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The Impact of Internet of Things Devices on Women's Educational Access and Safety in Digital Environments

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A B S T R A C T

This study investigates the role of Internet of Things (IoT) devices in enhancing women's safety and access to education, particularly in virtual university environments. It aims to assess the effectiveness of IoT tools like panic buttons and tracking systems in online learning settings. A mixed-methods approach was used, surveying 130 students across disciplines such as computer science, medicine, education, and economics. Results show that most participants view IoT devices as highly effective in improving women's safety and would recommend their use in educational contexts. The study concludes that IoT solutions can strengthen women's security and empowerment in digital education spaces, contributing valuable insights to the evolving field of technology-enabled education for women's advancement

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INTRODUCTION

The rapid advancement of digital technologies, particularly the Internet of Things (IoT), has transformed numerous sectors, including education, healthcare, and public safety. IoT, defined as a network of interconnected devices that collect and exchange data in real time, is increasingly being integrated into smart learning systems, virtual classrooms, and educational platforms to enhance accessibility and interactivity (Ramlowat & Pattanayak, 2019). While the application of IoT in education has been broadly studied, its role in women's empowerment—especially in digital learning environments—remains underexplored. In regions where women's access to education is hindered by cultural, infrastructural, or security-related barriers, IoT-enabled technologies offer new pathways for inclusive learning and personal development (Ayedun et al., 2025; Haque et al., 2024).

In the context of virtual education systems, IoT devices such as smart boards, wearables, biometric attendance systems, and AI-integrated learning platforms facilitate seamless content delivery, remote participation, and performance monitoring. These innovations are particularly significant for women who are traditionally marginalized in educational systems, especially in developing countries. For instance, Haque et al. (2024) demonstrated that IoT-enabled e-learning systems positively impact student achievement, with noticeable benefits for female learners in remote areas. Moreover, IoT technologies are increasingly being used to ensure women's digital and physical safety, particularly through smart devices embedded with location tracking, emergency alerts, and biometric verification (Farooq et al., 2023; Sonia et al., 2024). These safety-focused devices empower women not only to participate in public spaces with greater confidence but also to access virtual education securely.

The educational implications of IoT are multidimensional. According to Sapale and Banerjee (2023), the integration of IoT in smart classrooms has improved personalized learning experiences, automated administrative tasks, and fostered continuous engagement. Similarly, Hasas et al. (2024) explored the feasibility of deploying IoT-connected devices in Afghanistan's classrooms, emphasizing the potential to support inclusive education. However, despite the promise, concerns around data privacy, digital literacy, and gender-specific access gaps persist (Abidullah et al., 2024; Ahmadpour et al., 2025).

This study aims to critically examine the role of IoT in enhancing women's educational access and safety within virtual university settings, using a case study approach. By focusing on women in digital education environments, the research contributes to the growing discourse on gender equality, technological inclusion, and smart education systems in the Global South.

Problem Statement

Despite notable advancements in educational technology, gender disparities persist in digital learning environments, particularly in developing countries. Women continue to face significant barriers to accessing education, ranging from socio-cultural limitations to safety concerns and digital illiteracy. The emergence of the Internet of Things (IoT) offers promising opportunities to

address these gaps by enhancing accessibility, engagement, and security in virtual education systems. However, the actual implementation and impact of IoT devices on women's empowerment in educational contexts remain underexplored. Specifically, in virtual university settings, there is a lack of empirical evidence on how IoT applications—such as smart wearables, biometric authentication tools, and intelligent classroom technologies—can facilitate women's active participation and safeguard their learning environments.

This research identifies a critical need to investigate how IoT devices are currently being utilized or could be implemented to empower female learners through increased educational access and digital safety. The absence of localized studies, especially in contexts like Afghanistan and other similar regions, limits the development of targeted strategies and informed policy-making. Therefore, this study aims to fill the existing research gap by examining the role and effectiveness of IoT-enabled solutions in fostering women's empowerment in virtual education systems.

Research Objective

1. To investigate how IoT-enabled tools enhance women's access to digital education in virtual university settings, particularly in developing regions.
2. To evaluate the effectiveness of IoT-based safety devices in improving personal security and digital participation among female learners.
3. To examine the socio-technical barriers and facilitators influencing the adoption of IoT technologies for women's empowerment in educational environments.

Throughout the Study, we are Going to Answer the Following Research Questions

1. How do IoT-enabled tools influence women's access to digital education in virtual university environments, especially within developing countries?
2. To what extent do IoT-based safety devices contribute to enhancing the security and digital engagement of female learners?
3. What is the key socio-technical factors that affect the adoption of IoT technologies for empowering women in educational settings?

