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INVESTIGATING THE ROLE OF INDUSTRY 4.0 IN ENHANCING EMPLOYEE'S PSYCHOLOGICAL FLEXIBILITY: EVIDENCE FROM PAKISTAN

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ABSTRACT

This study explores the impact of Industry 4.0 technologies, including automation, artificial intelligence (AI), and the Internet of Things (IoT), on employees' psychological flexibility in Pakistan. Employing a quantitative, cross-sectional survey of 200 participants across diverse industries, the research investigates how these technologies foster adaptability and resilience in a digitally transforming workplace. The findings indicate that Industry 4.0 exposure and psychological flexibility are positively related, while the dominance of automation is leading to reduced repetitive tasks and increased cognitive capacity. IoT supports real-time decision-making, while AI is the source of analytical capabilities. Psychological adaptability has been identified as a critical mediator to show the relevance of resilience in bridging technological exposure and flexibility. The study furthers the theoretical positioning of JD-R and TAM models while providing practical recommendations to organizations for improving employee adaptability through training, supportive culture, and strategic deployment of technology. These will underpin successful digital transformation and workforce well-being.

Keywords: *Industry 4.0 technologies; artificial intelligence; digital transformation; Pakistan*

INTRODUCTION

Industry 4.0, or the "Fourth Industrial Revolution," is the paradigm shift in industries caused by integrating advanced technologies like automation, AI, and IoT. These enable smart factories where interconnected systems analyze real-time data, optimize decision-making, and enhance operational efficiency (Marcucci et al., 2021). It is with the help of such innovations that organizations can reap unprecedented productivity and flexibility to respond to volatile market demands and sustain their lead in the competitive, technology-swayed world marketplace. This is in agreement with (Mourtzis et al., 2016). However, at the same time, such rapid digital changes bring a number of challenges, especially for employees, in terms of great and increasing requirements for psychological flexibility, that is, the ability to adapt to changed circumstances and to stay resistant to stress.

All in all, adapting to AI-driven workflows, real-time decision-making systems, and enhanced communication networks via the IoT creates tremendous stress in the minds of workers. As such, to remain relevant at workplaces, one needs to adapt oneself constantly and continuously learn to be relevantly fit in work environments that have come a revolution's way; (Schultz et al., 2014). In emerging economies like Pakistan, where there has

been an increasingly fast pace toward Industry 4.0, the gap is wide regarding awareness of its psychological consequences. While these technologies are increasingly being implemented in various industries, research remains focused on the technical and organizational aspects of their implementation, with the important impact these changes have on the mental condition and adaptability of the employees being ignored (Russian, 2021). The discussion of this gap is crucial for a comprehensive assessment that ensures the benefits accruing from Industry 4.0 are not at the expense of resilience and productivity within the workforce.

Psychological flexibility is now an important prerequisite for employees to deal with the dynamic challenges posed by Industry 4.0 technologies. This construct encompasses the ability to shift perspective, embrace uncertainty, and respond effectively to unforeseen challenges, which are all crucial for a resilient and adaptable workforce (Schultz et al., 2014). Thus, such employees devoid of psychological flexibility will be challenged by modern fast-changing workplaces, rapid changes in technologies, and growing expectations and will suffer from stress and job dissatisfaction--and probably lowered productivity.

This is an even more significant issue in the Pakistani context because organizations usually function on limited resources with underdeveloped technological infrastructures. Such factors may worsen the problems that employees have to confront in order to switch over to Industry 4.0 environments. The present study tries to fill the literature gap by examining the impact of Industry 4.0 technologies on the psychological flexibility of employees in Pakistan.

Addressing these relationships, the study seeks to provide actionable insights that can inform the design of workplace strategies and HR policies enabling organizations to maximize the benefits of Industry 4.0 while safeguarding employee well-being. Moreover, it represents a theoretical contribution to psychological flexibility in industrial transformation and sets the stage for future research in this area.

Literature Review

Industry 4.0: A Comprehensive Overview

Industry 4.0, also known as the Fourth Industrial Revolution, is marked by the integration of technologies that blend physical and digital processes (Da Xu et al., 2018). At its core are several transformative technologies such as the Internet of Things (IoT), automation, machine learning, and cyber-physical systems (CPS), which collectively redefine industrial operations by connecting and enabling real-time data communication across devices (Pivoto et al., 2020). IoT especially allows for machine-to-machine communication incessantly, leading to a networked ecology wherein the systems automatically interact with each other in the operation management (Bello & Zeadally, 2014). Moreover, machine learning algorithms provide predictive capabilities, enabling the machines to make precise decisions while eliminating or at least minimizing productivity reduction and optimizing maintenance schedules (Madasamy et al., 2023).

Psychological Flexibility in the Workplace

Similarly, psychological flexibility involves the capacity to flexibly contact the present moment as a thinking human, in a manner that is changing with situational demands; it means capability for shifting one's perspective and acting in a way consistent with core values in the face of stressful situations or adversity (Reinhold, 2024). It includes facets such as resilience, open-mindedness toward experience, and even readiness for change.

