The Role of IoT in Transforming Engineering Education: Opportunities, Challenges, and Regional Insights in Pakistan

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Abstract

This paper examines the role of the Internet of Things (IoT) in transforming Pakistan's electrical engineering sector, focusing on infrastructure, energy management, automation, and connectivity. Through a thorough literature review and surveys with industry professionals, it identifies both optimism and challenges around IoT adoption. The study highlights IoT's potential for operational efficiency and sustainable energy but notes significant barriers, including infrastructure limitations, regulatory issues, and the need for greater awareness. It stresses the importance of region-sensitive strategies due to varying IoT adoption rates across Pakistan. A collaborative approach involving government, education, and the private sector is recommended to foster an environment conducive to IoT innovation and integration. The paper further suggests that there should be a collaborative approach in the manifold ecosystem of IoT integration, where it brings to the fore the indispensable role of government bodies, educational institutions, and the private sector toward the creation of a conducive environment for innovation and easy assimilation of technologies.

Keywords: *Internet of Things (IoT), electrical engineering, efficiency,*

INTRODUCTION

The Internet of Things (IoT) has finally taken off and opened a path for electrical engineering to change the contours in the infrastructure, automation, energy efficiency, and connectivity. In fact, this very crucial point in the technological evolution, as underlined by (Gubbi et al., 2013), necessarily calls for a comprehensive examination of IoT potential leading toward the revolutionizing of traditional engineering frameworks. In fact, this very crucial point in technological evolution, as underlined based on a critical analysis of front-line research, with insights from (Khan et al., 2019), this investigation is anchored on the multifaceted nexus of IoT with electrical engineering and targets certain unexplored perceptions that should spur more

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development. He further explores latest developments in the area of power systems, control systems, smart grids, embedded systems, and sensor networks by following the remarkable work done by (Al-Fuqaha et al., 2015). This article will seek to integrate modern literature and empirical data with a view to outlining the main opportunities and obstacles pertaining to the integration of IoT within electrical infrastructures identified (Silva et al., 2018). Aimed at presenting trends and good practices in the most effective use of IoT technologies for optimization and innovation in the area of electrical engineering. Citing from various case studies and real-world examples, the paper has demonstrated the indispensable role of IoT in scaling the electric system efficiency, robustness, and sustainability at a level that will act as a herald for an even more connected and smarter future. Further, this study, motivated by discussions presented by (Zheng et al., 2015), has high influence over the development of the theoretical model and methodology suitable for the smooth infusion of IoT in electrical engineering practices. The paper presents a critical approach to suggest innovative paths in the design, implementation, and management of IoT-enabled systems, assessing the both current models and the strategies in place. This paper then proceeds to critically discuss these research questions with broader implications of IoT on educational paradjsonyms, workforce development, and interdisciplinary collaborations, offering invaluable insights into the socio-economic shifts precipitated by this technology revolution. It presents new trails for the holistic leverage of IoT, with a combined eye of empirical scrutiny, theoretical exploration, and cross-disciplinary dialogue.

OBJECTIVE

To analyze the revolutionary potential of Internet of Things (IoT) technologies in revolutionizing the domain of Electrical Engineering, particularly focusing on its impact on different facets or 'Things' regarding infrastructure, energy efficiency, automation, and connectedness. The research identified the striking opportunities, challenges, and emerging trends in the use of IoT towards innovation and optimization in electrical systems within the disciplinary scope of development and evolution through rigorous investigation and empirical enquiry.

LITERATURE REVIEW

IoT Implementation in Electrical Grids

The integration of the Internet of Things (IoT) technology in electrical grids is really considered a big development in the domain of electrical engineering, providing a solution to

