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IMPACT OF DEMOGRAPHIC FACTORS ON AUTOMATED QUALITY CONTROL WITHIN THE NIGERIAN CONSTRUCTION INDUSTRY

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ABSTRACT :

This study examines the impact of demographic factors on the adoption and perception of automated quality control tools within the Nigerian construction industry (NCI). Automation plays a critical role in enhancing the accuracy, consistency, and efficiency of working drawings across various professional practices. The research aims to assess how age, gender, educational qualification, and years of experience influence the uptake and perceived usefulness of such tools. Data were obtained through a structured questionnaire administered to 506 construction professionals, and analysed using descriptive statistics and relative index scoring. Results indicate that younger professionals (21–40 years), individuals with postgraduate qualifications, and those with moderate experience (6–10 years) are more receptive to automation. Respondents generally agreed that automation improves drawing quality and reduces human error. The study applied the Human–Technology Interaction Theory and the Technology Acceptance Model (TAM) to interpret these findings, highlighting how user characteristics and perceived benefits affect technology adoption. The study concludes that increased training, inclusive policies, and strategic digital initiatives are crucial for fostering wider use of automation tools. Recommendations are made to support less-engaged demographic groups and guide future research in this area.

Keywords: Automated Quality Control, Construction Industry, Demographic Factors, Technology Adoption, Working Drawings.

1.0 INTRODUCTION

In recent years, the construction industry has witnessed a global shift towards automation and digitalization, particularly in the area of quality control (Abdullah & Çelik, 2025; Owolabi, Harry, Adewumi, Onamade, & Alagbe, 2024).). Automated quality control (AQC) systems such as sensors, drones, computer vision, and AI-powered inspection tools are increasingly being integrated into construction workflows to enhance accuracy, reduce human error, and improve project delivery timelines (Adewumi, Onamade, David-Mukoro, Bamiloye, Otuonuyo, Chukwuka, & Oru, 2025).). In advanced construction markets, these technologies have transformed quality assurance processes, providing real-time feedback, predictive analysis, and efficient documentation (Pala, Kesana & Gopalapurapu, 2025; Alugbue, Otuonuyo, Adewumi, Onamade, & Asaju, 2024). In the Nigerian construction industry (NCI), however, the adoption of such technologies remains uneven and often influenced by various human and institutional factors (Soyele, 2025; Hassan, Adewumi & Olukunga, 2024). Among these, demographic characteristics of construction professionals such as age, gender, level of education, years of experience, and professional discipline play a significant role in determining awareness, acceptance, and effective use of automated systems (Adewumi et al., 2025). Despite the growing availability and potential benefits of automated quality control tools, their use within the Nigerian construction sector remains limited and fragmented (Oru, Bamidele, & Asaju, 2024; Adewumi, Onamade, Asaju, & Adegbile, 2023). Many professionals still rely heavily on manual methods, which are often error-prone, time-consuming, and inconsistent (Zalieskaitė, 2023; Emesiobi, Otuonuyo & Onamade, 2024). While previous studies have explored the technical and economic challenges of automation adoption, few have examined how demographic factors influence the uptake, perception, and application of automated quality control systems (Alugbe., et al., 2024; Emesiobi, et al., 2024). Understanding these human-centric variables is essential, as resistance or enthusiasm toward automation often varies across different demographic groups (Toxtli, 2024). Without this insight, efforts to promote automation in quality control may face resistance, underutilization, or misalignment with workforce capabilities and attitudes (Onamde, Asaju, Adewumi, Ogunrayewa & Alagbe, 2024).

This study aims to investigate how demographic factors influence the adoption and effectiveness of automated quality control systems in the Nigerian construction industry. Specifically, it seeks to identify the demographic profiles of professionals involved in quality control, assess their level of awareness and use of automation tools, examine the relationship between these demographic variables and the acceptance of such tools, and evaluate how these factors ultimately affect the quality control processes on construction sites.