Psychological flexibility makes a great contribution to the well-being of employees because it acts like a buffer against job-related stress, good mental health, and increases job satisfaction. It will help employees participate in work activities that are valued without paralyzing themselves with stress or negative emotions, which again nurtures a facilitating work culture, enhancing life satisfaction (Holmberg et al., 2020). Psychological flexibility also serves as a predictor of lower levels of distress among high-stress professions, including nursing, where the construct mediates the effects of burnout and supports mental resilience, hence serving as an important component for workforce stability maintenance (Kroska et al., 2020). Furthermore, during a crisis the COVID-19 pandemic situation it was found that psychological flexibility is associated with less distress and more mental resilience, which in turn suggests the importance of psychological flexibility in the setting of employees' adversity (Kroska et al., 2020).

Psychological flexibility in the forms of resilience, openness, and adaptability becomes part and parcel of thriving in contemporary work scenarios. Not only does it make them more adaptable, but its consequences are also reflected in the sphere of mental well-being and, therefore, make the workforce resilient and productive.

Industry 4.0 and Employee Psychological Adaptability

Research on Industry 4.0 reveals that the introduction of technologies such as automation, artificial intelligence (AI), and the Internet of Things (IoT) is reshaping employee behavior and influencing adaptability in the workplace. Studies show that Industry 4.0 technologies enable decentralized control systems, where employees interact with automated machines and digital interfaces, which requires heightened adaptability and openness to technological changes. Moreover, the demand for employee proactivity and innovation increased more and more since workers were supposed to interact with autonomous systems that make decisions automatically in real-time complicating the role of employees (Brkic et al., 2019).

AI in Industry 4.0 contributes to better operational efficiency while simultaneously demanding increased flexibility of employees due to the constantly changing character of AI-driven workflows. In high-tech manufacturing environments, AI predictive capabilities drive automated maintenance and quality control, putting workers under the constant pressure of updating their skills to the latest AI tools and data analysis techniques introduced (Benešová & Tupa, 2017). Almost all technical changes are also cultural shifts for the organizations that mediant them and require a mind open to learn and flexibility from employees. Researchers suggest that continuous improvement involvement may decrease adverse levels of stress and increase adaptability among employees by means of feedback and learning platforms, for example (Tortorella et al., 2018).

Adaptability, too, becomes key to psychological well-being inasmuch as employees who perceive themselves as adaptable are, in the process, capable of handling uncertainties that Industry 4.0 technologies have only just brought along. Findings from the study by Dun & Kumar (2023) indicate that transformational leadership and emotional intelligence of managers may activate employees to be more accepting of Industry 4.0 tools, thereby further enhancing their adaptiveness along with reduced levels of stress. In turn, supportive and enabling environments instituted by leaders can help the employee to embrace such change through skill development which will have a positive effect on psychological well-being (Dun & Kumar, 2023).

Industry 4.0 technologies are affecting not only operational efficiency but directly impacting employees' behavior, adaptability, and well-being. Workers operating under a technologically integrated environment have to develop new competencies that would enable them to maintain resilience and job satisfaction in the face of continuous challenges. Training programs targeted at enhancing digital literacy and adaptive capabilities have become imperative to equip employees with the necessary qualities to meet work demands within Industry 4.0 environments (Flores et al., 2020). All in all, even though Industry 4.0 demands one important thing—the adaptability of employees a strategic focus on employee involvement, training, and leadership support will ensure a smooth transition into the digital era.

Identification of Gaps

Despite extensive studies undertaken regarding the technological and operational impacts of Industry 4.0, a gap still exists in the realm of psychological flexibility among employees in general, and for developing countries such as Pakistan in particular. Most research at this moment is focused on technical and productivity aspects, which often overlooks the psychological and adaptive challenges employees face in view of their interaction with advanced technologies such as artificial intelligence, automation, and the Internet of Things (Brkic et al., 2019; Tortorella et al., 2018). Moreover, although adaptability is acknowledged as a relevant competence to cope with Industry 4.0 contexts, only a few studies detail which particular aspects of Industry 4.0 affect this characteristic (Ahumada-Tello et al., 2023; Madonna et al., 2019). There is also still limited empirical research into the degree to which psychological flexibility might buffer the stress and cognitive burdens this encompassing technology brings about (Dun & Kumar, 2023). Addressing these gaps will provide insight into how Industry

4.0 technologies impact employee well-being and adaptability, informing effective HR and policy strategies for digital transitions in Pakistan.

Theoretical Framework and Hypothesis

The current study is theoretically embedded in the JD-R model and the Technology Acceptance Model for an overarching understanding of Industry 4.0 technologies' influence on employees' adaptability, psychological flexibility, and technology adoption. The JD-R Model postulates that these technologies will play a dual role: they will be a source of job demands and job resources, while TAM places emphasis on factors driving the acceptance of such innovations within workplace environments.