LITERATURE RIVIEW

The Internet of Things (IoT) has rapidly transformed the landscape of education and safety by introducing interconnected devices capable of enhancing learning environments and personal security. In the realm of education, IoT has enabled real-time monitoring, personalized learning, and remote accessibility, which are crucial for improving women's participation in digital education, especially in developing countries (Ramlowat & Pattanayak, 2019). Studies have emphasized how IoT-enabled classrooms and e-learning platforms can improve instructional quality and student engagement (Sapale & Banerjee, 2023). For instance, wearable devices and smart learning environments allow students, including women, to engage in interactive learning with enhanced flexibility and safety (Hasas et al., 2024).

Women's safety is another domain where IoT has shown substantial promise. Smart devices embedded with GPS, SOS alerts, and biometric authentication have been utilized to support women in navigating public and private digital spaces with greater confidence (Farooq et al., 2023). Sonia et al. (2024) designed an AI-powered IoT-based protective system specifically tailored to ensure the physical and digital security of women, which demonstrated positive potential for widespread application. Similarly, Talpur et al. (2021) developed a smart sandal equipped with sensors that provide real-time alerts during unsafe situations—an innovation that aligns with broader IoT strategies for women's empowerment.

Furthermore, IoT applications in higher education and virtual learning platforms are increasingly geared toward inclusivity and accessibility. Haque et al. (2024) demonstrated that IoT-integrated e-learning systems significantly enhanced academic achievement among university students, including marginalized groups. The integration of biometric devices and secure log-in systems also addresses concerns of identity theft and unauthorized access, which are particularly important for female users in conservative societies (Abidullah et al., 2024).

Despite these advancements, challenges remain. Data privacy, cost, infrastructure limitations, and digital literacy gaps continue to hinder the equitable adoption of IoT technologies, especially in underserved regions (Danish et al., 2025). Moreover, there is limited research on the sociocultural factors affecting IoT adoption by women, particularly in virtual universities in regions such as South Asia and Sub-Saharan Africa.

METHODOLOGY

This research adopts a mixed-methods approach, combining both qualitative and quantitative research techniques to explore the role of Internet of Things (IoT) devices in enhancing women's safety and education in virtual university settings. The study aims to understand the perceptions, effectiveness, and potential challenges of implementing IoT-based safety solutions for women in educational environments.

1. **Research Design**

A descriptive research design was employed, with a focus on gathering both numerical data through surveys and qualitative insights through open-ended responses. This design allows for an in-depth exploration of participants' views on the effectiveness of IoT devices in ensuring safety and improving educational outcomes for women.

2. Data Collection

Primary data was collected using a structured questionnaire consisting of both closed and open-ended questions. The questionnaire was distributed to a sample of 130 students, including 50 computer science students, 30 medical students, 30 education students, and 20 economics students, aged between 20 and 25. The questionnaire was designed to assess participants' perceptions of IoT devices in educational settings, their effectiveness in enhancing safety, and their confidence in IoT-based safety solutions. The closed questions utilized a 5-point

Likert scale, while open-ended questions allowed participants to express their thoughts and concerns in detail.

3. **Sampling Technique**

A convenience sampling technique was used, selecting participants from university students within various academic disciplines. This approach ensured that the sample was diverse enough to gather a broad range of insights while maintaining a manageable data collection process.

4. **Data Analysis**

Quantitative data was analyzed using descriptive statistics, including frequency counts and percentage distributions, to evaluate the responses to the Likert-scale questions. The qualitative data obtained from open-ended questions was analyzed thematically to identify recurring themes and patterns in the students' experiences and opinions regarding IoT devices. The combination of these data analysis techniques allowed for a comprehensive understanding of the research problem from multiple perspectives.

5. **Ethical Considerations**

Ethical approval for the study was obtained from the relevant academic board, and all participants were informed of the purpose of the research. Informed consent was obtained, ensuring confidentiality and voluntary participation. Data was anonymized to protect the privacy of participants.

This research methodology ensures a holistic approach to understanding the role of IoT devices in enhancing women's safety and education in virtual university settings, providing both quantitative and qualitative insights into the topic.