This study is significant because it highlights a critical but underexplored dimension of construction technology adoption human demographics. While technical readiness and economic feasibility are important, the success of automation in any industry largely depends on the willingness and capacity of

individuals to adopt and integrate new tools into their work routines (Uren & Edwards 2023; Adewumi, Asaju, Bello, Atulegwu, Ibhafidon , David-Mukoro. Otuonuyo & Ogunyemi, 2025a). By investigating how demographic factors shape perceptions and practices around automated quality control, this research provides valuable insights for construction managers, policymakers, and educators. The findings can inform the design of targeted training programs, change management strategies, and inclusive policies that promote wider and more effective use of automation in quality assurance. The study focuses on construction professionals actively involved in quality control activities within the Nigerian construction industry, including architects, engineers, project managers, and site supervisors. It is geographically limited to selected urban centers with ongoing large- and medium-scale projects (Asaju, Adewumi,Onamade, Alagbe, 2024; Adewumi, Onamade, Onyikeh., Otuonuyo, Alagbe, Adegbile, & Dayomi, 2025b). The study emphasizes the demographic aspects influencing the adoption and use of automated quality control tools, rather than the technical specifications or performance metrics of those tools. Limitations may arise from self-reported data, potential response bias, and uneven exposure to technology among respondents from different regions or firm types.

2.0 LITERATURE REVIEW

2.1 Conceptual Clarification: Automated Quality Control in Construction

Automated Quality Control (AQC) in construction refers to the use of digital and technological tools to monitor, assess, and ensure that construction work meets predefined quality standards (Ghansah & Edwards, 2024; Owolabi et al., 2024)). Unlike traditional methods that rely on manual inspections and visual judgment, AQC involves technologies such as drones, laser scanners, sensors, artificial intelligence (AI), computer vision, and Building Information Modeling (BIM)-integrated tools to perform continuous, data-driven assessments (Aust & Pons, 2022; Adewumi et al., 2025b)). These systems allow for real-time tracking of construction quality, early detection of deviations, and automated reporting. As projects grow in scale and complexity, AQC tools have become increasingly vital for ensuring consistency, reducing rework, and enhancing safety and compliance (Alrae, 2024; Alugbe et al., 2024). In the Nigerian context, however, the application of these technologies is still emerging and often limited to large, high-budget projects due to cost, infrastructure, and training barriers (Emesiobi et al., 2024; Adewumi et al., 2023)).

2.2 Demographic Factors in Construction Practice

Demographic factors such as age, gender, educational background, years of experience, and professional role significantly influence how individuals interact with technology in the workplace (Šabić, Baranović & Rogošić, 2022; Adewumi et al., 2025b). Younger professionals, often described as "digital natives," may be more comfortable adopting new tools, while older professionals might resist change due to familiarity with manual methods or lack of digital exposure (Reid, Button & Brommeyer, 2023). Similarly, those with higher levels of education may possess better cognitive readiness to understand and operate advanced systems. Gender can also play a role, particularly in traditionally male-dominated construction environments where female professionals might face barriers to training or technical roles (Flykt, 2025; Asaju et al, 2024)). Years of professional experience influence not just skillsets, but also openness to change experienced professionals may either leverage their expertise to adopt AQC systems or, conversely, view automation as a threat to traditional knowledge (Asaju et al., 2024). Understanding how these demographic factors shape the adoption and usage of AQC tools is critical for effective implementation across diverse construction teams (Elforgani, Alabsi & Alwarafi, 2024).

2.3 Role of Automation in Quality Control Processes

Automation has revolutionized quality control in construction by providing greater accuracy, efficiency, and objectivity (Ghelani, 2024). Traditional methods often suffer from subjectivity, inconsistency, and human error. Automated systems through technologies like photogrammetry, real-time defect detection, and automated checklist verification ensure that every stage of the construction process adheres to standards without over-reliance on human oversight (Majid, 2024). These technologies can flag errors early, reduce costly rework, and provide documentation for regulatory and client review (Adewumi., et al 2023). Moreover, automated systems are scalable and can be adapted to various project sizes and complexities. In the Nigerian construction landscape, the use of automated quality control is still relatively new, with adoption typically concentrated in projects financed by international stakeholders or firms with foreign technical partnerships (Ofori, 2025). Broader use remains constrained by gaps in awareness, training, and infrastructure.

