies are expected to be deployed at the fastest pace in professional, scientific, and technical activities. Gonzáles-Esteban and Calvo [44] noted that AI is coveted by scientific research centers, organizations, and science funding agencies due to its potential to significantly increase the productive, prospective, and predictive capacity of research activities.

Performance sensitivity analysis and the results in Table 4 let us answer the second research question. 'Using AI solutions in a project' and 'successful project implementation using AI' are the strengths, and 'adopting AI technologies in a project' is the weakness of 'professional, scientific and technical activities,' the first-ranked alternative concerning the global goal. On the other hand, 'adopting AI technologies in a project' is the only strength, while 'using AI solutions in a project', 'successful project implementation using AI', and 'improving the work of project leaders using AI' are the weaknesses of 'wholesale and retail trade, repair of motor vehicles and motorcycles', the last-ranked alternative concerning the global goal. Furthermore, 'improving the work of project leaders using AI' is the main strength of financial and insurance activities.

A more detailed comparative analysis was made regarding the second-level criteria (Table 2), as well; it is presented in Appendix C.

Good practices concerning the first- and second-level criteria in the first-ranked service sector activities should be explored and implemented in the lower-ranked service sector activities. For example, professional, scientific, and technical activities, otherwise first-placed concerning the global goal, can even improve its level of AI support to PM by following good practices in 'adopting AI technologies in a project' of wholesale and retail trade, repair of motor vehicles and motorcycles, with an emphasis on using program and portfolio structures for managing projects, having a digital transformation strategy, including AI adoption, using AI technologies in projects to plan new tasks, and to create teams in companies; and of financial and insurance activities when using AI technologies in projects for work design in companies. The implementation of AI in the marketing domain that enables exploring consumer behavior, consumer and service analytics [45] is namely required and well-developed both in wholesale and retail trade, repair of motor vehicles and motorcycles, and in financial and insurance activities, where AI is also used for financial and insurance products and services development, and performance and forecasting. On the other hand, wholesale and retail trade, repair of motor vehicles and motorcycles, otherwise last-ranked concerning the global goal, can improve its level of AI support to PM by following good practices of professional, scientific, and technical activities in using AI solutions in a project and successful project implementation using AI, except for improving compliance, security and project risks management with AI technologies, where financial and insurance activities should be followed. Furthermore, in improving the work of project leaders using AI, wholesale and retail trade, repair of motor vehicles and motorcycles should follow financial and insurance activities to allow the leader to release routine managerial tasks, and professional, scientific, and technical activities for allowing the leader can focus on the complex managerial tasks. Although not first ranked concerning the global goal, financial and insurance activities have no weaknesses in terms of minimum values by criteria and sub-criteria (Tables 2, 4). Information and communication activities, otherwise third-ranked concerning the global goal, can primarily improve their AI support by changing the use of program and portfolio structures for managing projects and in a digital transformation strategy, including AI adoption in companies, where wholesale and retail trade, repair of motor vehicles and motorcycles should be followed, and using AI technologies in projects for work design in companies and allowing the leader can run more projects, where financial and insurance activities should be followed as a benchmark.

### B. THEORETICAL AND PRACTICAL IMPLICATIONS

The paper contributes to the theoretical implications of AI support for PM measurement. Since there is a lack of comparisons of AI support in service sector activities, especially those of PM, in the existing literature, the presented multi-criteria measurement of the level of AI support to PM fills this gap. The methodological frame that is presented in the paper employs a mixed methodology, from descriptive statistics and exploratory factor analysis to multi-criteria decision-making, which can serve to perform measurements and benchmarking in various research fields.

Regarding practical implications, the paper illustrates how to measure the level and benchmark AI support for PM. The results obtained can help AI development policy makers, which sectors need to be supported and which ones should be set an example.

### C. LIMITATIONS AND FURTHER RESEARCH POSSIBILITIES

To illustrate in the paper-developed approach, the empirical and practical example is limited to the comparison of AI support to PM in four service sector activities: wholesale and retail trade; repair of motor vehicles and motorcycles, information and communication activities, financial and insurance activities, and professional, scientific and technical activities, in Slovenia. Further research possibilities include