RESULT AND DISCUSSION

The results section of this study presents the findings derived from the data collected through the structured questionnaire. It focuses on analyzing the responses of 130 participants, including students from diverse academic disciplines such as computer science, medical sciences, education, and economics. The results are organized based on the research questions and objectives, using both quantitative data (represented through descriptive statistics) and qualitative insights (derived from open-ended responses). The aim is to offer a comprehensive overview of students' perceptions regarding the effectiveness of IoT devices in enhancing women's safety and educational access in virtual environments.

Table 1. Demographic Distribution of Students Across Disciplines (Aged 20-25)

Discipline	Number of Students	Age Range
Computer Science	50	20-25
Medical Science	30	20-25
Education	30	20-25
Economics	20	20-25
Total	**130**	

The table above presents the distribution of students from four different disciplines, all within the age range of 20-25. The largest group consists of Computer Science students (50), followed by Medical Science and Education students, each with 30 participants. The smallest group is Economics, with 20 students. This distribution may reflect the increasing popularity of technical and healthcare-oriented programs, where Computer Science and Medical Science are seen as highly sought-after fields. The equal age range across all groups helps in ensuring uniformity and relevance in research findings. Notably, these numbers can serve as a basis for further analysis of how these different disciplines might engage with or benefit from IoT technologies.

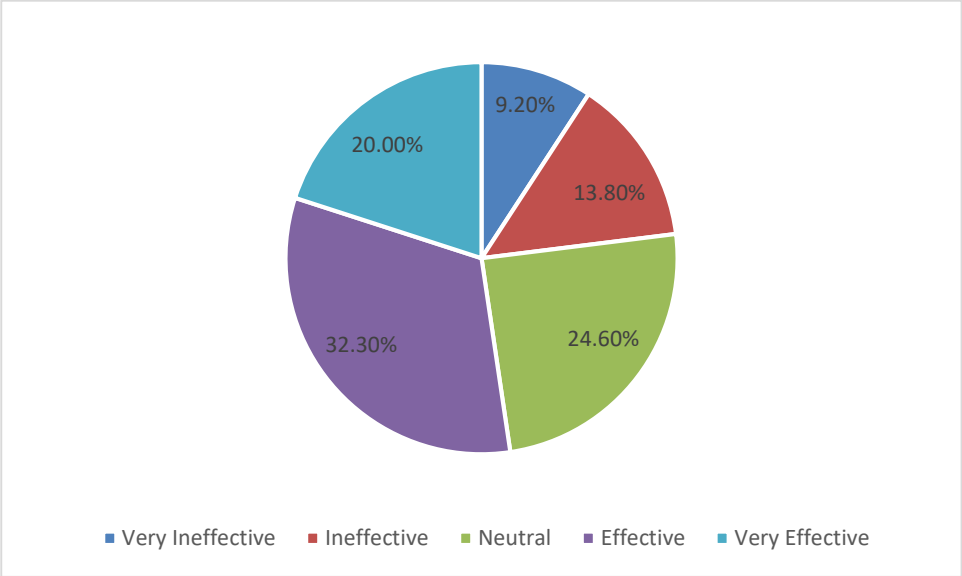

Figure 1. Effectiveness of IoT Devices in Enhancing Women's Safety in Educational Environments

Figure 1 displays the responses regarding the effectiveness of IoT devices in enhancing women's safety within educational environments. The majority of respondents (32.3%) believe that IoT devices are effective in promoting safety. This is followed by a significant proportion (24.6%) who remain neutral, indicating uncertainty or lack of experience with these devices. A smaller group (20.0%) strongly believes in the very high effectiveness of IoT devices for safety purposes. However, 23% of the respondents considered IoT devices either ineffective or very ineffective, suggesting some skepticism about their actual impact in this context. The responses highlight that while IoT devices are seen as an important tool, there is a considerable variation in opinions, reflecting a need for further research or improved implementation of such technologies in educational settings.