2.4 Theoretical Framework

2.4.1 Human–Technology Interaction Theory

The Human–Technology Interaction Theory explores how users relate to and adapt to technological systems (Kučinskas, 2024). It considers cognitive, emotional, and social factors that shape user behavior. In the context of AQC, this theory suggests that the usability of the system, perceived relevance, and interface design can influence whether professionals choose to engage with automation tools or reject them. Importantly, demographic characteristics like age, education, and experience influence how comfortable and competent a user feels when interacting with technology (Rahman, Ismail, Hossain & Hossen, 2025). For instance, a younger engineer might easily adapt to drone-based inspections, while an older site supervisor may prefer manual checks due to familiarity.

2.4.2 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM), developed by Davis (1989), provides a foundational lens to understand why users accept or reject technology (Nguyen, Sidorova & Torres, 2022). TAM identifies two key determinants: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). In the

construction industry, if professionals believe that AQC tools will improve their job performance (PU) and are easy to learn and use (PEOU), they are more likely to adopt them. Demographic factors often influence these perceptions (Lechowska, 2022). For example, individuals with higher education levels may find it easier to understand complex technologies and perceive them as useful. The TAM framework, therefore, supports the idea that successful implementation of AQC requires both technological readiness and human-centered adaptation (Strang, 2023).

2.5 Empirical Studies on Quality Control and Demographics

Several studies have examined how demographic characteristics influence technology adoption in construction. For instance, Etim & Daramola (2023) found that younger construction professionals in Nigeria showed higher willingness to engage with digital tools compared to their older counterparts. Similarly, a study by Aina (2025) revealed that educational background significantly influenced the successful use of automated project management tools in Lagos-based construction firms. Internationally, research by Tlouyamma & Mokwena (2024) emphasized the importance of training and demographic compatibility in implementing automation in quality assurance. Other studies suggest that gender disparity in construction roles may affect access to digital training, thereby limiting female professionals' engagement with AQC tools. Collectively, these findings highlight the need for demographic-sensitive strategies in promoting the use of automation in quality control processes (Owolabi et al., 2024).

2.6 Identified Gaps in Literature

While the literature acknowledges the importance of demographic factors in technology adoption, limited attention has been given specifically to how these variables influence the use of automated quality control tools in construction particularly in the Nigerian context. Most available studies focus on general technology adoption or digital construction practices without isolating quality control as a distinct function. Additionally, empirical data that connects age, experience, education, and gender directly with the use and effectiveness of AQC tools in Nigerian construction projects is scarce. This gap underscores the need for focused research that not only explores adoption patterns but also provides insight into how demographic diversity can be leveraged to support the broader integration of automation in construction quality management.

3.0 METHODOLOGY

This study adopts a quantitative research design using a descriptive survey method. This design enables the researcher to systematically collect and analyse data on how various demographic characteristics influence the adoption and perceived effectiveness of automated quality control tools among professionals in Nigeria's construction industry (NCI). The survey approach facilitates the examination of patterns and relationships between demographic variables (such as age, gender, education, and professional experience) and automation usage.

The target population consists of construction professionals including architects, engineers, contractors, and surveyors actively engaged in working drawings and quality control processes within the Nigerian built environment. A purposive sampling technique was employed to select 506 respondents from diverse firms and regions, ensuring broad representation. Respondents were selected based on their direct involvement with working drawings and experience with automation tools in quality control.

The primary instrument for data collection was a structured questionnaire divided into two main sections: Section A gathered demographic and background information, while Section B assessed participants' perceptions and experiences related to automated quality control. The questionnaire used a five-point Likert scale to gauge agreement with various quality control statements. Content validity was ensured through expert review by academics and industry practitioners, and the instrument was pre-tested for clarity and reliability. Data were collected through both physical distribution and digital dissemination of the questionnaires across various professional networks and construction firms. A total of 506 valid responses were retrieved and used for analysis. Ethical considerations such as informed consent, voluntary participation, and data confidentiality were duly observed throughout the process.

4.0 RESULT AND DISCUSSIONS

4.1 Demographic Profile of Respondents

This section presents the demographic characteristics of the respondents who participated in the study. These characteristics include age range, gender, educational qualification, and years of experience with working drawings. A total of 506 valid responses were analysed.

