Vol. 08, No. 1 (2026) 161-170 , doi: 10.24874/PES08.01.017

Proceedings on Engineering Sciences

www.pesjournal.net

DETERMINANTS OF THE INTENTION TO ADOPT INDUSTRY 4.0 TECHNOLOGIES: AN EMPIRICAL ANALYSIS BASED ON TAM AND UTAUT IN A MULTI-SECTOR CONTEXT

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Received 10.07.2025.
Revised 27.10.2025.
Accepted 18.11.2025.

Keywords:

Industry 4.0, Technology Acceptance, Technology Acceptance Model (TAM), Unified Theory of Acceptance and Use of Technology (UTAUT), Perceived Usefulness, Ease of Use, Social Influence, Facilitating Conditions

A B S T R A C T

The adoption of Industry 4.0 technologies, including the Internet of Things (IoT), artificial intelligence (AI), and Big Data, represents a pivotal strategic challenge for industrial enterprises. This study examines the behavioral and organizational factors influencing employee acceptance of these technologies within a multi-sectoral context. Grounded in the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT), a questionnaire survey was conducted with 150 employees from diverse industrial sectors. The primary objective was to evaluate the effects of perceived usefulness, ease of use, social influence, and facilitating conditions on employees' intentions to adopt these technologies.

The findings demonstrate that perceived usefulness and ease of use are significant determinants of adoption intention, while social influence, although less pronounced, still exerts a notable effect. Moreover, facilitating conditions were identified as a moderating variable, amplifying the relationship between perceived usefulness and adoption intention. These results provide valuable theoretical contributions and practical recommendations for enhancing the effective integration of Industry 4.0 technologies in industrial enterprises.

1. INTRODUCTION

Industry 4.0 marks a significant technological revolution, characterized by the profound transformation of industrial operations through the convergence of advanced technologies such as artificial intelligence (AI), the Internet of Things (IoT), digital twins, and intelligent automation (Reznikov & Turlakova, 2024). These innovations redefine production systems by integrating highly flexible and customized processes while delivering superior-quality outputs. They enable close collaboration between business partners and customers in value creation, optimizing operations through intelligent monitoring and near-instant decision-making. In this context, the adoption of these technologies has become essential for companies aiming to enhance productivity,

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improve operational efficiency, and ensure high product quality, all while maintaining competitiveness in a constantly evolving global environment (Beyerer et al., 2015).

However, despite their potential benefits, the adoption of these technologies encounters significant technical and human challenges, including system complexity, necessary organizational transformations, and employee resistance, all of which can significantly disrupt production processes (Szabó et al., 2023). These challenges underline the necessity of adopting a user-centered approach to the design and implementation of Industry 4.0 technologies, emphasizing user needs and addressing concerns to foster acceptance across diverse organizational contexts (Rane et al., 2024).

Employee acceptance of Industry 4.0 technologies serves as a critical enabler of their successful implementation. According to classical theoretical models such as the Technology Acceptance Model (TAM) (Davis, 1989), highlighting perceived usefulness and ease of use, and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003), emphasizing social influence and facilitating conditions, these factors are pivotal in determining the intention to adopt new technologies (Taherdoost et al., 2024).

Although some studies have explored the determinants of Industry 4.0 technology acceptance, their scope is often confined to specific or single-sector contexts. This gap underscores the need for a comprehensive investigation into how behavioral and organizational factors shape the adoption of these technologies across multiple sectors.

The primary objective of this study is to examine the behavioral and organizational factors influencing the acceptance of Industry 4.0 technologies in diverse industrial sectors. By leveraging the TAM and UTAUT models, this research tests the following hypotheses:

- H1: Perceived usefulness of Industry 4.0 technologies is positively associated with adoption intention.
- H2: Perceived ease of use fosters technology acceptance.
- H3: Social influence positively affects the intention to use these technologies.
- H4: Facilitating conditions positively moderate the relationship between employees' perceived usefulness and their intention to adopt Industry 4.0 technologies.

This article is structured as follows: The Literature Review section discusses relevant theoretical models and prior studies on technology acceptance within the Industry 4.0 context. The Methodology section outlines the quantitative approach used, including measurement tools and data collection processes. The Results section presents statistical analyses and hypothesis testing. The Discussion section interprets the findings in relation to existing theoretical frameworks and highlights practical implications. Finally, the Conclusion summarizes the study's contributions and proposes directions for future research.