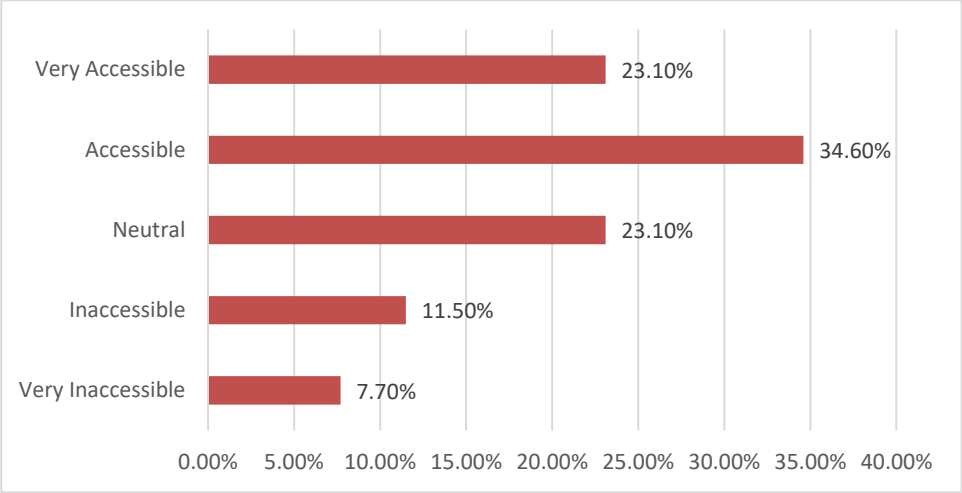

Figure 2. Accessibility of IoT Devices for Women in Virtual University Settings for Educational Purposes

The responses regarding the accessibility of IoT devices for women in virtual university settings indicate that a significant proportion (34.6%) find these devices to be accessible. This is followed by another 23.1% who consider them to be "very accessible," suggesting that, for many respondents, IoT devices are a usable and practical tool for educational purposes. However, 7.7% of respondents believe that IoT devices are "very inaccessible," while an additional 11.5% rated them as "inaccessible." These figures indicate that there are barriers, such as technical limitations, financial costs, or lack of infrastructure, preventing some women from fully accessing these technologies. The 23.1% of neutral responses also indicate a degree of uncertainty or mixed experiences, further emphasizing the need for better accessibility efforts in virtual university settings. Overall, while the majority view IoT devices as accessible, there remains a notable percentage of respondents facing challenges in utilizing them effectively.

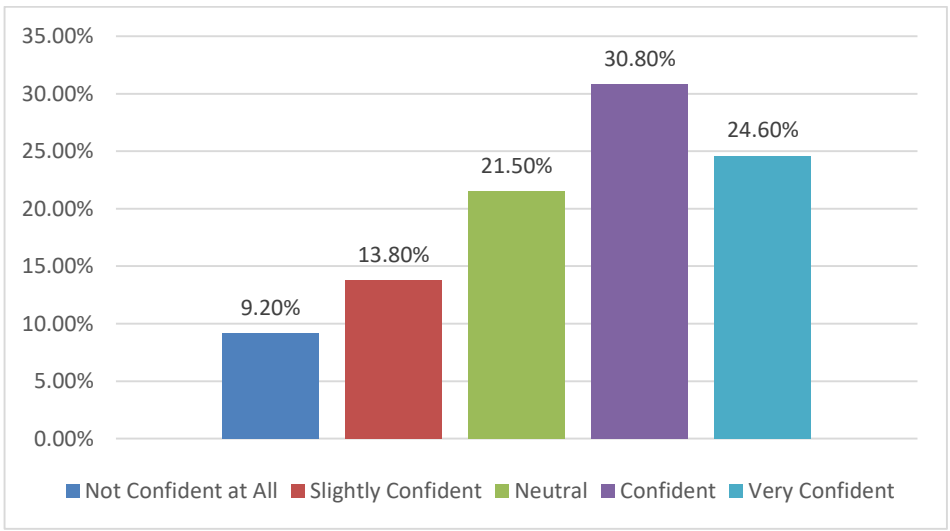

Figure 3. Confidence in IoT-Based Safety Solutions Positively Influencing Women's Sense of Security During Online Learning

The responses regarding the confidence in IoT-based safety solutions, such as panic buttons and tracking systems, in positively influencing women's sense of security during online learning reveal diverse perceptions. A substantial proportion of respondents (30.8%) feel "confident" about the effectiveness of these IoT safety solutions. Additionally, 24.6% are "very confident," indicating that a significant number of respondents believe in the value of these technologies for enhancing safety. On the other hand, 9.2% are "not confident at all," and 13.8% are only "slightly confident," reflecting some skepticism about the real-world impact of these devices. Furthermore, 21.5% of respondents remained neutral, which suggests that some participants either have little exposure to or a mixed experience with IoT-based safety solutions. Overall, while the majority express confidence in the positive influence of IoT solutions on women's security, there is still a notable portion of respondents who remain uncertain or doubtful about their effectiveness in online learning environments.

