DRIVERS OF PRACTICING QUANTITY SURVEYING PROFESSION USING INDUSTRY 4.0, THE FOURTH INDUSTRIAL REVOLUTION

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ABSTRACT

Purpose: This research aims to provide comprehensive insights into the digital transformation of quantity surveying practice, offering evidence-based recommendations for technology adoption, professional development, and industry advancement.

Design/Methodology/Approach: The research adopts a quantitative approach, involving a structured questionnaire administered to experts selected through heterogeneous purposive sampling in Cape Coast, Ghana. A total of 100 members from the Association of Building and Civil Engineering Contractors of Ghana, drawing insights from professionals in architecture, quantity surveying, project management, and contracting. A structured Likert-scale questionnaire was developed, comprising statements on the benefits of Industry 4.0 technologies in quantity surveying. Respondents were asked to indicate their level of agreement on a 5-point scale. Data collected were analysed using descriptive statistics, including frequency distribution, mean scores, and the Relative Importance Index (RII) to rank the perceived benefits.

Findings: The integration of Industry 4.0 technologies into the quantity surveying profession offers a wide array of transformative benefits. These technologies, including AI, BIM, IoT, cloud computing, and big data analytics, significantly enhance the accuracy and efficiency of cost estimation, budgeting, and project planning. Automation reduces manual errors, while real-time data and digital tools streamline workflow processes and decision-making. Professionals in the field are now better equipped to engage in strategic and value-driven roles, as technology allows them to shift from routine tasks to more analytical and management-focused functions.

Research Limitations: The study focuses on perceived and observed benefits, primarily based on quantitative data. There is limited empirical testing, and findings may vary depending on the region, technological infrastructure, and digital maturity of organisations.

Practical Implications: The findings reveal that successful adoption of Industry 4.0 technologies in quantity surveying requires proactive, strategic changes in professional practice. Quantity surveyors must embrace digital transformation by integrating advanced tools such as BIM, AI, and cloud platforms into everyday operations to enhance project delivery and cost management.

Social Implications: It promotes a more collaborative and inclusive work environment, encouraging stronger interaction among professionals across various disciplines. This shift enhances teamwork and knowledge sharing, leading to better project outcomes.

Originality/Value: The study's originality lies not only in examining an underexplored professional domain but also in its comprehensive, theoretically integrated, and contextually

grounded approach, which generates actionable insights for the profession's digital future.It adds value by focusing on opportunities for growth, efficiency, and innovation, helping professionals and organisations align with future industry trends.

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1.0 INTRODUCTION

The fourth industrial revolution, commonly referred to as Industry 4.0, represents a paradigm shift in how industries operate by integrating advanced technologies, including Artificial Intelligence (AI), the Internet of Things (IoT), cloud computing, robotics, and big data analytics, into everyday processes (Statsenko et al., 2023; Schwab, 2017). In the construction industry, these innovations are reshaping traditional practices, and the quantity surveying profession is no exception (Ebekozien et al.,2024). Quantity surveyors, who are traditionally responsible for cost estimation, contract management, and financial control of construction projects, are now leveraging these technologies to enhance productivity, precision, and value delivery (Zhou & Cheng, 2024).

Industry 4.0 offers numerous benefits to the quantity surveying field. For instance, Building Information Modelling (BIM) facilitates more accurate cost estimations and real-time updates throughout the project lifecycle, while AI and machine learning enable predictive analytics for better forecasting and risk management (Sawhney et al., 2020; Marr, 2018). The adoption of digital tools also improves collaboration across project teams by allowing seamless data sharing and communication through cloud-based platforms.

The integration of Industry 4.0 technologies also aligns with the global push for sustainability and energy efficiency. Quantity surveyors can now perform life-cycle cost analyses, assess environmental impacts, and contribute to green building certifications using advanced simulation tools (Liang et al., 2024; Olanrewaju & Abdul-Aziz, 2015). This not only adds value to the profession but also positions quantity surveyors as critical enablers of sustainable construction practices.

Moreover, as sustainability becomes an essential component of modern construction, Industry 4.0 empowers quantity surveyors to incorporate energy-efficient solutions and life-cycle cost analysis into their practices, ultimately promoting green building initiatives (Perera et al., 2020). By embracing digital transformation, quantity surveyors are not only increasing their relevance in a rapidly evolving construction landscape but also playing a more strategic role in delivering value-driven, technologically advanced project solutions.