The JD-R Model frames workplace factors within two categories: job demands, which include heavy cognitive loads, and the requirement for continuous learning; and job resources-which provide the supportive tools and autonomy. Full implementation of IoT, AI, and automation-each typical of Industry 4.0 technologies-increase the cognitive pressure on employees who have to act upon real-time data and advanced operation mechanisms. The TAM, in turn, focuses on how perceived ease of use and perceived usefulness alone affects employees' acceptance of any new technologies. Complex systems might slow down their adoptive process while well-designed interfaces and extensive training can enhance the perceived ease of use. Similarly, if employees perceive that there is some real benefit, such as improving efficiency, reducing task complexity, among others, then they are likely to accept those technologies (Tubaishat, 2017; Chatterjee et al., 2021). In general, therefore, the TAM framework gives insight into how organizations might spur adaptability and psychological flexibility via perceptions and attitudes that address employees' acceptance of technologies.

Drawing from these models, this study advocates for a conceptual framework that relates Industry 4.0 technologies to psychological flexibility, underlining in particular cognitive psychological adaptability. Though the demands of continuous skill development and adaptive learning are imposed by Industry 4.0 environments, they also provide opportunities for growth and resilience through routine task automation and enhanced decision processes.

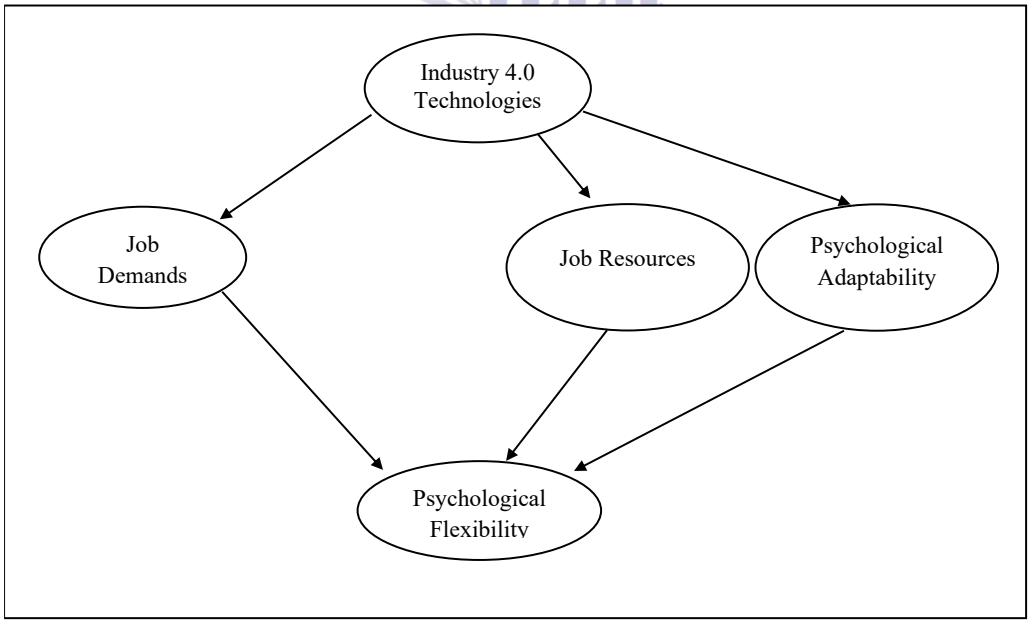

Figure 1: Theoretical Framework

The following hypotheses are derived from this framework:

H1: Industry 4.0 technologies have a positive impact on psychological flexibility.

The hypothesis, based on the JD-R Model, is that job resources provided by Industry 4.0 enable employees to make better use of automation, leap into real-time insights, and thus manage workplace

stressors better and foster psychological flexibility (Dalmarco et al., 2019).

H2: Different aspects of Industry 4.0 differently affect psychological flexibility.

The working hypothesis considers the differential functions of various technologies; for example, automation reduces the load on cognition; IoT enables real-time monitoring, and AI helps to make more accurate predictions about future states, thus influencing psychological flexibility differently (Ahumada-Tello et al., 2023).

H3: Psychological adaptability mediates the influence of Industry 4.0 exposure on psychological flexibility (Tubaishat, 2017).

Research Methodology

Research Design

This study has utilized a quantitative cross-sectional survey design to assess the effect of Industry 4.0 technologies, that includes AI, IoT, and automation, on employees' psychological flexibility in Pakistan. The quantitative approach is appropriate to identify the relationship between different variables because, by using numerical data, it provides very accurate measurement that helps in analyzing trends and relationships in a strong way (Creswell & Creswell, 2017).

The cross-sectional design entails the collection of data at one point in time and hence gives a snapshot of the current state of Industry 4.0's influence on psychological flexibility. This type of design is particularly useful in fast-evolving fields and provides timely insight into how technological changes shape employee adaptability (Vannette & Krosnick, 2017). The questionnaires provide standardized measurement for perceptions associated with the adaptation of technology and psychological constructs of flexibility that can be compared among respondents. The results will have practical implications for human resources managers and policy makers in helping to understand how to nurture adaptability and psychological resilience during digital transformation.

Sampling Method and Sample Size

The sampling strategy will be a form of purposive sampling, which deliberately selects the participants based on strict criteria-that they work for organizations that are either adopting or in the process of adopting Industry 4.0 technologies (Campbell et al., 2020). This method ensures the inclusion of people with direct exposure to advanced technologies and allows the study to obtain rich, focused data on the impact of Industry 4.0 on psychological flexibility. By focusing on participants who are active users of these technologies, the study does not waste any data from non-users or casual users, which could dilute the findings, thus making the data more relevant and accurate.