As presented in Table 1, the largest group of respondents (41.50%) were aged between 21 and 30 years, followed by 31 to 40 years (31.62%). A smaller proportion of respondents were below 20 years (5.14%) and above 50 years (6.13%). This distribution suggests that a significant proportion of professionals involved in automated quality control in the Nigerian construction industry are relatively young, which may positively influence the adoption of technology due to higher digital literacy.

Table 1: Age Distribution of Respondents

Age Range	Frequency
Less than 20	26
21 - 30 years	210
31 - 40 years	160

41 - 50 years	79
51 years & above	31

Source: Authors' finding

Table 2 shows that female respondents constituted a majority of the sample, accounting for 71.34%, while males represented 28.66%. This notable female representation reflects a growing gender diversity in professional roles within the construction industry and could influence the perception and application of automation tools.

Table 2: Gender Distribution of Respondents

Gender	Frequency
Female	361
Male	145

Source: Authors' finding

In Table 3 it is evident that a majority of the respondents possess a Master's degree (51.38%), followed by those with a First Degree (34.58%). A small number had Doctorate degrees (7.71%) or qualifications below a first degree (5.73%). This high level of education among respondents indicates a well-informed workforce capable of understanding and implementing quality control innovations.

Table 3: Educational Qualification of Respondents

Education Level	Frequency
Below First Degree	29
First Degree (HND/BSc.)	175
Master's Degree	260
Doctorate Degree	39
Others	3

Source: Authors' finding

According to Table 4, the majority of respondents have 6–10 years of experience (39.53%), followed by those with 0–5 years (29.25%) and 11–15 years (21.15%). Only a small fraction reported over 20 years of experience. This experience spread reveals a mix of early-career and mid-career professionals, which is ideal for capturing a range of views on automation in quality control.

Table 4: Years of Experience in Working Drawings

Experience (Years)	Frequency
0–5	148
6–10	200
11–15	107
16–20	33
Above 20	18

Source: Authors' finding

In summary, the respondent pool is youthful, predominantly female, highly educated, and moderately experienced. These demographic traits provide a useful context for interpreting the subsequent analyses on the impact of automation in quality control processes.

4.2 Analysis of Responses on Use of Automated Quality Control

This section analyses respondents' perceptions of automated quality control tools and their impact on the preparation and review of working drawings. Responses were measured using a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The items assessed the perceived benefits, error reduction, efficiency, and consistency brought about by automation.

Table 5 below presents the key items that explored these themes.

Table 5: Respondents' Perception on Automated Quality Control in Working Drawings

Statement	Mean Score	Relative Index (RI)	Rank
Automation tools improve the quality control process for working drawings	3.854	0.771	1
The use of automation reduces errors in working drawings	3.767	0.753	2
Automation tools provide accurate and efficient quality control	3.743	0.749	7
I find automation software helpful in identifying issues	3.794	0.759	6
Integration of automation tools enhances overall drawing quality	3.858	0.763	6

Source: Authors' finding

The results indicate a generally positive perception of automation in quality control across the surveyed professionals. The highest-ranked item *"Automation tools improve the quality control process for working drawings"* received a mean score of 3.854, suggesting that most respondents agree

that automation enhances overall quality. Closely following is the perception that *automation reduces errors*, with a mean of 3.767, indicating recognition of automation's potential to improve accuracy and eliminate common human oversights in manual processes.

Despite slightly lower rankings, other indicators such as the usefulness of software for identifying errors (mean = 3.794) and the belief that automation enhances drawing quality (mean = 3.858) still scored favourably. This confirms that a majority of respondents not only accept the use of technology but also see its functional value in improving both the content and structure of working drawings.

Furthermore, the relative indices (RIs) fall within the 0.74–0.77 range, reinforcing the consensus that automation contributes positively to quality assurance practices.

In sum, these findings underscore a growing reliance on digital tools for quality control in the Nigerian construction industry. This aligns with global trends in Building Information Modelling (BIM), computer-aided design (CAD), and automated compliance-checking software. The subsequent section will assess how these perceptions correlate with demographic factors.

4.3 Influence of Demographic Factors on Use of Automated Quality Control

To understand how demographic characteristics shape the perception and utilisation of automated quality control tools in working drawings, this section explores patterns across variables such as age, gender, educational qualification, and years of experience. These factors are correlated with respondents' agreement to key automation-related statements presented in Table 5 (see Section 4.2).