**TABLE 5. Means of agreement with the statements describing AI support to PM.**

| Statement | Alternative | | | |
|---|---|---|---|---|
| | G | J | K | M |
| ATP1. Our company uses program and portfolio structures for managing projects. | 3.90 | 3.75 | 3.76 | 3.75 |
| ATP2. Our company has a digital transformation strategy, including AI adoption. | 4.38 | 4.22 | 4.27 | 4.25 |
| ATP3. Our company uses AI technologies in projects for work design. | 3.48 | 3.41 | 3.55 | 3.41 |
| ATP4. Our company uses AI technologies in projects to plan new tasks. | 3.90 | 3.76 | 3.78 | 3.71 |
| ATP5. Our company uses AI technologies in projects to create teams. | 4.36 | 4.06 | 4.16 | 4.00 |
| UAIP1. We use ChatBots (Digital Assistants) to improve the work on the project. | 3.71 | 3.84 | 3.94 | 4.06 |
| UAIP2. We use Predictive Analytics Tools to improve the work on the project. | 4.33 | 4.47 | 4.31 | 4.57 |
| UAIP3. We use Robotic Process Automation to improve the work on the project. | 3.74 | 4.08 | 4.16 | 4.20 |
| UAIP4. We use Project scheduling software (it helps in planning, tracking, and analysis of projects) to improve the work on the project. | 3.93 | 4.22 | 4.22 | 4.35 |
| SPI1. AI technologies improve communication with stakeholders. | 3.73 | 3.92 | 4.08 | 4.12 |
| SPI2. AI technologies improve compliance, security, and project risk management. | 3.66 | 3.90 | 4.08 | 3.92 |
| SPI3. AI technologies improve project performance and reporting. | 3.73 | 3.92 | 3.92 | 4.14 |
| SPI4. AI technologies improve decision-making regarding project work/tasks. | 3.70 | 3.96 | 3.98 | 4.10 |
| SPI5. AI technologies improve resource utilization. | 3.74 | 3.96 | 3.92 | 4.04 |
| SPI6. AI technologies provide accurate data and information related to project work. | 3.70 | 3.90 | 3.88 | 4.06 |
| SPI7. AI technologies increase productivity by freeing up project managers to focus on more important decisions. | 3.85 | 3.94 | 4.00 | 4.43 |
| SPI8. AI technologies reduce costs and delivery time. | 3.71 | 4.00 | 3.94 | 4.18 |
| IWPL1. AI allows the leader to be released from routine managerial tasks. | 3.86 | 3.94 | 4.04 | 3.96 |
| IWPL2. AI allows the leader can allocate more time to leading the project team. | 4.01 | 3.98 | 4.06 | 3.88 |
| IWPL3. AI allows the leader can focus on complex managerial tasks. | 3.86 | 3.92 | 4.02 | 4.04 |
| IWPL4. AI allows the leader can run more projects. | 3.95 | 3.82 | 4.02 | 3.86 |

Symbols: G – Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles, J – Information and Communication Activities, K – Financial and Insurance Activities, M – Professional, Scientific, and Technical Activities.

the performance of research in other sectors and other countries and the comparison of AI support to PM among them.

The methodological limitation of the multi-criteria measurement of the level of AI support to PM that we would like to highlight is as follows. When expressing judgments on the criteria's importance, merely pairwise comparisons – one of the fundamental features of the AHP – that are based on a ratio scale were used. A further limitation is also an assumption that criteria do not interact with each other. It could be overcome by using the multiplicative [46] and the fuzzy models [47] or by a networking approach supported by the Analytic Network Process (ANP) [41]. The ANP model construction for measuring the level of AI support to PM thus offers as a further research possibility. Moreover, after analyzing the results of measurement and benchmarking, it is advisable to set the next global goal, e.g., in terms of implementing measures for improvements, and to use optimization methods [43].

In our future research, we plan to explore the interrelationships among various constructs in the context of using AI in project management. To achieve this, we will employ SEM, enabling us to conduct a complex analysis of potential relationships between constructs. Furthermore, we will include an analysis of discriminant validity, which is crucial for ensuring that the constructs in our study are truly distinct and unique. Thus, discriminant validity analysis will be an important part of our methodological approach in exploring the dynamics and complexities of using AI in project management. With this approach, we aim to contribute to a better understanding and assessment of the potential of AI in project management, which will be beneficial for both the academic community and the practice of project management.

Our study acknowledges the traditional Iron Triangle (Scope, Time, and Cost) as a foundational framework for project success. However, recognizing the evolving nature of project management, we have expanded our definition to include additional dimensions that are increasingly relevant in today's context, especially when considering the integration of AI in project management.

In our study, we addressed a sample encompassing both SMEs and large Slovenian companies. This approach was chosen to gain a broader insight into the use of AI in project management. However, we are aware that these two types of business structures significantly differ in terms of organizational structure, resources, decision-making processes, and innovation capabilities. In the future, it would be beneficial to conduct separate analyses for SMEs and large companies, or to use statistical tests, such as the t-test, to determine if there are significant differences in the adoption and use of AI between these two groups. This consideration opens up possibilities for further research, which could more closely examine how different types of business structures impact the adoption and effectiveness of AI in project management. Understanding these differences