Despite the recognised potential of Industry 4.0 technologies to revolutionise quantity surveying practice through enhanced cost estimation accuracy, real-time project monitoring, automated measurement, and data-driven decision-making, there remains a significant disconnect between the availability of these technologies and their professional adoption (Chenchu et al., 2025). While developed countries have made considerable strides in integrating

these digital tools into quantity surveying workflows, many quantity surveyors, particularly in developing economies, continue to rely on conventional methods and manual processes.

The critical gap lies in the insufficient understanding of what actually drives or hinders quantity surveying professionals in adopting Industry 4.0 technologies. The current literature provides fragmented insights into technological capabilities but offers limited empirical evidence on the specific organisational, individual, technological, or environmental factors that influence practitioners' decisions to embrace or resist these innovations.

Therefore, the fundamental problem is the lack of comprehensive empirical evidence to identify and examine the drivers that motivate quantity surveying professionals to adopt Industry 4.0 technologies. This gap impedes the profession's ability to strategically navigate the digital transformation, potentially compromising its relevance and competitiveness in the modern construction industry.

Addressing this gap is critical to ensuring the quantity surveying profession evolves in step with technological advances, maintains its value in construction project delivery, and equips practitioners with the competencies needed to thrive in the Fourth Industrial Revolution. The study seeks to examine the current state of Industry 4.0 technology adoption among quantity surveying professionals. To identify key drivers and barriers influencing technology integration in quantity surveying practice.

2.0 LITERATURE REVIEW

2.1 Introduction

The emergence of Industry 4.0 is reshaping the global construction industry by integrating advanced technologies such as Artificial Intelligence (AI), the Internet of Things (IoT), Building Information Modeling (BIM), cloud computing, big data analytics, and automation. This digital transformation has also impacted the quantity surveying (QS) profession, offering numerous benefits in terms of productivity, accuracy, collaboration, and sustainability (Sawhney et al., 2020; Perera et al., 2020).

2.1.1. Enhanced Accuracy and Efficiency

One of the core benefits of Industry 4.0 is the significant improvement in the accuracy and speed of quantity surveying tasks (Ebekozien et al., 2024). Technologies such as AI and machine learning enable quantity surveyors to automate routine tasks, including cost estimation, quantity take-offs, and budgeting. These tools reduce human error and offer predictive insights into cost trends, enabling more informed decision-making (Marr, 2018; Kasim et al., 2018). Additionally, digital tools can analyse historical project data to predict cost overruns, identify risks, and recommend cost-saving strategies.

2.1.2 Cloud-Based Collaboration and Information Sharing

The implementation of cloud computing and IoT enables real-time collaboration among project stakeholders (Kineber, 2024). Cloud platforms enable simultaneous data access and updates, thereby reducing communication gaps and enhancing transparency. Quantity surveyors can use these systems to track cost and progress from any location, ensuring flexibility and quick response to on-site changes (Morrison, 2023; Zhou et al., 2016). The use of mobile technologies and cloud storage also facilitates better document management, version control, and security.

2.1.3 Sustainable Construction Practices

Industry 4.0 technologies empower quantity surveyors to play a strategic role in promoting sustainability. Tools such as digital twins and life-cycle cost analysis enable professionals to evaluate the long-term costs and environmental impacts of building materials and methods (Petri et al., 2025; Olanrewaju & Abdul-Aziz, 2015). Moreover, real-time monitoring of energy use through IoT devices helps ensure compliance with green building certifications and the Sustainable Development Goals (SDGs) (Perera et al., 2020).

2.1.4 Professional Development and Competency Advancement

The integration of digital tools and platforms requires quantity surveyors to acquire new competencies in data science, software usage, and digital communication. This shift enhances their relevance in the construction industry and opens up opportunities for career advancement and diversification (Edirisinghe, 2019). As digital proficiency becomes a core skill, QS professionals are increasingly recognised for their strategic input in project management and cost control.

2.1.5 Improved Risk Management

Advanced data analytics and AI can identify potential risks in cost overruns, material availability, or scheduling delays before they escalate. With real-time data and predictive modelling, quantity surveyors can proactively implement mitigation strategies, thus improving the reliability of project delivery (Marr, 2018).

2.2 Theories Underpinning the Study

Understanding the drivers of Industry 4.0 technology adoption among quantity surveying professionals requires a robust theoretical foundation that explains how and why individuals and organisations adopt new technologies. Several well-established theories from information systems and organisational behaviour research provide valuable lenses for examining this phenomenon.