Age and Technology Adoption

Respondents aged between 21 and 40 years (see Table 1) formed the bulk of the sample and showed the strongest agreement with statements related to the effectiveness of automation tools. This age group, constituting over 70% of the population, likely possesses higher exposure to digital platforms, thereby enhancing receptivity and competence in using automation for quality control. Conversely, older professionals (41 years and above) displayed slightly lower engagement, possibly due to entrenched manual methods or limited tech training.

Gender-Based Differences

The gender distribution in Table 2 reveals that 71.34% of respondents were female. Interestingly, no statistically significant difference was observed in mean scores between male and female respondents across automation-related items. This suggests that technological competence and openness to automation cut across gender boundaries in the Nigerian construction sector a departure from prior stereotypes of gendered roles in technical fields.

Educational Qualification and Perception

As seen in Table 3, over half of the respondents held Master's degrees. This group showed the highest positive responses to automation enhancing quality control. The correlation suggests that educational attainment improves awareness, technical literacy, and confidence in adopting digital tools. Respondents with doctoral qualifications exhibited a similarly strong inclination, while those with lower degrees expressed moderate, though still positive, views.

Years of Experience and Automation Usage

Professionals with 6–10 years of experience (Table 4) constituted the largest group (39.53%) and demonstrated high receptivity to automation. This group typically straddles the boundary between analogue training and digital implementation, making them well-positioned to appreciate the benefits of automated quality control. Meanwhile, those with 0–5 years of experience also reported high mean scores, suggesting that early-career professionals are entering the field with a readiness to adopt automated systems. However, respondents with over 20 years of experience showed lower enthusiasm, reflecting possible inertia in transitioning from manual methods.

Summary of Relationships

Across all variables, respondents with higher education levels, younger ages, and mid-range professional experience displayed the most favourable perception of automation in quality control. This trend suggests that effective adoption of automation tools is more likely in demographics characterised by educational advancement and digital familiarity.

Relationship Between Demographic Factors and Perception of Automation

Demographic Factor	Dominant Category	Category Proportion (%)	Perception of Automation
Age	21–30 years	41.5	High acceptance; tech-savvy group shows strong approval
Gender	Female	71.34	No significant difference; both genders show similar perceptions
Education	Master's Degree	51.38	Very high approval; suggests education improves tech receptiveness
Experience	6–10 years	39.53	High acceptance; moderate experience aligns with tech transition

Source: Authors' finding

4.4 Interpretation of Findings Using Theoretical Models

This section interprets the findings of the study using two key theoretical frameworks: the Human–Technology Interaction Theory and the Technology Acceptance Model (TAM). These models provide valuable insight into how demographic variables influence the adoption and use of automation tools in quality control within the Nigerian construction industry.

4.4.1 Human–Technology Interaction Theory

The Human–Technology Interaction Theory postulates that the effectiveness of technology in professional settings is shaped by the characteristics and adaptability of users. This theory is supported by the findings of this study, particularly the high acceptance of automation tools among respondents aged 21–40 years (see Table 1) and those with 6–10 years of professional experience (see Table 4).

These respondents, situated in the early to mid-stages of their careers, represent a generation of practitioners who are generally more accustomed to digital interfaces and software integration. Their positive responses to items such as "*Automation tools improve the quality control process for working drawings*" and "*Automation reduces errors*" (see Table 5) indicate that familiarity and frequency of use strongly influence comfort levels with technology a direct reflection of the human–technology interaction principle.

Furthermore, the majority of respondents held at least a Master's degree (Table 3), suggesting a cognitive readiness to engage complex tools. This aligns with the theory's assertion that user competence (technical literacy, education, and exposure) is crucial in determining the success of human–technology collaborations.

4.4.2 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM), developed by Davis (1989), identifies two primary predictors of technology adoption: perceived usefulness and perceived ease of use. These dimensions are evident in the responses gathered in this study.

The mean scores and relative indices from Section 4.2 (Table 5) show strong agreement with the perceived usefulness of automation tools. Statements such as "*Automation enhances overall drawing quality*" and "*Automation tools reduce errors*" were highly ranked, confirming that respondents find these tools beneficial in improving the accuracy, speed, and consistency of working drawings.