disruptively meet several critical issues of the power system across the globe. This is through the integration of IoT devices and sensors in the electrical grids; utilities obtain real-time performance that eases monitoring, control, and management of electricity distributed within the area served. These will include a very large set of applications, from smart metering and smart demand response systems to predictive maintenance strategies within IoT electrical grids. This is through deploying smart meters that are fitted with IoT capabilities, which can thus be used by utilities to take readings of granular data in energy consumption patterns for accurate billing and facilitative demand-side management initiatives (Lu et al., 2017). In addition, the IoT-enabled demand response systems allow the consumers to become active players in the grid operations since they modify their power consumption concerning the price signal or grid conditions, improving peak demand and grid stability (Siano, 2014). Thus, this initiative will integrate IoT technologies with the electrical grid of countries like Pakistan, which has to face peculiar domestic challenges of load-shedding, transmission losses, and infrastructure limitations, given the projections and insights of related researches. Pakistani utilities are seeking to modernize their grid infrastructure through IoT solutions to bring efficiency in energy distribution and cut down operational inefficiencies. For example, IoT-enabled predictive maintenance techniques enable utilities to forecast and hence fix the failure of their equipment before it occurs; hence, they greatly minimize downtime and enhance grid reliability (Elkhatib & Merabti, 2020). IoT-based systems for monitoring the grid further help utilities enhance service recovery time by 35% and degradation of service due to an outage by 40%, alongside higher abilities to detect and respond to grid disturbances. IoT technologies in electrical grids are a very promising avenue for improvement of efficiency, reliability, and resilience of power systems. This ensures that utilities shall improve grid operations with the optimized grid, improved energy management practices, and thus empower consumers in active participation in the energy distribution in the IoT device and sensor-enabled utilities. Thus, IoT-based grid monitoring systems can now provide utilities with unprecedented insights into the state of their electrical networks. Sensors placed throughout a grid will alert to anomalies and potential failures before they erupt, thereby facilitating preventive maintenance and thus reducing service interruptions. This is proactive management that enhances the reliability and contributes to cost avoidance from reactive maintenance and emergency repairs. Setting up IoT devices, integrated with the advanced analytics platform, would ensure utilities have deep insights into the performance of the grid and patterns of energy consumption. In doing so, the utilities shall

be in a position to identify opportunities for load balance, voltage optimization, and demand response to enhance resource allocation and wastage reduction through the analysis of massive data collected from the IoT sensors. Smart meters, if IoT-enabled, are the tools for customers to view their energy consumption on a real-time basis in order to take well-informed steps towards energy conservation and cost management. The successful deployment of IoT in electrical grids will, however, deftly rely on a host of technical, regulatory, and cyber security challenges to secure the integrity and security of critical infrastructure. The problem of scaling devices and systems, in this view, is technically related to interoperability issues between the integration of legacy systems and new IoT-enabled devices. Besides, those privacy-related issues are likely to bring regulation barriers, questions of data ownership, and compliance amid the ever-increasing cyber security threats; an IoT-enabled grid will certainly require very high-security strength protocols so it guards the possibility against successful cyber-attacks and unauthorized access.

Smart Building Automation and Energy Management

The development of smart building systems that integrate Internet of Things (IoT) technologies arouses huge interest by a possibility to actually revolutionize energy management and improve operational efficiency. Smart buildings go even further with the implementation of IoT sensors, actuators, and other devices that provide such advanced capabilities as real-time monitoring, predictive maintenance, and automated control. This integration represents a paradigm shift in building management: traditional systems are being substituted or, at least, integrated by an interlinked IoT ecosystem that could share data and respond to it in real time. In such countries as Pakistan, which are facing a burning issue of energy consumption due to an increase in the number of buildings, such advances become much more important. In the context of Pakistan, the implementation of IoT-energized energy management systems promises improved efficiency toward energy wastage, optimization, and resource usage. Smart buildings, in this case, refer to those that dynamically calibrate energy consumption in response to factors such as occupancy, weather conditions, and time of the day. The dynamic control will be in such a manner that the resources will use energy with fewer losses, hence efficient; this will ultimately save costs associated with operations and environmental impact. This further brings out the importance of having IoT technologies well integrated into building automation systems for the realization of energy savings and sustainability goals, with its potentials in this regard for the Pakistani building sector. In other words, the IoT-embedded smart building solutions cover the