It will represent a sample of 200 respondents, which balances statistical robustness with the constraint of time and resources. Such a sample size provides a satisfactory quantitative research material from which one may elicit meaningful trends or relationships. However, for finding medium-to-large effect sizes of social science studies (Memon et al., 2020), this threshold could be quite apt-maybe these results are appropriate with regard to the validity and generalizability of findings across all employees operating Industry 4.0 working environments.

The following will be gathered from the respondents: age, gender, type of industry, level in the organization, and years of experience. This would ensure a diverse sample, thus enabling subgroup analyses and providing insights into how various demographic factors influence employees' adaptability and psychological flexibility in the context of Industry 4.0 technologies.

Data Analysis Techniques

This is analyzed through the structured questionnaire by tapping into descriptive statistics, correlation, and simple regression analyses. The above techniques have been selected in order to have a comprehensive understanding of the relationships: Industry 4.0 technologies and psychological flexibility while assuring findings that are statistically robust and actionable (Chattamvelli & Shanmugam, 2023).

Descriptive statistics will be used to summarize demographic information on industry type and role level from participants as filled out in Section 1 of the questionnaire, see Appendix 1. Frequency, percentage, mean, and standard deviation are calculated in an overview of sample characteristics according to Chattamvelli & Shanmugam, 2023. These figures are important in ensuring that this sample is representative and cuts across various industries and occupations. The usage of Industry 4.0 technologies across

industries is a good example, for instance, of a different level of exposure and depth of adoption. A simple regression analysis describes the magnitude to which variation in an independent variable, that is, an individual's exposure to Industry 4.0 technologies, will bring about variation in a dependent variable, psychological flexibility. This is analyzed through SPSS, a general software used in analyzing statistics in social sciences research. SPSS was chosen since it is friendly to the atmosphere and powerful in running complicated statistical tests such as the correlation and regression tests (Roni & Djajadikerta, 2021).

Data Analysis and Findings

This chapter presents the analysis of data collected in this study on the influence of Industry 4.0 technologies on the psychological flexibility and adaptability of employees in Pakistan. Correlation analysis explores the relationships between Industry 4.0 exposure, psychological flexibility, and adaptability, quantifying the strength and direction of these associations. Regression analysis examines the predictive impact of Industry 4.0 technologies and their components—automation, AI, and IoT—on psychological outcomes, testing the hypotheses regarding their varying influences. These analyses directly connect to the study's objectives by highlighting the mechanisms through which Industry 4.0 fosters adaptability and resilience, aligning with the overarching aim to provide actionable insights for organizational and policy-level interventions.

Descriptive Statistics

This section provides a detailed analysis of participant demographics, focusing on their primary industries and organizational roles. The insights are supported by bar charts to visualize key findings.

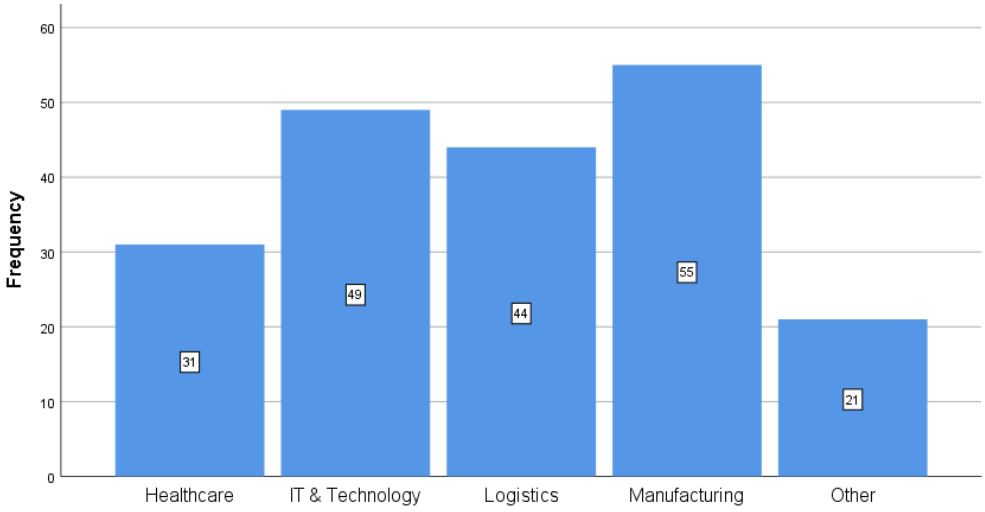

Figure 2: Primary Industry

Figure 1 bar chart illustrates the frequency distribution of participants across various industries. The manufacturing sector exhibits the highest participation, with 55 respondents, reflecting its advanced adoption of Industry 4.0 technologies like automation and IoT. IT & Technology follows closely with 49 participants, indicating the sector's pivotal role in driving digital transformation. Healthcare and Logistics sectors contribute 31 and 44 participants, respectively, suggesting moderate integration of Industry 4.0 technologies. The "Other" category, with 21 participants, encompasses a variety of industries that also experience the impacts of digitalization.