2. LITERATURE REVIEW

This section explores theoretical models and existing research on technology acceptance, with a specific focus on the context of Industry 4.0. It examines key frameworks, such as the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT), evaluating their relevance for the adoption of advanced technologies in industrial organizations. Additionally, it underscores organizational and social factors, including facilitating conditions and social influence, that impact technology acceptance. The review concludes by identifying gaps in the literature, emphasizing the necessity for this study.

2.1 Theoretical Models of Technology Acceptance

The principal frameworks for studying technology acceptance in organizational contexts are the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT). Technology adoption within Industry 4.0 heavily relies on the two foundational constructs of TAM, proposed by Davis (1989) : perceived usefulness (PU) and perceived ease of use (PEOU). PU refers to the belief that using a technology enhances job performance, while PEOU represents the degree to which the technology is perceived as user-friendly. These dimensions significantly influence users' intentions to adopt new technologies, as confirmed by extensive validation across various industrial contexts. Recent research corroborates that these socio-psychological factors remain central to adoption intentions for Industry 4.0 technologies (Bagheri et al., 2024).

The UTAUT model, developed by Venkatesh et al. (2003), extends TAM by incorporating additional constructs such as social influence and facilitating conditions. Recent studies demonstrate the positive effect of these elements on employees' intentions to adopt technologies, such as collaborative robots in textile factories (Nguyen, 2022). These findings highlight the crucial role of organizational support and social dynamics in facilitating technology adoption, particularly in Industry 4.0 settings.

2.2 Industry 4.0 and Technology Acceptance

Industry 4.0 represents a strategic initiative to transform industrial practices by integrating advanced technologies, such as the Internet of Things (IoT), artificial intelligence (AI), and cyber-physical systems (CPS). These innovations enable intelligent and autonomous communication among people, products, and complex systems, forming the backbone of optimized industrial operations (Anderl, 2014). However, their implementation often demands significant changes in workplace practices, which may face resistance from employees due to perceived complexity or fear of change (Attiany et al., n. d.).

Research demonstrates that factors such as perceived usefulness, perceived ease of use, facilitating conditions, and social influence significantly shape employees' attitudes and intentions to adopt these innovations (Jum'a & Alkhodary, n. d.). Consequently, TAM and UTAUT continue to serve as relevant frameworks for examining acceptance determinants, even in less conventional applications like remote healthcare technologies (Rouidi et al., 2022).

2.3 Organizational and Behavioral Factors in Technology Acceptance

Organizational factors are critical in shaping employees' perceptions of technology adoption. Support from senior management, coupled with effective change management practices—such as training, communication, and recognition—positively influence attitudes toward adopting Industry 4.0 technologies (Ouadahi, 2008; Mutavdzija, 2023; Kovacic, 2023). Zhang et al. (2020) emphasized the importance of facilitating conditions, including training and resource availability, in enhancing perceived usefulness and promoting acceptance. These practices mitigate adoption barriers by fostering a supportive environment.

Social influence also profoundly affects workplace technology adoption (Graf-Vlachy et al., 2018). In industrial environments, employees are often influenced by colleagues and supervisors, adopting new technologies when they perceive a positive organizational culture. According to Weidman & Young-Corbett (2011), innovation champions—influential and knowledgeable employees—play a pivotal role in driving technology adoption within teams. However, misidentification of these champions can lead to improper usage or abandonment of new solutions.

2.4 Gaps in the Literature and Study Rationale

Despite significant advancements, several gaps persist in understanding technology acceptance within Industry 4.0. Many studies focus narrowly on specific technologies or sectors, limiting the generalizability of their findings. Integrated approaches are rare, and the moderating role of facilitating conditions in industrial environments remains underexplored. Therefore, a more holistic investigation of the transformation toward Industry 4.0 is warranted (Demeter et al., 2020).

This study addresses these gaps by adopting a systemic and multidisciplinary framework that accounts for the complex interplay of technological, organizational, and cultural factors unique to Industry 4.0 (Häring et al., 2023). By examining the role of organizational factors as moderators, this research aims to provide both theoretical and practical insights into adoption dynamics across diverse industrial settings.