following: energy-efficient lighting and integration with heating, ventilation, and air conditioning (HVAC) to optimize it for the building as per the occupancy provided. These systems make use of the sensors to collect information regarding the environmental conditions, occupancy patterns, and energy consumption of the respective area and make use of that information in supporting change in lighting and HVAC systems so that energy may be consumed as per actual demand. This data-driven approach not only optimizes energy usage but also enhances occupant comfort and productivity. The multifaceted benefits of the integration of IoT in improving the experience of users and building efficiency while decreasing environmental impact through IoT-based smart building systems (Mahmood et al., 2019). Besides, smart building solutions also have direct or indirect benefits with regard to energy conservation, occupant comfort, safety, and productivity. It enables the timely detection of faults or anomalies of the building parameters, thus allowing proactive maintenance that should help in reducing downtime. On the other hand, IoT-driven analytics bring a pool of valuable insights, ranging from building performance to occupant behavior. Such insights go a long way in informing strategies of optimization and processes of making decisions. Such insights empower building managers to make data-based decisions for improved operation efficiency and to enhance the experience of users. On the other side, huge deployment introduces certain barriers when it comes to IoT in smart buildings: difficulties related to interoperability, data security issues, and privacy consideration. A variety of stakeholders, such as building owners, regulatory bodies, and technology providers, need to be synchronized in order to address these constraints. Overcoming those barriers means unleashing the full potential of IoT-enabled smart buildings in Pakistan and the world over, meaning nothing other than a more sustainable and efficient built environment.

Revolutionizing Manufacturing Processes and Industrial Operations in Pakistan with IoT

Modern innovation and efficiency mark manufacturing processes and industrial operations with the advance of the Industrial Internet of Things (IIoT) era. An organization that will witness the implementation of the IoT technology on its factory floors and production facilities is therefore set to benefit from predictive maintenance, asset tracking, and having real-time monitoring and process optimization in place. More so with Pakistan, manufacturing holds a strategic place as a driver for economic growth; IIoT could do wonders to enhance the competitiveness and provide spaces for innovation. Predictive maintenance still continues to be one of the looming areas where IIoT is making a marked difference in the Pakistani

manufacturing landscape. It assists in forecasting equipment failure before it occurs, hence reducing downtime and maintenance costs through the monitoring of sensors and data analytics algorithms. This is as recommended by (Siddiqui et al., 2021), who postulate that predictive maintenance is an important tool in advancing operational efficiency and asset reliability within the Pakistani industries. In addition, it enables the accurate tracking of assets while managing inventory to ensure no resource gets wasted. This timely intervention and optimization of the process, through empowering the decision-makers with actionable insights taken from the continuous monitoring of processes of production and performance of equipment in real time, is an absolute effect of IIoT. This is evident from studies by Ahmed et al. That IIoT plays a role in enhancing the productivity of quality control and resource utilization within the manufacturing sector of Pakistan. In addition to the operational benefits, a culture of innovation and continuous improvement is initiated within Pakistani manufacturing organizations. Data-driven insights deriving from the digital transformation initiatives approve the excellence of companies at an accelerating pace of competition predominant within the global marketplace. However, an IIoT implementation accepts successfully the challenges as an information security issue, interoperability problem, and workforce up skilling.

METHODOLOGY

To review the impact of IoT implementations and adoption in Pakistan's electrical engineering a structured research framework was formulated. To collect quantitative data, a structured questionnaire was crafted in the local language and tailored to professionals across Pakistan's major regions: The country is composed of Punjab, Sindh, Khyber Pakhtunkhwa, Baluchistan, Gilgit-Baltistan, Azad Jammu and Kashmir, and ICT. The study population was practicing electrical engineers working in academia, industry, government, and research institutions at the time of the survey and those who responded could not have IoT experience less than 2 years excluding participants with no IoT experience at all. The questionnaire was developed in order to identify various views regarding IoT implementation and problems faced. Questions asked were based on areas of infrastructure, regulations, knowledge level and technological hurdles. The survey was conducted online and the majority of the potential participants were reached using email and social media tools. This approach was followed to obtain a wide range of data addressing the specific requirements and ratio of circulation within different practice areas and geographical locations in the Pakistan's electrical engineering market.