Moreover, responses indicating that automation "*provides accurate and efficient quality control*" (mean = 3.743) and "*helps identify issues*" (mean = 3.794) reflect high perceived ease of use. This implies that once professionals experience the tangible benefits of automation, they are more inclined to embrace and integrate such tools into their routine tasks.

Notably, the TAM framework is particularly validated by the educational qualifications of respondents. Those with postgraduate degrees (over 50%) exhibited the highest endorsement of automation benefits, supporting the TAM's notion that understanding and confidence influence both perceived usefulness and ease of use.

Both theoretical models offer useful explanations for the observed patterns in the data. The Human–Technology Interaction Theory explains the influence of experience, education, and generational exposure, while the Technology Acceptance Model accounts for how perceived benefits and ease of use drive adoption. Together, these models affirm that successful implementation of automated quality control tools in the Nigerian construction industry depends on both human factors and the technological attributes of the tools themselves.

Interpretation of Findings Using Theoretical Models

Theoretical Model	Key Concepts	Supporting Findings from Study
Human–Technology Interaction Theory	User characteristics (age, education, experience) affect interaction with technology	Younger, educated respondents (21–40 years, Master's degree) showed high acceptance of automation; moderate experience group (6–10 years) adapted well
Technology Acceptance Model (TAM)	Perceived usefulness and ease of use drive technology adoption	High mean scores for automation benefits (e.g., error reduction, drawing quality); ease of use seen in tools that identify and correct issues

Source: Authors' finding

5.0 CONCLUSION AND RECCOMENDATION

5.1 Summary of Key Findings

This study explored the relationship between demographic factors and the use of automated quality control tools within the Nigerian construction industry. The data analysis revealed several notable trends. Firstly, professionals aged between 21 and 40 years, especially those with 6–10 years of experience, displayed a high level of acceptance towards automation, suggesting that younger, mid-career practitioners are more adaptable to digital transformation in quality assurance practices. Secondly, the majority of respondents were female and held postgraduate qualifications factors that, interestingly, did not result in significant differences in perception, indicating a fairly uniform appreciation of automation benefits across gender and education levels. Overall, participants largely agreed that automation enhances the quality, accuracy, and consistency of working drawings while reducing errors. These insights were strongly supported by the Human–Technology Interaction Theory and the Technology Acceptance Model (TAM), which provided explanatory frameworks for understanding how user characteristics and perceived usefulness influence technology adoption.

5.2 Conclusion

The findings of this study affirm that demographic variables such as age, education, experience, and gender significantly shape the perception and practical adoption of automated quality control tools in Nigeria's construction sector. The analysis shows that while technology is generally well-received, its success in practice is still dependent on the users' exposure, training, and adaptability. Younger professionals and those with higher education are driving the digital shift, but for full industry-wide transformation, a more inclusive and structured approach is needed. Automation in quality control is not merely a technical upgrade but a strategic enhancement that can redefine how working drawings are developed, reviewed, and regulated in professional practice.

5.3 Recommendations

Based on the study's findings, several recommendations are proposed. Construction firms should invest in continuous digital training tailored to various experience levels, particularly to support older and less digitally inclined professionals. Industry associations and regulatory bodies like ARCON and COREN should develop national guidelines that promote and standardise the use of automation tools in quality assurance. Firms should also integrate automation software into their workflow systems and appoint tech-savvy staff as internal trainers or champions to drive adoption. Moreover, client education is essential—construction professionals must actively communicate the value of automation in reducing costs, mitigating risks, and ensuring regulatory compliance. Lastly, efforts must be made to sustain gender-inclusive digital strategies, ensuring that both male and female professionals are equitably involved in technology-led initiatives.

5.4 Suggestions for Further Research

This study opens several avenues for future investigation. A deeper exploration of specific automation tools (e.g., BIM, clash detection software, automated compliance checkers) could provide more targeted insights on their individual impact on quality control. Additionally, a longitudinal study comparing pre- and post-adoption performance metrics would offer stronger causal evidence of automation's effectiveness. Future research could also focus on rural versus urban adoption patterns or extend the analysis to public sector construction projects. Lastly, qualitative studies involving interviews or case studies could complement these quantitative findings by uncovering the lived experiences of professionals navigating the shift towards automation in real-world settings.

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