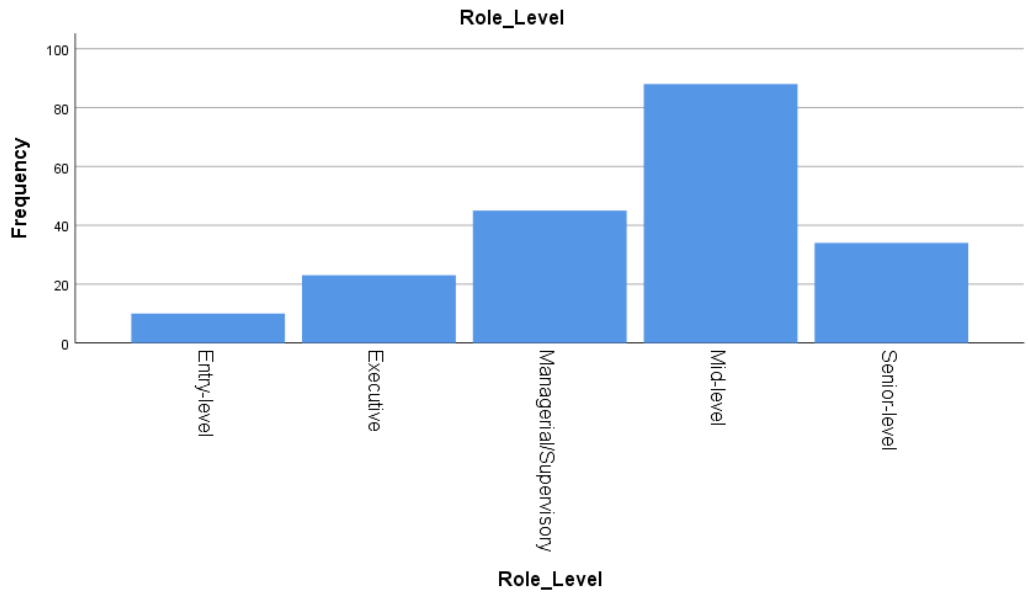

Figure 3: Role in the Organization

The second bar chart presents the distribution of participants by organizational role levels. The majority of respondents belong to mid-level roles (n=90), indicating their active engagement with the operational implications of Industry 4.0. Managerial/Supervisory positions account for 50 participants, reflecting their involvement in decision-making and technological adaptation strategies. Senior-level roles constitute 35 participants, showcasing the perspective of leadership in navigating digital transitions. Executives (n=20) and Entry-level employees (n=5) form smaller portions, potentially due to their limited exposure to advanced technologies or strategic decision-making processes.

Reliability Analysis

Reliability analysis is among the important steps that will make sure the measurement scales applied in this study consistently measure the underlying constructs they were designed for. In this study, Cronbach's Alpha was used to assess the internal consistency of three major constructs: Industry Exposure, Psychological Flexibility, and Psychological Adaptability. The SPSS-calculated results for all the scales showed that they have good to excellent reliability, thus allowing them to be used in further statistical analysis and testing of the hypotheses.

Industry Exposure

The Industry Exposure scale measures participants' interactions with Industry 4.0 technologies, such as automation, artificial intelligence (AI), and the Internet of Things (IoT). The scale includes items assessing exposure, comfort, and perceived efficiency of these technologies. The Cronbach's Alpha for this scale was 0.786, exceeding the commonly accepted threshold of 0.7 for reliability. This result indicates that the items within this scale are well-aligned in capturing participants' Industry 4.0 engagement.

Table 1: Reliability Testing for the Scale: Industry Exposure

Reliability Statistics	
Cronbach's Alpha	No. of Items
.786	3

Psychological Flexibility

The Psychological Flexibility scale shows the degree to which participants can adapt to rapid technological changes, manage workplace stress, and make effective decisions in Industry 4.0 environments. This scale is highly reliable, with a Cronbach's Alpha of 0.793, thus being valid to capture this complex construct. The value reflects

the internal coherence of items measuring adaptability, stress reduction, confidence in managing change, and decision-making based on real-time data.

Table 2: Reliability Testing for the Scale: Psychological Flexibility

Reliability Statistics

Cronbach's Alpha	No. of Items
.793	5

Psychological Adaptability

Psychological Adaptability had the highest reliability score, testing participants on resilience, openness to change, and the changing approaches to work; it is measured by the Cronbach's Alpha: 0.904. The exceptionally high value assures the internal consistency of this scale and measures precisely how capable the employees are to handle challenges brought in unpredictably by Industry 4.0 technologies.

Table 3: Reliability Testing for the Scale: Psychological Adaptability

Reliability Statistics

Cronbach's Alpha	No. of Items
.904	5

The result of the reliability analysis performed, on one hand, attests that all three scales meet thresholds for Industry Exposure, Psychological Flexibility, and Psychological Adaptability with a Cronbach's Alpha way above the threshold for acceptability at 0.7, hence ensuring strong reliability and the fact that the measurement tools used for testing the relationships existing between Industry 4.0 exposure and psychological outcomes will be valid. The consistent results of the three constructs create a firm foundation for further statistical analyses of correlation and regression, hence making the findings credible and sound statistically.