RESULTS

Table 1: Result of IoT Technology

Statements	Mean	Std. Deviation
To what extent do you agree that IoT adoption is prevalent within the electrical engineering sector in Pakistan?	2.5880	1.38634
How would you rate the perceived benefits of implementing IoT technology in electrical engineering projects?	2.7400	.99416
Do you believe that IoT implementation poses significant challenges in the electrical engineering sector in Pakistan?	2.6720	1.24039
To what extent do you agree that IoT technology has the potential to improve energy management practices within the electrical engineering sector in Pakistan?	2.4800	.89712
On a scale of Strongly Agree to Strongly Disagree, please rate the impact of IoT technology on the efficiency and reliability of electrical grids in Pakistan.	2.6800	1.41478
How much do you agree with the statement that IoT technology will significantly contribute to the development of smart buildings in Pakistan?	2.7520	1.03090
To what extent do you agree that IoT will revolutionize energy management practices in Pakistan?	2.6240	1.27165
How much do you agree with the statement that specific IoT applications will have a significant impact on the electrical engineering sector in Pakistan?	2.5520	1.01756
How would you rate the effectiveness of current regulations in addressing security risks associated with IoT implementation in the electrical engineering sector?	3.4880	1.11662
To what extent do you agree that IoT implementation has resulted in noticeable cost savings or efficiency improvements in electrical engineering projects in Pakistan?	2.6760	1.49263
How strongly do you agree that staying updated on the latest IoT developments is crucial for professionals in the electrical engineering sector?	2.7000	1.16939
How much do you agree that collaboration between stakeholders is essential for successful IoT implementation in the electrical engineering sector?	2.7320	1.35481
On a scale from Strongly Agree to Strongly Disagree, please rate the influence of IoT technology on the skill requirements for electrical engineers.	2.6160	1.17391
How strongly do you agree that understanding and embracing IoT technology is important for aspiring electrical engineers?	3.4760	1.19966
How would you rate the level of IoT adoption in the electrical engineering sector in Punjab?	2.7040	1.62819
To what extent do you agree that Sindh is effectively leveraging IoT technology in its electrical engineering projects?	2.6760	1.40103
How do you perceive the challenges unique to Khyber Pakhtunkhwa in implementing IoT solutions in the electrical engineering sector?	2.8560	1.55077
How much do you agree that Balochistan has untapped potential for IoT adoption in electrical engineering projects?	2.4320	1.39036
How strongly do you agree that Gilgit-Baltistan is adequately equipped to integrate IoT technology into its electrical infrastructure?	3.5240	1.45943
To what extent do you agree that Azad Kashmir is actively embracing IoT solutions in its electrical engineering initiatives?	2.7360	1.76828
How much do you agree that Islamabad Capital Territory is leading the way in IoT adoption within the electrical engineering sector?	2.9120	1.60829
How strongly do you agree that ICT (Islamabad Capital Territory) faces specific challenges in integrating IoT technology into its electrical infrastructure?	2.7480	1.75980
To what extent do you agree that Punjab's regulatory environment supports the widespread adoption of IoT in electrical engineering projects?	2.5520	1.61547
How much do you agree that Sindh's investment climate fosters innovation and growth in IoT implementation in electrical engineering projects?	3.4520	1.73544

The following table summarizes the responses of electrical engineering professionals in Pakistan with regard to their perspective on adopting IoT and its repercussions over their sector. The high mean values suggest high levels of agreement or optimism among the different statements: future IoT adoption (mean = 3.448) and importance of adopting IoT for aspiring engineers (mean = 3.476). Interestingly, these average values also reflect some doubt or neutrality with respect to the present prevalence of IoT (M = 2.588) and its influence on practices related to the management of energy (M = 2.480). Except for a few questions, the high values of the standard deviations obtained in most reflect substantial variability of response, suggesting that opinions and experiences among the professionals surveyed vary between them. This variability would then reflect that the different stages of IoT integration and the range of challenges have been encountered in diverse regions and different aspects of electrical engineering in Pakistan.