In summary, this review emphasizes the continued relevance of TAM and UTAUT in understanding technology acceptance within Industry 4.0. It highlights the significant impact of organizational and social factors—such as social influence and facilitating conditions—on adoption processes. Finally, it justifies the need for a multi-enterprise investigation to bridge existing literature gaps and contribute to a deeper understanding of technology acceptance in varied industrial contexts.

3. METHODOLOGY

This section presents the methodological framework employed to collect and analyze data in our study, which aims to identify the factors influencing the acceptance of Industry 4.0 technologies and to evaluate the moderating effect of facilitating conditions on the relationship between perceived usefulness (PU) and intention to use (IU). It details the study design, variables measured, data collection procedures, and statistical techniques used to test the research hypotheses.

3.1 Study Design

This study adopts a quantitative research approach to investigate the determinants of Industry 4.0 technology acceptance across various industrial sectors. The analysis is grounded in the theoretical frameworks of the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT). These frameworks propose that the intention to adopt technologies is influenced by four key factors: perceived usefulness (PU), perceived ease of use (PEU), social influence (SI), and facilitating conditions (FC). These models were selected for their established applicability and efficacy in explaining technology adoption across diverse professional contexts, as demonstrated in prior studies (Cours EBSI, 2020).

The study utilizes a structured questionnaire, designed and disseminated via Google Forms, to systematically capture employees' perceptions and attitudes. The survey was distributed online through professional networks and communities to ensure comprehensive data collection.

3.2 Variables and Measurements

The study evaluates five primary variables derived from TAM and UTAUT, each measured using a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). Each variable is assessed with four specific items. The specific variables, their descriptions, and sample items are presented in Table 1.

Table 1. Variables and Sample Items

Variable	Description	Sample Items
Perceived Usefulness (PU)	Measures the perceived impact of technologies on employee productivity.	"This technology improves my productivity."
Perceived Ease of Use (PEU)	Assesses the perceived simplicity of using the technologies.	"This technology is easy to learn."
Social Influence (SI)	Evaluates the influence of colleagues and superiors on technology adoption.	"My supervisor encourages me to use this technology."
Facilitating Conditions (FC)	Measures perceived organizational support, such as access to resources and training.	"I have access to necessary resources."
Intention to Use (IU)	Assesses employees' willingness to sustainably adopt the technologies.	"I am willing to use this technology."

3.3 Sampling and Target Population

The target population includes employees across various industrial sectors with exposure to, or direct use of, Industry 4.0 technologies. The sectors covered are:

- Manufacturing (automotive, textile, chemical, metallurgy)
- Information and Communication Technology (ICT) and Electronics
- Energy and Environment (renewable energy, smart energy management)
- Agri-Food Industry (smart agriculture, automated food processing)
- Healthcare and Pharmaceuticals (smart health systems, biotechnology)

A sample of 150 participants was recruited through targeted posts on LinkedIn, Facebook, and specialized online platforms such as Quora, StackExchange, and Reddit. Although the sampling approach is non-probabilistic, it allowed for a geographically and sectorally diverse population. This diversity provides a suitable foundation for studying technology acceptance while acknowledging the potential limitations in generalizability due to sampling biases.

3.4 Data Collection and Analysis Procedure

Data collection was conducted over a four-week period using an online questionnaire. Participant anonymity and confidentiality were strictly maintained in accordance with ethical research standards.

The collected data were analyzed using JAMOVI statistical software, enabling robust statistical analysis. The following techniques were applied:

- **Principal Component Analysis (PCA):** Used to validate the structure of the measured variables and reduce dimensionality while preserving key information. PCA confirmed the validity of the five theoretical dimensions (PU, PEU, SI, FC, IU) and accounted for a significant portion of the variance, reinforcing the robustness of the model.
- **Multiple Linear Regressions :** Applied to explore relationships between the independent variables (PU, PEU, SI, FC) and the dependent variable (IU). Statistical significance (p-values < 0.05) and adjusted R^2 coefficients were used to assess the robustness of these relationships and the model’s explanatory power.
- **Moderation Analysis:** Conducted to evaluate the moderating effect of facilitating conditions (FC) on the relationship between perceived usefulness (PU) and intention to use (IU), elucidating contextual factors that influence this dynamic within technology adoption.