Hypothesis Testing

Hypothesis 1

"Industry 4.0 positively impacts psychological flexibility."

To test this hypothesis, both correlation and regression analyses were conducted to examine the relationship between Industry 4.0 exposure and psychological flexibility. The results demonstrate significant and robust evidence supporting the hypothesis.

Correlation Analysis

Table 4: Correlation Analysis of Industry 4.0 Exposure and Psychological Flexibility

Correlations

		Exposure_Industry4_0	Industry Exposure	Psychological Flexibility
Exposure_Industry4_0	Pearson Correlation	1	.859**	.869**
	Sig. (2-tailed)		0	0
	N	200	200	200
Industry Exposure	Pearson Correlation	.859**	1	.731**
	Sig. (2-tailed)	0		0
	N	200	200	200
Psychological Flexibility	Pearson Correlation	.869**	.731**	1

	Sig. (2-tailed)	0	0	
	N	200	200	200

**. Correlation is significant at the 0.01 level (2-tailed).

The correlation analysis revealed a strong positive relationship between Industry 4.0 exposure and psychological flexibility, with a Pearson correlation coefficient of $r = 0.869$ ($p < 0.01$). This result indicates a highly significant association, where increased exposure to Industry 4.0 technologies aligns with greater psychological flexibility among employees. The strength of this relationship underscores the critical role that advanced technologies, such as automation, IoT, and AI, play in enhancing employees' ability to adapt to changing work environments and effectively handle complexity.

This strong correlation aligns with prior studies suggesting that digital technologies create adaptive work ecosystems, fostering resilience and decision-making capabilities. Employees working in organizations actively adopting Industry 4.0 are more likely to demonstrate flexibility in managing rapid technological advancements and dynamic operational demands.

Regression Analysis

Table 5: Regression Analysis of Industry 4.0 Exposure and Psychological Flexibility

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.731[a]	0.535	0.532	0.34337

a. Predictors: (Constant), Industry Exposure

The regression analysis further validated the hypothesis, showing that Industry 4.0 exposure is a significant predictor of psychological flexibility. The model yielded an R^2 value of 0.535, indicating that 53.5% of the variance in psychological flexibility is explained by Industry 4.0 exposure. The standardized regression coefficient ($\beta = 0.731$, $p < 0.01$) confirms a strong positive effect, highlighting that as exposure to Industry 4.0 increases, employees' psychological flexibility improves significantly.

The adjusted R^2 value of 0.532 suggests minimal variance inflation, confirming the model's robustness. The findings emphasize that Industry 4.0 technologies not only enhance productivity but also empower employees to navigate uncertainty and respond to evolving workplace demands effectively.

The hypothesis is strongly supported by the data. Both the high correlation and significant regression results validate that Industry 4.0 exposure fosters psychological flexibility, enabling employees to adapt and thrive in technologically advanced environments.

Hypothesis 2

"Specific components of Industry 4.0 (e.g., AI, IoT, automation) have varying degrees of influence on psychological flexibility."

This hypothesis investigates the relative impact of key components of Industry 4.0—Automation, Artificial Intelligence (AI), and the Internet of Things (IoT)—on employees' psychological flexibility. A component-wise regression analysis was conducted to assess these technologies' contributions, providing nuanced insights into how they foster adaptability and resilience in the workplace.

Component-Wise Regression Analysis

Table 6: Multiple Linear Regression Model Summary

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.763[a]	.583	.576	.32686

a. Predictors: (Constant), IoT_Process_Monitoring, AI_Data_Analysis, Automation_Workload

Table 7: Multiple Linear Regression for Different Industry Components

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.025	.213		4.812	.000
	Automation_Workload	.409	.054	.425	7.610	.000
	AI_Data_Analysis	.138	.035	.217	3.995	.000
	IoT_Process_Monitoring	.213	.035	.314	6.024	.000

a. Dependent Variable: Psychological Flexibility

The regression analysis yielded a model with an R^2 of 0.583, indicating that 58.3% of the variance in psychological flexibility can be explained by the combined influence of Automation, AI, and IoT. Among these predictors, Automation was the strongest contributor, $\beta = 0.425$, $p < 0.01$, followed by IoT, $\beta = 0.314$, $p < 0.01$, and AI, $\beta = 0.217$, $p < 0.01$.

These results make Automation and IoT more relatively importance drivers of flexibility, thereby ranking higher on an organizations' investment chart; hence, AI becomes complimentary because of its important enabling value added to the enhancement and rationalization of decisional and discretionary processes.

Hypothesis 3

"Psychological adaptability mediates the relationship between Industry 4.0 exposure and psychological flexibility."

This hypothesis investigates the mediating role of psychological adaptability in the relationship between Industry 4.0 exposure and psychological flexibility. The analysis employs correlation and regression methods to assess the sequential influence of these variables, highlighting the critical role of adaptability in fostering flexibility within technologically advanced workplaces.

Correlation Between Psychological Flexibility and Adaptability

A correlation analysis revealed a strong positive relationship between psychological flexibility and psychological adaptability, with $r = 0.734$ ($p < 0.01$). This statistically significant correlation indicates that employees who are more adaptable tend to exhibit higher levels of flexibility in the face of dynamic changes brought about by Industry 4.0 technologies.