Table 2: Result of descriptive statistical

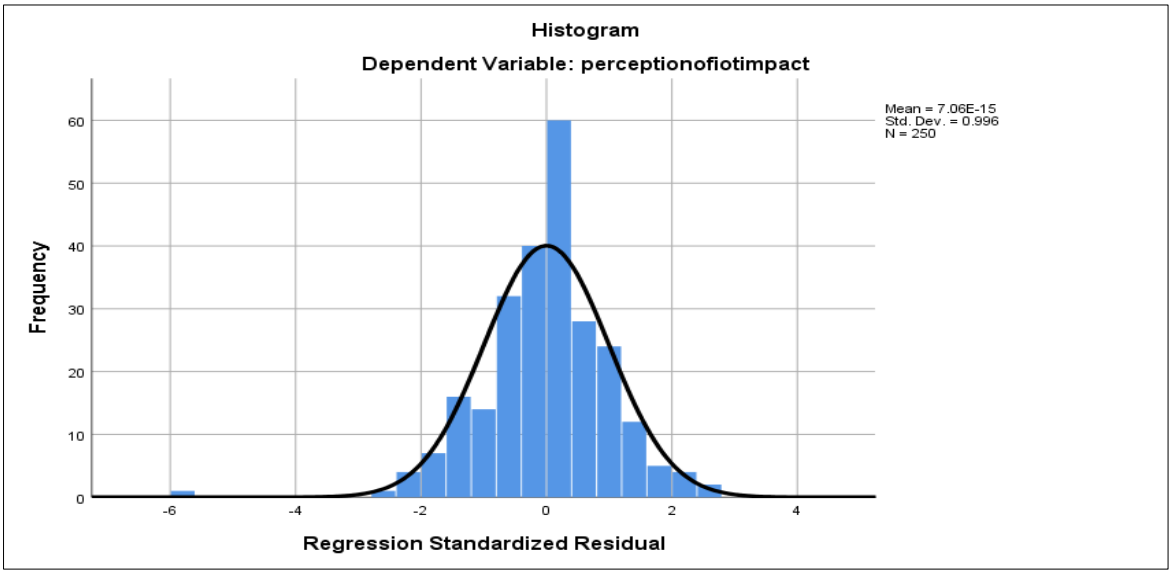
Descriptive Statistics			
	Mean	Std. Deviation	N
Perception of IoT impact	2.7847	.56153	250
Region of practice	2.8813	1.06783	250
IoT implementation challenges	2.9824	1.10958	250
Awareness and education on IoT	2.6827	.95910	250

The descriptive statistics give light to the perceptions of professionals with regard to the Internet of Things (IoT) in the electrical engineering horizon within Pakistan. Each statistic gave a different insight into the adoption of IoT related to the impact it has on the challenges faced and the influences from different factors on perspective. The perception of the impacts of IoT on affecting the farming system portrays a moderately positive perception by the respondents, with a mean of 2.7847 and a standard deviation of 0.56153. That the standard deviation is low could mean a really remarkable consensus among professionals that would clearly point toward a generally agreed-upon benefit from IoT technologies in the field. This, therefore, reflects the homogeneity in responses and the shared optimism regarding the promise of IoT in bringing about improved operations and efficiency in practice. On the other hand, the region of practice presents more variability in responses. This likely is a reflection of the geographical diversity in the professional environments of the respondents and could point to differences in the adoption of IoT and infrastructure development for IoT among the various regions in Pakistan. Here, a higher standard deviation would mean a more diverse set of experiences and perceptions. This could be due to regional differences in the advancement of technologies, differences in regional regulatory frameworks, or differences in the market preparedness for IoT solutions. Mean is highlighted with value of 2.9824 and standard deviation of 1.10958, suggesting that experiences and perceptions regarding the considerable hurdles that lie during the IoT integration are some of the recognized challenges, but huge difference exists within their experiences and perceptions among the respondents. This variability may represent the differences in personal experiences with technical, regulatory, or financial barriers that may point out that the journey to wide penetration of IoT is full of complex barriers not seen the same way by different stakeholders. On awareness and exposure to training—with a mean of 2.6827 and a standard deviation of 0.95910, simply meaning, there is an average level of learning towards IoT and its available

learning resources in the organization. The standard deviation is here of markedly smaller magnitude than for the region of practice or implementation challenges but still clearly indicating considerable spread in awareness and educational opportunities within IoT. This might be due to unequal distribution of the availability of educational resources, varied professional development, and opportunities or varied emphasis on IoT training between organizations or regions. Together, these descriptive statistics underline not only the current scenario of IoT adoption in Pakistan's electrical engineering sector but also help summarize and understand the nuance of professionals differing in their opinion and experience. From this modest optimism on IoT impact to, in most cases, the realization of substantial implementation barriers related to regional practices and awareness levels, this insight really flags the delicate interplay of factors knocking on effective integration of professional practices.