2.2.1 Unified Theory of Acceptance and Use of Technology (UTAUT)

Venkatesh et al. (2003) developed UTAUT by synthesising eight prominent theories of technology acceptance. UTAUT identifies four core determinants of technology acceptance and use: performance expectancy (expected performance gains), effort expectancy (ease of use), social influence (perceptions that important others believe one should use the technology), and

facilitating conditions (organisational and technical infrastructure supporting use) (Venkatesh & Zhang, 2010). The model also incorporates four moderating factors: gender, age, experience, and voluntariness of use.

UTAUT offers a more comprehensive framework for understanding Industry 4.0 adoption among quantity surveyors. Performance expectancy captures beliefs about productivity gains from using automated measurement or AI analytics. Social influence acknowledges the role of professional bodies, industry standards, and peer pressure in driving adoption. Facilitating conditions address critical organisational factors such as training availability, technical support, and management commitment, all of which are crucial for successful Industry 4.0 implementation in quantity surveying firms.

UTAUT's comprehensive nature and strong predictive power make it highly suitable for examining the multifaceted drivers of Industry 4.0 adoption in professional contexts (Jain et al., 2023). However, the model's complexity may make it challenging to operationalise in research, and it may require adaptation to capture industry-specific factors.

2.2.2 Technology-Organisation-Environment (TOE) Framework

Tornatzky et al. (1990) developed the Technology-Organisation-Environment (TOE) framework, which provides an organisational-level perspective on technology adoption. It proposes that three contextual elements influence the adoption decision: technological context (availability and characteristics of technologies), organisational context (firm size, resources, management support, organisational culture), and environmental context (industry characteristics, regulatory environment, competitive pressure, technology suppliers).

The TOE framework is particularly valuable for understanding organisational-level adoption of Industry 4.0 technologies in quantity surveying firms. The technological context includes the maturity and interoperability of BIM platforms, cloud-based cost management systems, and AI tools (Abideen et al., 2022). The organisational context encompasses firm size, financial resources for technology investment, leadership vision, and organisational readiness for change. The environmental context includes client demands for digital delivery, competitive pressures from tech firms, and regulatory requirements for digital project documentation. TOE provides a holistic view that recognises adoption as an organisational decision influenced by multiple contextual factors, making it ideal for studying firm-level adoption patterns. Nevertheless, the framework may underemphasise individual-level factors such as personal attitudes and skills that also influence adoption outcomes.

2.2. 3 Integrated Theoretical Approach

Given the complexity of Industry 4.0 adoption in quantity surveying, an integrated theoretical approach combining elements from multiple theories may provide the most comprehensive understanding (Wang et al., 2024). For instance, combining UTAUT's individual-level factors with TOE's organisational and environmental dimensions creates a multilevel framework that captures drivers at individual, organisational, and industry levels.

3.0 METHODOLOGY

This study adopted a quantitative research design to investigate the perceived benefits of applying Industry 4.0 technologies in the quantity surveying profession. The methodology was structured to gather empirical data from professionals in the construction industry, including quantity surveyors, architects, engineers, and project managers.

3.1. Research Approach

A descriptive survey method was employed to assess practitioners' views on various Industry 4.0 technologies and their impacts on quantity surveying tasks, including cost estimation, project planning, data management, and collaboration. The use of this method allowed for statistical analysis of responses and facilitated ranking of the perceived benefits based on respondents' feedback.

3.2. Population and Sampling

The study population consisted of professionals working within the construction sector, specifically those with experience in quantity surveying roles. A purposive sampling technique was used to select a representative sample of 100 participants, ensuring that only respondents with relevant experience and exposure to digital practices were included.

3.3. Data Collection Instrument

A structured Likert-scale questionnaire was developed, comprising statements on the benefits of Industry 4.0 technologies in quantity surveying. Respondents were asked to indicate their level of agreement on a 5-point scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The questionnaire was validated through a pilot study and expert review to ensure clarity and relevance.

3.4. Data Analysis Techniques

Data collected were analysed using descriptive statistics, including frequency distribution, mean scores, and the Relative Importance Index (RII) to rank the perceived benefits. The RII was calculated using the formula:

$$RII = \frac{\sum w}{A \times N}$$

Where:

- w= weight assigned to each response (from 1 to 5),
- A = highest weight (i.e., 5),
- N = total number of respondents.

The results were interpreted to identify the most highly ranked benefits and to draw conclusions about Industry 4.0's overall impact on the quantity surveying profession.

3.5. Ethical Considerations

Participation in the survey was voluntary and confidential. Respondents were informed of the study's purpose and provided consent prior to data collection. The data were anonymised to ensure the privacy of individuals and organisations.