This methodological framework provides a comprehensive analysis of the factors influencing the intention to adopt Industry 4.0 technologies. By integrating TAM and UTAUT models with advanced statistical analyses, the study offers valuable insights for researchers and practitioners aiming to promote technology adoption in industrial contexts.

4. RESULTS

This section presents the findings obtained from the analysis of the collected data. It begins with a descriptive analysis detailing the demographic and professional characteristics of the participants. Subsequently, the results of statistical analyses are outlined, including the validation of dimensions using Principal Component Analysis (PCA), hypothesis testing through multiple linear regression, moderation effect analysis, and a synthesis of the key outcomes.

4.1 Descriptive Analysis

The study sample exhibits considerable diversity at both sectoral and functional levels, thereby ensuring the representativeness of the results across a wide range of organizational contexts.

Sectoral Diversity:

- Manufacturing Industry (40%): Includes sectors such as automotive, textiles, chemicals, and metallurgy.
- Information and Communication Technologies (ICT) and Electronics (25%): Comprises companies specializing in advanced technologies.
- Energy and Environment (19%): Encompasses sectors focusing on renewable energy and smart energy management.

- Other Sectors (16%): Includes the agro-food industry, healthcare, and pharmaceutical sectors.

Functional Diversity:
- Engineers and Technical Specialists (33%): Engaged in research, development, and automation activities.
- Managers and Supervisors (26%): Responsible for team management and project coordination.
- Operators and Technicians (21%): Play a key role in daily technical operations.
- Other Roles (19%): Include strategic decision-making, administrative, and support functions (e.g., human resources, finance).

This sectoral and functional diversity ensures that the sample encompasses a wide range of organizational contexts, thereby enhancing the representativeness of the study's findings. As emphasized in the literature, a diverse sample more effectively captures the inherent variability within target populations, offering a more precise and broadly applicable understanding of the studied markets or organizations. This methodological approach enables researchers to draw conclusions that resonate across all analyzed segments (Ahmed, 2024).

4.2 Validation of Dimensions (PCA)

Principal Component Analysis (PCA) was employed to reduce the complexity of the five measured dimensions while maintaining the essential underlying structures and trends. This method facilitated dimensionality reduction while preserving critical information. The analysis revealed that the first principal component accounted for 69.94% of the total variance, indicating its ability to capture a substantial portion of the data's variability. These findings suggest a coherent and meaningful factor structure, providing a robust basis for analyzing the studied dimensions.

Factor loadings exceeding 0.5 for each dimension indicate an adequate representation of the principal components. This aligns with the criteria established by Hair et al., (2010), who consider loadings above 0.5 as acceptable and those above 0.7 as optimal, thereby reinforcing the validity of the identified structure (Ghadi et al., 2012).

The validity of PCA was confirmed through tests assessing sample adequacy and the quality of the correlation matrix. The KMO measure (0.808) exceeded the threshold of 0.5, affirming the suitability of the sample for PCA. Additionally, Bartlett's test of sphericity ($p < 0.05$) validated the correlation matrix, indicating that the variables were sufficiently correlated to justify the application of PCA (Miljko, 2020).
Finally, Cronbach's alpha coefficients, which were used to assess the internal consistency reliability, ranged from 0.922 to 0.964. These values indicate a high degree of reliability for the measurement instruments across all dimensions, confirming that the items consistently assess the intended constructs (Marketeur Expert, n. d.). These results highlight the robustness of the measurement scales and reinforce the validity of the examined dimensions. The specific eigenvalues and explained variance are detailed in Table 2.

Furthermore, the PCA results regarding the dimensions, factor loadings, and reliability scores are summarized in Table 3.

Table 2. Eigenvalues and Variance Explained

Component	Eigenvalue	% Variance	% Cumulative
1	3.497	69.94	69.94
2	0.705	14.11	84.00
3	0.424	8.47	92.50
4	0.199	3.99	96.50
5	0.175	3.50	100.00

Note: The first component (Component 1) explains 69.94% of the total variance, making it critical for dimensionality reduction and understanding the data structure.

Table 3. PCA Results

Dimension	Eigenvalue	Average Factor Loadings	Cronbach's Alpha
Perceived Usefulness (PU)	3.497	0.657	0.933
Perceived Ease of Use (PEU)	0.705	0.901	0.922
Social Influence (SI)	0.424	0.878	0.941
Facilitating Conditions (FC)	0.199	0.813	0.964
Intention to Use (IU)	0.175	0.907	0.960

Note: The average factor loadings indicate a strong alignment of variables with their respective dimensions, while Cronbach's alpha coefficients demonstrate high internal consistency for each dimension.