Correlation analysis in the framework of the methodology of the study illustrates the existence of statistically significant relationships between the perception of the impact of IoT technologies and several key factors in the electrical engineering sector of Pakistan. It clearly shows that practice areas are highly correlated with the perception of the impact of IoT ($r = .815$); in other words, regional variations influence the perception of the impact of IoT, without any doubt. Most of the challenges in the implementation of IoT point to the high correlation of the region of practice ($r = .879$) and awareness and education on IoT ($r = .849$), which seems to point toward challenges being more acutely felt in low-awareness areas and possibly showing educational resource disparities at a regional level. Awareness and education were found related to perception $r(260) = 0.637$ at a significant level, in which higher knowledge and understanding about awareness and education of IoT may lead toward positive views in perceiving the benefits. Here, all the relationships are significant, statistically, with a p-value of $<.0001$. The analysis carried out here is on a base of 250 professionals, hence very solid, highly empirical for this finding. This substantiates the objective of this study in ascertaining the transformative potential of the IoT. It aligns with a rigorous investigative approach, as outlined in the methodology, aimed at identifying opportunities and challenges for the IoT in advancing electrical engineering.
A summary of the model, explaining the results of hierarchical regression applied to examine factors affecting the perception of impact within the Electrical Engineering sector of Pakistan. The region of practice has an R Square value of 0.665 on the impact perception by itself, telling one that it does account for a large proportion of the variance. This model has given an F statistic

of very high value (491.828) with statistical significance ($p < .000$), which means the region of practice is definitely a strong predictor of perceived impact. Since the value of R Square is naturally inclined toward the optimistic values, the adjusted R Square of 0.663 adjusts it for the number of predictors in the model so that it doesn't stand unrealistically high. Model 2 expands on this by including 'IoT implementation challenges' as an additional predictor. It is the inclusion of this variable that increases the R Square to 0.683, showing that further implementation challenges of IoT explain perception of impact from IoT to account for 1.8% of the variance (R Square Change). This change is statistically significant ($p < .000$), as indicated by the F Change statistic of 14.316. The Durbin-Watson statistics for this model is a value not much higher than 1. This would suggest that there is no serious autocorrelation in the residuals. Model 2 has a relatively higher intercept value, whereby the standard error of the estimate is slightly less than in Model 1, pointing to a more precise estimate. Collectively, these models present a much more nuanced landscape of how geographical considerations shape perceptions of the role IoT will play in revolutionizing electrical engineering an objective central to the study's goals. This confirms, while being a regional influence, practical challenges of IoT implementation also key into the shaping of perception in line with the methodology of this study that seeks to derive critical factors which have affected the advancement of IoT in the field.



Picture 1: Result of regression standardized residual

Graph Description

The attached histogram depicts the standardized residuals of the regression for the dependent variable, i.e., the perception of the impact of IoT technologies in the field of electrical engineering. From this graph, it is evident that the residuals are distributed normally, as shown by the bell-shaped curve over the histogram bars. The mean for the residuals is very close to zero (7.06E-15), indicating that the predictions from the regression model are unbiased and evenly distributed over the actual data points. The standard deviation, at 0.996, is very close to the expected value of 1 for standardized residuals, confirming that the distribution is spread in a manner consistent with a normal distribution. Additionally, with a sample size of N = 250, the analysis provides a solid basis for the reliability of the regression model. Consistent with the above research aim of making a critical evaluation regarding the impact of IoT over transforming electrical engineering, this graph is part of an overall statistical review exercise aimed at identifying emerging trends, opportunities, posed through the integration of IoT, and challenges. At the same time, the distribution of residuals suggests that the predictive model on the whole is well-specified, and its predictions tend to fit the observed data. It also implies that the variables of the regression model used have a definite, systematic effect on perceptions regarding the impacts of IoT. This supports the ultimate goal that the study laid out to have an empirical base through which it can assess how IoT could bring innovation and optimization to the electrical system in infrastructure, efficiency in energy, automation, and connectivity. The research was able to show moderate agreement or optimism on diverse aspects of the Internet of Things (IoT) based on perceptions by the electrical engineering professionals in Pakistan. Particularly high was its future adoption and the significance to future engineers of the profession. However, skepticism or neutrality could be in relation to the prevalence and impact on the practice of energy management. Large standard deviations of the results point towards the variability lying among the responses, reflecting that the considered responses may reflect both different stages of IoT integration and a range of challenges faced in regions and different aspects of electrical engineering in Pakistan. Descriptive statistics further depict insights on the view of professionals towards the impact of IoT, regional disparities in adoption rates, and a number of major implementation challenges that "put complex barriers" in the way of widespread IoT adoption. The correlational analyses pointed out that the perception of the impact of IoT was significantly related to such factors as regional practices and emphasized a very detailed landscape

influencing the integration of IoT in professional practices. The hierarchical regression analysis indicated that geographical factors and implementation challenges significantly formed perceived roles of IoT in transforming electrical engineering, based on the presence of a well-specified predictive model from the distribution of residuals. This nuanced understanding highlights the transformative potential of IoT in optimizing electrical systems through improved infrastructure, energy efficiency, automation, and connectivity, aligning with the study's goal to critically assess IoT's impact in the electrical engineering sector in Pakistan.