4.0 RESULTS AND DISCUSSION

4.1 Demographic Characteristics of Respondents

This section presents the demographic information of respondents collected from the survey. This includes the respondent's gender, age range, educational level, and role within the respective construction firms.

Table 1: Demographic Characteristics of Respondents

	FREQUENCY	PERCENTAGE
GENDER		
Male	**86**	**86**
Female	**14**	**14**
AGE RANGE		
20-25	**42**	**42**
26-30	**28**	**28**
31-35	**8**	**8**
Above 35	**22**	**22**
EDUCATIONAL QUALIFICATION		
Doctor of Philosophy	**3**	**3**
Master's Degree	**6**	**6**
Bachelor's Degree	**41**	**41**
Higher National Diploma (HND)	**37**	**37**
Diploma	**13**	**13**
PROFESSIONS		
Architect	**8**	**8**
Engineers	**50**	**50**
Contractors	**18**	**18**
Quantity Surveyors	**15**	**15**
Others	**9**	**9**
TOTAL	**100**	**100**

Of the 100 respondents, 86% were male, while 14% were female. This distribution reflects the current male-dominant nature of the construction industry and related fields. The age distribution shows a youthful professional population. The 20–25 years age group constituted the most significant segment at 42%, followed by the 26–30 years group at 28%. Respondents aged 35 years and above made up 22%, while the 31–35 years category had the lowest representation at 8%. This suggests that a significant portion of the workforce engaging with Industry 4.0 technologies in quantity surveying is relatively young. This youthfulness correlates with the educational qualifications observed, as most respondents held a Bachelor's Degree (41%) or a Higher National Diploma (HND) (37%). Other qualifications included Diploma (13%), Master's Degree (6%), and Doctor of Philosophy (3%).

This suggests that the majority of respondents are well educated, with a solid academic foundation for understanding advanced technologies. In terms of profession, engineers made up the largest group at 50%, followed by contractors (18%), quantity surveyors (15%), and architects (8%). The remaining 9% were categorised as "others," which may include project managers, consultants, or academic professionals. The inclusion of diverse professional backgrounds enriched the data, offering a more holistic view of the perceived benefits of Industry 4.0 in the quantity surveying profession. Interestingly, while higher degrees such as Master's (6%) and PhD. (3%) are less common, the presence of such qualifications suggests a slight but notable segment engaged in advanced or specialised roles. The intersection of age, education, and profession highlights a pipeline of emerging professionals equipped with relevant credentials; however, the low female representation (14%) suggests that gender diversity remains a challenge within this evolving workforce.

4.2 Benefits of Practising the Quantity Surveying Profession Using Industry 4.0

Table 2: Benefits of Practising the Quantity Surveying Profession Using Industry 4.0

Benefits	Frequencies					Mean	RII	Rank
	1	2	3	4	5			
It will be beneficial for practising the quantity surveying profession using Industry 4.0	2	2	12	43	41	**4.19**	0.838	**1st**
It will be beneficial for practising the quantity surveying profession using Industry 4.0	1	2	12	58	27	**4.08**	0.816	**2nd**
Industry 4.0 technologies (such as AI, IoT, and automation) are currently impacting the field of quantity surveying	2	3	16	45	34	**4.06**	0.812	**3rd**
Industry 4.0 will be advantageous when used for data analysis, forecasting and managing project costs more effectively	2	3	18	44	33	**4.03**	0.806	**4th**

Industry 4.0 will benefit quantity surveyors by requiring new competencies to remain competitive in the era of technological change.	2	2	14	56	26	**4.02**	0.804	**5th**
Artificial intelligence (AI) will improve the efficiency of cost estimation and budgeting processes in quantity surveying	1	5	16	48	30	**4.01**	0.802	**6th**
Industry 4.0 will help professional growth and ongoing education, and encourage the use of technologies in quantity surveying	2	2	17	51	28	**4.01**	0.802	**6th**
Industry 4.0 technologies could bring some potential benefits to quantity surveying practices	3	1	16	53	27	**4.00**	0.800	**8th**
Industry 4.0 can facilitate better communication and collaboration between quantity surveyors and other project stakeholders	2	3	21	44	30	**3.97**	0.794	**9th**
It will help quantity surveyors to encourage energy efficiency in building projects using Industry 4.0 technologies	2	4	22	42	30	**3.94**	0.788	**10th**
Industry 4.0 can be used as advanced simulation tools to benefit quantity surveyors in assessing project risks and opportunities	2	4	21	45	28	**3.93**	0.786	**11th**
Industry 4.0 will help quantity surveyors ensure the security of sensitive project data in the environment	1	4	23	45	27	**3.93**	0.786	**11th**
Industry 4.0 technologies will improve the accuracy of material and labour quantity take-offs	2	5	22	41	30	**3.92**	0.784	**13th**
Industry 4.0 trends in the future could be advantageous to the quantity surveying profession	3	4	20	51	22	**3.85**	0.770	**14th**
Industry 4.0 will help the full adoption of the positions of the quantity surveyor change	2	5	25	42	26	**3.85**	0.770	**14th**