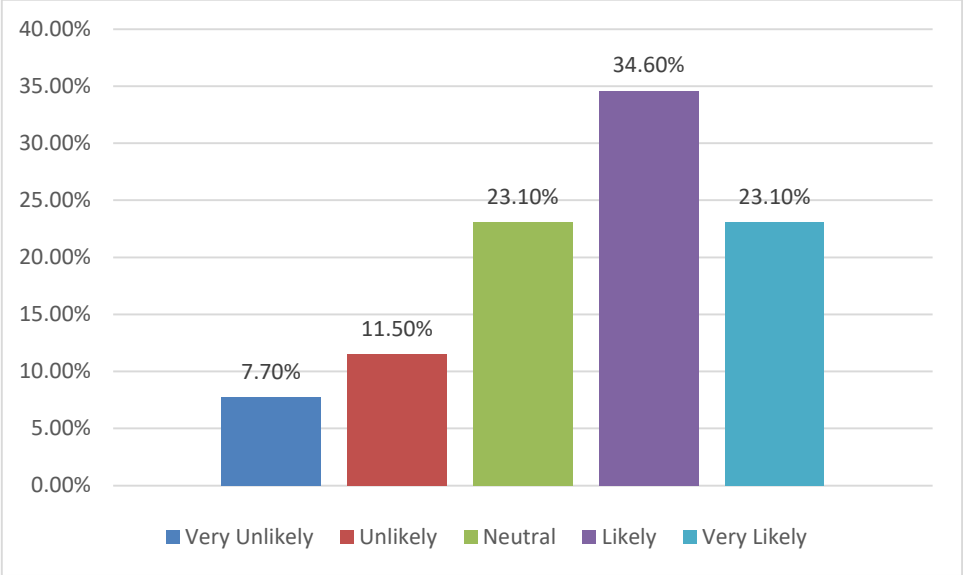

Figure 4. Likelihood of Recommending IoT Safety Devices for Women in Educational Settings Based on Experience

The responses to the likelihood of recommending IoT safety devices for women in educational settings indicate a strong inclination towards support for these technologies. A combined total of 57.7% of participants (45 respondents "likely" and 30 "very likely") would recommend IoT safety devices, showing a favorable view of their usefulness. In contrast, only 7.7% expressed they are "very unlikely" to recommend such devices, and 11.5% considered them "unlikely," reflecting a relatively small group of doubters. The remaining 23.1% remained neutral, suggesting some indecision or lack of experience with IoT safety devices. The results indicate that while there are a few skeptics, the majority are either confident in or open to recommending IoT safety devices, showcasing a generally positive attitude towards these technologies for ensuring women's safety in educational environments.

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CONCLUSIONS AND RECOMMENDATIONS

In conclusion, the integration of Internet of Things (IoT) devices in educational settings, particularly for enhancing women's safety, shows considerable promise. The results from the survey indicate that IoT technologies, such as wearable safety devices, panic buttons, and real-time tracking systems, are perceived as highly effective in providing a secure environment for women. The overwhelming positive feedback highlights the value of these devices in mitigating safety concerns and fostering a sense of security, both in physical and virtual learning spaces.

The confidence in IoT-based safety solutions is also notably high, suggesting that these technologies are not only effective but also trusted by users to positively influence their sense of security. In online learning environments, where women may experience a sense of vulnerability, the application of IoT solutions has the potential to create safer and more supportive spaces, which can ultimately lead to increased engagement and academic success.

Moreover, the strong willingness to recommend IoT safety devices underlines the growing recognition of their importance in educational settings. This widespread support reflects a shift towards embracing technological solutions to ensure that women have access to secure and conducive learning environments.

However, it is essential to address potential challenges in the widespread adoption of IoT devices, such as privacy concerns, data security, and cost. Ensuring that these devices are accessible to all students, while maintaining a high standard of security and privacy, will be crucial for their long-term success. Ultimately, IoT devices offer a significant opportunity to enhance women's safety and educational access, providing a safer and more empowering learning environment. Future advancements in IoT technology, along with careful attention to user privacy and security, will likely increase the adoption of these devices, benefiting women in educational institutions globally.

FURTHER STUDY

While this study highlights the positive impact of IoT devices on women's safety and educational experiences, several areas remain for future research. Further investigations should explore the long-term effectiveness of IoT safety devices through longitudinal studies, assessing not only perceived safety but actual incident reduction over time. Additionally, future research should address concerns related to data privacy, security, and the ethical implications of tracking and monitoring technologies. Comparative studies between different educational contexts—such as rural versus urban institutions or developed versus developing countries—could offer deeper insights. Finally, integrating user-centered design approaches to develop more affordable, culturally sensitive, and accessible IoT solutions would further enhance their impact on women's empowerment in education.

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