Table 8: Correlation Between Psychological Flexibility and Adaptability

		Psychological Flexibility	Psychological Adaptability
Psychological Flexibility	Pearson Correlation	1	.734**
	Sig. (2-tailed)		0
	N	200	200
Psychological Adaptability	Pearson Correlation	.734**	1
	Sig. (2-tailed)	0	
	N	200	200

**. Correlation is significant at the 0.01 level (2-tailed).

Regression Analysis

To test the mediating effect, two regression analyses were conducted:

Industry 4.0 Exposure Predicting Psychological Adaptability

Table 9: Linear Regression Model Summary

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.803[a]	.646	.644	.35365

a. Predictors: (Constant), Industry Exposure

Table 10: Regression Analysis for Industry Exposure and Psychological Adaptability

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	0.235	0.218		1.074	0.284
	Industry Exposure	0.926	0.049	0.803	18.992	0

a. Dependent Variable: Psychological Adaptability

The first regression model demonstrated that Industry 4.0 exposure is a strong predictor of psychological adaptability, with an R^2 value of 0.646, indicating that 64.6% of the variance in adaptability can be explained by exposure to Industry 4.0 technologies. The standardized regression coefficient ($\beta = 0.803$, $p < 0.01$) confirms the significant and positive impact of Industry 4.0 exposure on employees' ability to adapt to new environments and challenges. This finding supports the premise that advanced technologies foster adaptability by equipping employees with tools and processes to handle uncertainty effectively.

Psychological Adaptability Predicting Psychological Flexibility

Table 11: Linear Regression Model Summary

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.734[a]	.538	.536	.34207

a. Predictors: (Constant), Psychological Adaptability

Table 12: Regression Analysis for Psychological Adaptability and Psychological Flexibility

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.679	.180		9.333	.000
	Psychological Adaptability	.621	.041	.734	15.187	.000

a. Dependent Variable: Psychological Flexibility

The second regression model showed that psychological adaptability significantly predicts psychological flexibility, with an R^2 value of 0.538, explaining 53.8% of the variance in flexibility. The standardized regression coefficient ($\beta = 0.734$, $p < 0.01$) highlights that adaptability plays a pivotal role in enhancing employees' ability to manage

stress, adjust to technological changes, and maintain resilience.

These findings align with the Job Demands-Resources (JD-R) Model, wherein Industry 4.0 technologies act as resources to mitigate job demands, and adaptability serves as a key mechanism for transforming these resources into psychological flexibility. The results emphasize that fostering adaptability through targeted training and support initiatives can amplify the benefits of Industry 4.0 technologies on workforce resilience and productivity.

Discussion

Interpretation of Key Findings

This section analyses the results of the study to address the research questions and underlines their implications in the context of Industry 4.0 adoption in Pakistan. The study reveals a strong positive relationship between Industry 4.0 exposure and psychological flexibility ($r = 0.869$, $p < 0.01$). This finding underscore how advanced technologies foster adaptability by enabling employees to handle complex, non-routine tasks and respond effectively to dynamic workplace demands. Industry 4.0 technologies of automation, AI, and IoT collectively contribute to smoothing workflows, reducing repetitive tasks, and providing real-time insights to create an enabling environment for resilience and flexibility. Employees in technology-intense roles showed better decision-making abilities, which reflects the adaptive benefits of those innovations. Automation came to be the most influential component, with the standardized coefficient being $\beta = 0.425$, $p < 0.01$. In essence, automation frees employees from tedious repetitive tasks and frees more cognitive resources for strategic and creative problem-solving. IoT followed closely at $\beta = 0.314$, $p < 0.01$, which is understandable because real-time monitoring by IoT improves situational awareness and rapid decision-making.

While significant, AI had a relatively lower impact, with $\beta = 0.217$ ($p < 0.01$), complementing human intelligence with predictive analytics and data-driven insights. The magnitude of the differences in impact underlines the strategic imperative of deploying these technologies by organizations to maximum employee adaptability. Psychological adaptability mediates the relationship between Industry 4.0 exposure and psychological flexibility. This means that employees who were able to show more adaptability mediated the negative effects of technological change and were better positioned to capitalize on exposure to Industry 4.0 for meaningful outcomes. Regression analysis confirmed that Industry 4.0 exposure strongly predicts psychological adaptability with $\beta = 0.803$ and $R^2 = 0.646$, which in turn significantly predicts psychological flexibility, with $\beta = 0.734$ and $R^2 = 0.538$.

Practical Implications

The findings of the current study have provided a way whereby practical strategies for psychological flexibility and adaptability of employees by fostering the benefits of Industry 4.0 technologies could take place. These implications stress in the highest terms human capital development, strategic technology integrations, and sector-level initiatives that ensure seamless sustainable transitions into the digitalized workplaces. Special training programs, which could increase the adaptability of employees to the technologies of Industry 4.0, are the main recommendations for HR professionals and managers.