In summary, the PCA results confirm the robustness of the factorial structure across the five dimensions studied and demonstrate the reliability of the measurement instruments. This is supported by the results of the validity tests (KMO and Bartlett's test) and the Cronbach's alpha coefficients. These findings validate the robustness of the scales and the methodological approach adopted in this study. Consequently, they establish a solid foundation for analyzing the relationships between the variables in the subsequent sections.

4.3 Hypothesis Testing

Linear regression analyses were performed to evaluate the relationships between the independent variables—Perceived Usefulness (PU), Perceived Ease of Use (PEU), Social Influence (SI), and Facilitating Conditions (FC)—and the dependent variable, Intention to Use (IU). The results indicate that all hypotheses are supported, with the exception of the hypothesis related to Social Influence (SI). Statistically significant β coefficients were observed for PU, PEU, and FC ($p < 0.05$), whereas the coefficient for SI was not significant ($p = 0.069$).

- H1: Perceived Usefulness (PU) is positively associated with intention to use (β = 0.297, $p < 0.001$), confirming that the perception of usefulness significantly increases the intention to adopt technologies.
- H2: Perceived Ease of Use (PEU) has a positive influence on intention to use (β = 0.228, $p = 0.012$), emphasizing the importance of simplicity in technology adoption.
- H3: Social Influence (SI) shows a positive but less pronounced relationship with intention to use (β = 0.150, $p = 0.069$), indicating that the influence of peers or referents plays a role in adoption intention but is marginally non-significant at the 0.05 threshold and less impactful than PU and PEU.
- H4: Facilitating Conditions (FC) are strongly associated with intention to use (β = 0.358, $p < 0.001$), underlining the critical role of organizational resources and support in driving technology adoption.

The detailed regression results for all hypotheses are summarized in Table 4.

Table 4. Regression Results

Hypothesis	Independent Variable	β	p-value	Result
H1	Perceived Usefulness	0.297	<0.001	Confirmed
H2	Perceived Ease of Use	0.228	0.012	Confirmed
H3	Social Influence	0.150	0.069	Confirmed
H4	Facilitating Conditions	0.358	<0.001	Confirmed

4.4 Moderating Effects

The relationship between Perceived Usefulness (PU) and Intention to Use (IU) was examined using a moderated regression analysis. The results reveal a significant interaction between PU and Facilitating Conditions (FC) (β = 0.103, $p = 0.013$), indicating that the positive effect of Perceived Usefulness on Intention to Use is strengthened when Facilitating Conditions are favorable. This moderation effect is illustrated in the interaction graph shown in Figure 1, which depicts the following:

- When Facilitating Conditions are low (one standard deviation below the mean), the relationship between Perceived Usefulness (PU) and Intention to Use (IU) is less pronounced.
- At moderate levels of Facilitating Conditions, the relationship between PU and IU becomes more noticeable.
- When Facilitating Conditions are high (one standard deviation above the mean), the slope of the relationship between PU and IU is steepest, underscoring the amplifying effect of Facilitating Conditions (FC).

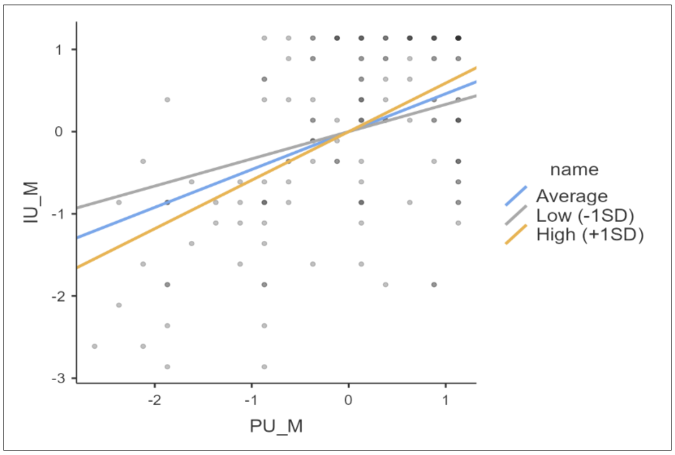

Figure 1. Moderating Effect of Facilitating Conditions on the Relationship Between Perceived Usefulness and Intention to Use

Description: The findings highlight the pivotal importance of Facilitating Conditions in driving the adoption of Industry 4.0 technologies. An organizational environment that ensures comprehensive support—encompassing training, resources, and assistance—significantly enhances the perceived usefulness of these technologies. This, in turn, fosters a stronger intention among employees to embrace their implementation.