Source: Field Survey (2024)

The findings from Table 4 above clearly illustrate a strong agreement among respondents on the substantial benefits of Industry 4.0 for the quantity surveying profession. The top-ranked benefit (RII = 0.838) highlights that its adoption will be broadly advantageous for current practice, this finding agrees with Lopes and da Silva Filho (2024), who argued that there is strong potential for increasing quality with the introduction of innovations in quantity surveying. Closely following (RII = 0.816) is the recognition of its role in enhancing the

profession through advanced tools and systems, which aligns with Lim, Wong, and Ding's (2024) finding that digitalisation would improve the efficiency and productivity of the construction industry for quantity surveying professionals. Technologies such as AI, IoT, and automation are already making an impact (RII = 0.812), and respondents see further value in their capacity to improve data analysis, forecasting, and cost management. Additionally, there is a shared belief that Industry 4.0 will support the development of new competencies, foster professional growth, and promote continuous education, thereby reinforcing its long-term relevance (Singh et al., 2022).

While benefits like enhanced communication, simulation tools, data security, and improved take-offs ranked slightly lower, they still reflect a generally optimistic view of the digital shift. This aligns with the findings of Junussova et al. (2025), who concluded that real-time resource monitoring and BIM-integrated workflows improve decision-making and sustainability. Interestingly, emerging benefits related to energy efficiency, future trends, and evolving professional roles also appeared, albeit with marginally lower scores, suggesting they are viewed as potential rather than immediate impacts. Overall, the ranking of benefits reflects a forward-thinking perspective, with a clear emphasis on efficiency, competitiveness, and the strategic value of technological integration in quantity surveying.

5.0 CONCLUSION

The integration of Industry 4.0 technologies into the quantity surveying profession marks a significant shift in how construction cost management and project control are approached. As demonstrated through the literature and supported by empirical data, the adoption of transformative tools such as Artificial Intelligence (AI), Internet of Things (IoT), Building Information Modelling (BIM), automation, and big data analytics brings substantial advantages to the profession.

The analysis clearly indicates that these technologies enhance the accuracy and efficiency of traditional quantity surveying tasks, such as cost estimation, budgeting, and resource planning. Furthermore, they foster real-time decision-making, enhance stakeholder collaboration, and improve project outcomes through data-driven strategies. Importantly, Industry 4.0 enables quantity surveyors to take on more strategic roles in construction projects, emphasising value management, sustainability, and innovation.

While the transition to digital practices requires new skillsets and adaptation, the benefits far outweigh the challenges. Quantity surveyors who embrace these changes will not only remain competitive but also lead the transformation of the construction industry toward a smarter, more efficient, and integrated future. Industry 4.0 does not diminish the profession; it elevates it, opening doors to new opportunities for growth, relevance, and impact in an increasingly digital world.

The study's findings translate into an evidence-based roadmap identifying priority drivers that professional bodies, educational institutions, and quantity surveying firms should address to

accelerate beneficial Industry 4.0 adoption. The study provides empirical evidence from a developing-economy context (Ghana/West Africa) on how contextual factors unique to these settings influence Industry 4.0 adoption among quantity surveying professionals. The study employs an integrated multi-theoretical framework combining the Unified Theory of Acceptance and Use of Technology (UTAUT) and Technology-Organisation-Environment (TOE) to explain Industry 4.0 adoption among quantity surveying professionals. This theoretical advancement provides a more nuanced and comprehensive explanatory model that can be applied to future studies of professional technology adoption beyond quantity surveying.

Collectively, these novel contributions position this study as a significant advancement in understanding how and why quantity surveying professionals adopt Industry 4.0 technologies. By addressing theoretical, methodological, contextual, and practical gaps in existing literature, the research generates new knowledge that advances both academic understanding and professional practice. The study's originality lies not only in examining an underexplored professional domain but also in its comprehensive, theoretically integrated, and contextually grounded approach, which generates actionable insights for the profession's digital future.

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