Workshops and simulation-based training can also expose employees to real-world scenarios involving IoT systems and AI-driven decision-making, thus increasing familiarity and confidence with these tools. Such training should be continuous, adapting to emerging technological trends in order to keep the workforce up to date. Feedback mechanisms should be incorporated in order to help employees understand and adapt to AI-driven workflows: providing clarity over how such systems influence outcomes, and instigating iterative learning. Healthcare organizations should spend their money on AI-type systems that simplify complex information and support clinical decision-making and thereby free up professionals' time to care for a patient.

Theoretical Contributions

This study, within the TAM framework, extends perceived usefulness to include a mediating role of psychological adaptability. In other words, people are able to estimate the utility of technology more with increasingly adaptive perceptions, which in turn lead to increased psychological flexibility. This would help embed TAM into an already relevant domain of adaptability and, therefore, could bring an advanced explanation of the

technologies' acceptance and behavior implication within a dynamic working group.

Furthermore, the study provides novel insights into the mediating role of psychological adaptability, an under researched area in the literature of Industry 4.0. By embedding adaptability within the narrative, findings link technical and psychological approaches through a holistic framework for understanding how technological transformation affects employee well-being and resilience.

Conclusion

Key Findings

This study explored the influence of Industry 4.0 technologies—automation, artificial intelligence (AI), and the Internet of Things (IoT)—on employees' psychological flexibility, with a focus on the context of Pakistan. It aimed to uncover how exposure to these technologies' fosters adaptability and resilience, while also examining the role of psychological adaptability as a mediator in this relationship. The findings underline how Industry 4.0 has made employees' psychological flexibility different. Automation was one of the significant enablers, since this allowed them to reallocate their attention to the more strategic and creative solving of problems. IoT stands out due to its contribution in promoting adaptability, because it allows it to carry out real-time monitoring and decision-making activities. On the other side, AI supplemented these technologies with contributions to data-driven insights.

This paper focuses on advanced technologies interacting with employees' well-being in order to provide insights for organizations willing to fully exploit the benefits of digital transformation. Industry 4.0 is not an opportunity to enhance operational efficiency only but also a driver that can increase the adaptability and resilience of the workforce. This study concludes by underlining the fact that integration of technology should be combined with strategies that enhance psychological flexibility in order to keep a balanced approach toward modernization.

Practical Recommendations

In this line, to maximize the advantages of Industry 4.0 technologies and increase adaptability among its employees, industry leaders need to take targeted strategies wherein technological advancement is integrated with human resource development. These range from leveraging automation, AI, and IoT to fostering a work culture that allows flexibility and resilience.

- **Leverage Technology for Adaptability**

Automation and the adoption of IoT at work should be the concern of every leader in each industry to reduce the level of routine load and mental tension, making employees think about and solve high-order problems and fulfill strategic tasks. Automation in streamlining regular processes-like the inventory processes of manufacturing-relieves people for creative thinking and value creation. It should go further in integration with an IoT system, which enables the view of real-time operation insight for making a proper informed decision quickly.

- **Cultivate an Adaptable Workplace Culture**

More than anything, it's a question of creating a culture of adaptability, which is at least as important as the technological implementation itself. The industry leaders should foster an environment of continuous learning and psychological resilience. This will be achieved through structured training programs that address technical competencies, adaptability skills in managing uncertainty, and navigating change. Mentorship and peer-support systems will be set up that would encourage collaborative learning, while regular feedback loops can help employees adjust to new technologies and workflows.

Limitations of the Study

Even as this research study provides critical insights into the impact of Industry 4.0 technologies on psychological flexibility, it is important to recognize its own limitations. The first major limitation relates to the research design being cross-sectional in nature, capturing information at one point in time. This restricts any possibility of establishing causation effects between Industry 4.0 exposure and psychological flexibility and observing long-term trends.

Though the sample is a purposive selection directed to employees of various industries who are joining Industry 4.0, the results may not be generalized to the greater workforce in Pakistan. The purposeful sampling method has inherent biases in selection, where participants who had greater exposure or were familiar with advanced

technologies could be overrepresented. Although the sample size was statistically sound, that is, 200, it may not allow generalization to even larger and more diverse populations.

Directions for Future Research

The future study should overcome such limitations by investigating other methodologies and expanding the scope of analysis. For instance, longitudinal studies could explore the changes in psychological flexibility over time in employees' interaction with Industry 4.0 technologies. These would give far more detailed insights into temporal dynamics of adaptability and sustainability of psychological resilience under changing work environments.

Another important direction is expanding the scope of research across geographical and sectoral dimensions. Comparative studies across regions or industries may provide contextual variations in how Industry 4.0 technologies influence psychological flexibility. For instance, contrasting findings from developed and developing economies may suggest infrastructural and cultural factors in shaping employee adaptability.

Future research should also examine the interaction between certain psychological characteristics, like openness to experience or emotional intelligence, and the adoption of Industry 4.0 technologies. Investigating these individual differences can enrich the understanding of adaptability drivers. Besides, mixed-methods approaches, which combine quantitative surveys with qualitative interviews or case studies, may allow an integrated perspective. These may also reveal deeper insights into the lived experiences of employees and help bridge the gap between statistical trends and practical realities. These are the future directions that may help expand both theoretical and practical knowledge about the human impact of Industry 4.0.

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