4.5 Synthesis of Results

The findings confirm that Facilitating Conditions (FC), Perceived Usefulness (PU), and Perceived Ease of Use (PEU) are critical determinants of the intention to adopt Industry 4.0 technologies. Furthermore, Social Influence (SI) exhibits a positive but marginal relationship with usage intention. Notably, Facilitating Conditions play a dual role: they not only have a direct influence on the intention to use but also function as moderators, enhancing the effect of Perceived Usefulness on Intention to Use.

In conclusion, the analysis underscores significant relationships among the variables examined. Perceived Usefulness, Perceived Ease of Use, and Facilitating Conditions emerge as pivotal predictors of the intention to adopt Industry 4.0 technologies. Although Social Influence is present, it does not constitute a decisive factor. Additionally, the moderating role of Facilitating Conditions amplifies the influence of Perceived Usefulness on usage intention. These results establish a strong foundation for the discussion in the subsequent section.

5. DISCUSSION

This section interprets the findings from the previous section, situating them within a comprehensive theoretical and practical framework. The analysis focuses on the influence of the variables studied on the adoption of Industry 4.0 technologies, emphasizing their implications for both theoretical advancements and practical applications in business and academic research. Additionally, the study’s limitations are critically examined, providing a foundation for proposing directions for future research.

5.1 Interpretation of Results

The findings confirm that Perceived Usefulness (PU) is a critical determinant in the adoption of Industry 4.0 technologies ($\beta = 0.297$, $p < 0.001$). When employees recognize that these technologies enhance their productivity and efficiency, their intention to adopt them is significantly strengthened. This observation aligns with existing studies, which consistently highlight PU as the strongest predictor of adoption intentions across various technologies and contexts. Organizations can leverage this insight to boost adoption rates by effectively demonstrating the practical advantages and tangible value of these technologies to potential users (OurMentalHealth, 2023).

Ease of Use (EOU) also emerges as a crucial factor influencing the intention to adopt new technologies ($\beta = 0.228$, $p = 0.012$). As noted by Meleis (1995), simplifying technologies to improve their usability is fundamental for fostering adoption. In industrial settings, where technologies are often perceived as complex, it is essential to adopt a user-centered design approach that addresses the needs and expectations of end users. This approach facilitates the development of accessible, intuitive, and satisfying technological solutions, thereby promoting adoption and enhancing the efficiency of implemented systems (Team, 2024). These findings are consistent with the perspective of Seneler et al. (2009), who emphasize that while user interface design is sometimes considered secondary, its quality plays a pivotal role in the adoption process of information technologies.

Regarding social influence, although it has a positive role, its impact is relatively minor compared to perceived usefulness and ease of use ($\beta = 0.150$, $p = 0.069$). This result is consistent with the findings of Venkatesh and Zhang (2010), who showed that while social influence positively correlates with the intention to adopt new technologies, its effect may be less pronounced in specific organizational contexts (Skoumpopoulou et al., 2018).

Facilitating conditions not only exert a significant direct effect on the intention to adopt technology ($\beta = 0.358$, $p < 0.001$) but also play a critical moderating role. The interaction between perceived usefulness and facilitating conditions demonstrates that enhancing these conditions amplifies the impact of perceived usefulness on the intention to use technology ($\beta = 0.103$, $p = 0.013$). This finding aligns with the conclusions of Dwivedi et al. (2019), who emphasize the crucial role of organizational support in fostering technology adoption. As noted, factors such as training programs and support services significantly shape individuals' attitudes toward technology by fostering positive perceptions and encouraging adoption.

5.2 Theoretical Implications

The findings of this study provide a substantial contribution to the literature on technology acceptance models, particularly within the context of Industry 4.0. By demonstrating that perceived usefulness, ease of use, and social influence have a direct and positive impact on the intention to adopt technologies, this research validates and extends the applicability of the TAM and UTAUT frameworks to advanced industrial settings.