**TABLE 6. Results of the pairwise comparisons of the criteria importance by each expert.**

| Global goal. Measuring the level of AI support to PM | | | | |
|---|---|---|---|---|
| Level | Criterion | DM expert | PM expert | AI expert |
| | Concerning the global goal, CR | 0 | 0 | 0 |
| 1 | Adopting AI technologies in a project | 0.109270 | 0.062053 | 0.214286 |
| 1 | Using AI solutions in a project | 0.109270 | 0.062053 | 0.642857 |
| 1 | Successful project implementation using AI | 0.572450 | 0.573590 | 0.071429 |
| 1 | Improving the work of project leaders using AI | 0.209009 | 0.302303 | 0.071429 |
| | Concerning 'adopting AI technologies in a project', CR | 0.02 | 0.01 | 0 |
| 2 | Using program and portfolio structures for managing projects in the company | 0.060614 | 0.099733 | 0.479038 |
| 2 | Having a digital transformation strategy, including AI adoption in the company | 0.276030 | 0.473306 | 0.171527 |
| 2 | Using AI technologies in projects for work design in the company | 0.228123 | 0.289813 | 0.088954 |
| 2 | Using AI technologies in projects to plan new tasks in the company | 0.207110 | 0.037415 | 0.088954 |
| 2 | Using AI technologies in projects to create teams in the company | 0.228123 | 0.099733 | 0.171527 |
| | Concerning 'using AI solutions in a project', CR | 0.01 | 0 | 0.03 |
| 2 | Using ChatBots (Digital Assistants) to improve the work on the project | 0.072172 | 0.187500 | 0.099712 |
| 2 | Using Predictive Analytics Tools to improve the work on the project | 0.217876 | 0.562500 | 0.308765 |
| 2 | Using Robotic Process Automation to improve the work on the project | 0.122786 | 0.062500 | 0.041798 |
| 2 | Using Project scheduling software to improve the work on the project | 0.587166 | 0.187500 | 0.549725 |
| | Concerning 'successful project implementation using AI', CR | 0 | 0 | 0.05 |
| 2 | Improving communication with stakeholders | 0.047735 | 0.031171 | 0.033910 |
| 2 | Improving compliance, security, and project risk management | 0.099234 | 0.164286 | 0.033910 |
| 2 | Improving project performance and reporting | 0.047735 | 0.093390 | 0.182746 |
| 2 | Improving decision-making regarding project work/tasks | 0.047735 | 0.093390 | 0.182746 |
| 2 | Improving resource utilization | 0.232481 | 0.216273 | 0.132349 |
| 2 | Providing accurate data and information related to project work | 0.047735 | 0.031171 | 0.132349 |
| 2 | Increasing productivity by freeing up project managers to focus on more important decisions | 0.232481 | 0.093390 | 0.150995 |
| 2 | Reducing costs and delivery time | 0.244865 | 0.276931 | 0.150995 |
| | Concerning 'improving the work of project leaders using AI', CR | 0 | 0 | 0 |
| 2 | Allowing the leader to be released from routine managerial tasks | 0.185424 | 0.045274 | 0.187500 |
| 2 | Allowing the leader can allocate more time to leading the project team | 0.185424 | 0.216827 | 0.187500 |
| 2 | Allowing the leader can focus on complex managerial tasks | 0.532012 | 0.393757 | 0.562500 |
| 2 | Allowing the leader can run more projects | 0.097141 | 0.344143 | 0.062500 |

Symbols: DM – decision-making, PM – project management, AI – artificial intelligence, CR – consistency ratio. Note: Rounded to five decimal places, each sum of weights concerning the upper criterion is 1.

could lead to more targeted strategies for implementing AI across various business contexts.

## APPENDIX A

See Table 5.

## APPENDIX B

See Table 6.

## APPENDIX C

The results of performance sensitivity analysis regarding the second-level criteria are as follows. Concerning 'adopting AI technologies in a project'(ATP), the main strength of financial and insurance activities is that their companies use AI technologies in projects for work design, while wholesale and retail trade, together with repair of motor vehicles and motorcycles leads the way in all other ATP sub-criteria. On the other hand, all ATP sub-criteria except having a digital transformation strategy, including AI adoption are the weaknesses of 'professional, scientific, and technical activities,' the last ranked alternative concerning ATP. Using program and portfolio structures for managing projects, having a digital transformation strategy, including AI adoption, and using AI technologies in projects for work design are the weaknesses of companies in information and communication activities, too. Concerning 'using AI solutions in a project' (UAIP), all UAIP sub-criteria are the strengths of professional, scientific, and technical activities and, except for using predictive analytic tools to improve the work on the project, the weaknesses of wholesale and retail trade, repair of motor vehicles and motorcycles. In addition, using predictive analytics tools to improve the work on the project is the weakness of financial and insurance activities. Concerning 'successful project implementation using AI weights' (SPI), improving compliance, security, and project risk management is the strength of financial and insurance activities, and all other SPI sub-criteria are the strengths of professional, scientific, and technical activities, while all SPI sub-criteria are the weaknesses of wholesale and retail trade, repair of motor vehicles and motorcycles. Concerning 'improving the work of project leaders using AI' (IWPL), however, allowing the leader can focus on complex managerial is the main strength of professional, scientific, and technical activities, and the fact that AI allows a leader to release from routine managerial tasks, can allocate more time for leading the project team and can run more projects are the strengths of financial and insurance activities. The last place according to the IWPL

sub-criteria belongs to various alternatives: in wholesale and retail trade, and repair of motor vehicles and motorcycles, allowing the leader to release from routine managerial tasks and focus on the complex managerial tasks should improve; allowing the leader to allocate more time for the project team should be strengthened in professional, scientific and technical activities; and allowing the leader to run more projects is the weakness of information and communication activities.

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