DISCUSSION

The perceptions and realities of the penetration of IoT (Internet of Things) within the electrical engineering industry in Pakistan. Thus, a moderate level of aspiration and relevance towards the IoT was ascertained from the results with future engineers. From this result, therefore, an average level of skepticism was with regard to how influential or prevalent the skepticism in contemporary energy management practices is. According to the survey, respondents showed moderate agreement or optimism toward many aspects of IoT, the most prominent being the chance of adopting IoT technologies in the future and the relevance of IoT with regard to their engineering aspirations. The data is in line with previous research pointing to increasing interest in IoT in developing markets. However, the current prevalence of a skeptical current on IoT and its impacts on energy management, combined with tangible concerns related to infrastructure readiness and practical implementation hurdles in developing countries, is now prevailing (Ahmed et al., 2020). However, the standard deviations have indicated that there is variance in the responses, proving an indication that professionals may have diverse opinions due to the range of the encountered challenges as part of the varying stages of IoT integration (Iqbal & shah, 2023). The same is observed with the regional disparities in IoT adoption reflected through the varied perceptions across different areas of Pakistan that respond identically to findings associated with technological advancement and the regulatory framework influencing IoT integration (Nawaz et al., 2023). This would determine the difference and, hence, there would be a necessity for a different approach to deploying IoT, so as to be able to meet the opportunities and challenges that are bound to be reflected in those areas. The results would argue for a complex landscape that has a strong correlation with the perception of the impact of IoT on the regional practices and implementation challenges of IoT integration in professional practices. This is well testified by more current studies along with global trends in which regional

technological readiness, with the presence of supportive ecosystems, has been a determining factor for the successful adoption of IoT (Ali et al., 2022). In terms of hierarchical regression analysis, the results further support that geographical factors are equally important in perception toward the role of IoT for the revolution in electrical engineering along with implementation challenges. This generally reflects a global trend, where most of the pragmatics in IoT implementation lie, on the one hand, more often than not, within the challenges, while the potential benefits continue to attract interest and optimism. The research could be of particular interest because the remarkable optimism for the future of IoT recognizes IoT as a cornerstone of critical technology for the next generation of engineering. Such a life cycle starts with skepticism and gradually moves towards acceptance once the realization of the value beginning to show up and the issues with implementation are realized (Kumar & Patel, 2023). Summing up, one may add that though there exists a general consensus with respect to the possible benefits of IoT within the electrical engineering sector of Pakistan, yet the approach to going for IoT applications at a large scale is surrounded by challenges. These include technological infrastructure, regulatory frameworks, and increased awareness and education about IoT. Only a serious effort by all the stakeholders, including governmental agencies and educational institutions, toward creating an ecosystem that encourages innovation in IoT and supports smooth interfacing with IoT technologies will meet these challenges.

CONCLUSION

Through the Internet of Things (IoT), the landscape for the electrical engineering industry in Pakistan is one of cautious optimism, marked by the recognition of hefty challenges in the practical use of the technology. There is a modest level of agreement among professionals in this field regarding the potential benefits of IoT, and most of them are quite optimistic about the value it is likely to add toward the revolution of current management practices in energy and efficiency of infrastructure. Although skepticism against its current adoption levels and tangible impacts has been rendered, an element of reflection of broader concerns around infrastructural readiness and hurdles of practical application in the developing context remains. This, to be sure, speaks of the variation in perception as they are brought out by the survey findings, reflective of a nuanced picture of optimistic scenarios vis-à-vis the future possibilities and realistic appraisals concerning the present. These also unveiled regional disparities for adoption that require a tailored approach. This paper is broadly an acknowledgment that the IoT has great potential in

making huge advancements in the field of electrical engineering. At the same time, he recommends that governments, academia, and industry work together to guide through today's complex landscape of technologies, regulatory frameworks, and educational initiatives. He felt that the collaborative approach must open up the opportunities for unleashing the full potential of IoT in revolutionizing practices pertaining to electrical engineering, driving efficiency, and enabling productive innovation in the emerging digital landscape of Pakistan.

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