Moreover, this study deepens the understanding of the moderating role of facilitating conditions, a dimension that remains underexplored in prior research. Unlike most studies focusing solely on the direct effects of user perceptions, our results indicate that favorable organizational conditions significantly amplify the influence of positive perceptions on adoption intentions. These findings highlight the critical role of integrating contextual factors to comprehensively understand the dynamics of technology acceptance in industrial environments.

5.3 Practical Implications

Companies aiming to integrate Industry 4.0 technologies can derive several critical insights from this study. First, the findings underscore the importance of clearly articulating and persuasively demonstrating the added value of these technologies to motivate employee adoption. By implementing tailored training programs and practical strategies that emphasize the tangible benefits of technological innovations, organizations can not only enhance employee perceptions of utility but also expedite the adoption process.

Second, the emphasis on ease of use highlights the necessity of designing technologies to be intuitive and user-friendly, thereby minimizing initial resistance. To address this, companies should invest in training programs that simplify the learning process for technological tools, particularly targeting employees who may be less familiar with such innovations.

While social influence exerts a moderate effect, it represents a strategic opportunity for promoting technological adoption. Organizations can leverage "innovation champions"—influential and knowledgeable employees—to serve as advocates, encouraging their peers to embrace new technologies and fostering a culture of innovation.

Finally, facilitating conditions emerge as a decisive factor. Establishing a supportive environment equipped with adequate resources and streamlined access to technological tools can significantly enhance favorable perceptions, fostering adoption and optimizing organizational outcomes.

5.4 Study Limitations and Suggestions for Future Research

While this study makes significant contributions, several limitations must be acknowledged. The reliance on a convenience sample, restricted to a limited range of industrial sectors, limits the generalizability of the findings across broader contexts. Future research could enhance the robustness of these conclusions by including a more diverse set of industries and geographical regions. Additionally, the quantitative methodology employed, while effective in identifying relationships between variables, does not facilitate an in-depth exploration of the interpersonal and organizational dynamics underlying these relationships. Complementary qualitative approaches, such as in-depth interviews or case studies, could offer richer insights into employee resistance, motivations, and decision-making processes concerning the adoption of Industry 4.0 technologies.

In conclusion, this study underscores key factors influencing the acceptance of Industry 4.0 technologies—namely, perceived usefulness, ease of use, social influence, and facilitating conditions. The findings provide practical recommendations for organizations seeking to promote the adoption of these technologies and lay the groundwork for future research to explore the critical role of organizational and social dimensions in the technological adoption process.

6. CONCLUSION

The adoption of Industry 4.0 technologies represents a pivotal strategic priority for organizations aiming to enhance operational efficiency and sustain competitiveness in an increasingly digital and automated environment. This study underscores the key determinants influencing the adoption of these technologies, employing established theoretical frameworks such as the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT). The findings reaffirm the importance of perceived usefulness, ease of use, and facilitating conditions in shaping employees' intentions to adopt Industry 4.0 technologies. Moreover, while social influence is acknowledged as a contributing factor, its impact is comparatively moderate relative to other examined variables.

From a theoretical perspective, this research extends existing models of technology acceptance by contextualizing them within the framework of Industry 4.0, thereby offering a refined lens for analyzing facilitating conditions. These conditions, rather than functioning as secondary factors, emerge as pivotal moderators in the adoption process. This nuanced perspective sheds light on how well-optimized organizational environments can magnify the positive influence of user perceptions on adoption outcomes.

In practical terms, organizations must prioritize demonstrating the tangible value of Industry 4.0 technologies, designing intuitive user interfaces, and implementing comprehensive training programs to enhance accessibility. Additionally, fostering internal innovation advocates and establishing supportive conditions are critical for driving successful adoption.

Nonetheless, this study is not without limitations. Its focus on industrial sectors and reliance on quantitative methodologies constrains a more comprehensive exploration of the human and organizational dynamics at play. Future research should address these limitations by expanding the scope to include a broader range of industries and employing qualitative methods to gain deeper insights into the contextual and behavioral factors influencing technology adoption.

In conclusion, this study provides a valuable contribution to the understanding of the mechanisms underpinning the adoption of Industry 4.0 technologies. It offers actionable strategies for organizations while paving the way for future research to further explore and refine these insights.

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