

IMPACT OF INFORMATION AND COMMUNICATION TECHNOLOGIES ON THE
PREPARATION OF BILL OF QUANTITIES IN BENIN CITY

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DECLARATION

I declare that this project is an original work carried out by me, **KELLY IGHOFIMONI** with Matriculation Number **ENV1805851** in the Department of Quantity Surveying, Faculty of Environmental Sciences, University of Benin, Benin City.

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CERTIFICATION

We certify that this project with the title: **IMPACT OF INFORMATION AND COMMUNICATION TECHNOLOGIES ON THE PREPARATION OF BILL OF QUANTITIES IN BENIN CITY** submitted by **IGHOFIMONI KELLY**, with Matriculation Number ENV1805851 has satisfied the regulations governing the award of Bachelor’s Degree in Quantity Surveying from the University of Benin, Benin City, Edo State.

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DEDICATION

This Research work is dedicated to Almighty God and my family for making it possible for me throughout these years as a student. May God keep bless you all.

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My sincere appreciation to God Almighty for the favor, love, and mercy he shown me since the start of my degree till date.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Information and Communication Technology (or Technologies) is the acquisition, processing, storage, and dissemination of vocal, pictorial, textual, and numerical information by a microelectronics-based combination of computing and telecommunications (Karl, 1961). According to UNESCO “ICT is a scientific, technological and engineering discipline and management technique used in handling information, its application and association with social, economic, and cultural matters”. ICT is a branch of Information Technology (IT) that emphasizes the communication technologies that affect our society and how we communicate or share data or information. Four main types of communication devices help with the ease of sharing information across the globe, these are the internet, television, radio, and telephone. ICT has been defined by many scholars and authors over the years and the definitions are central to the sharing of information for easier communication. ICT encompasses a spectrum of technologies involved in gathering, storing, processing, transmitting, and presenting information. This includes but is not limited to the Internet, wireless networks, cell phones, and various other communication mediums (Clement and Shade, 2000). ICT pertains to a collection of technologies facilitating information access via telecommunications. While bearing similarities to Information Technology (IT), it underscores the significance of communication technologies in this context (Reichertz, 2006).

ICT enhances communication through instant messaging, video conferencing, and email, fostering global connectivity, in education provides access to a wealth of information, interactive learning materials, and online courses, expanding learning opportunities (Majumdar, 2015). ICT tools streamline business processes, automate tasks, and improve decision-making, leading to increased efficiency and productivity (Kundurur, 2023). It enables access to a vast amount of information worldwide, empowering individuals and organizations to stay informed on a global scale. ICT fosters innovation and creativity by providing tools for collaboration, research, and problem-solving (Tsalapatras, 2022).

Due to research conducted, some scholars argue that the digital divide, the gap between those with access to ICT and those without, can exacerbate social and economic inequalities (Jarboe, 2001). The combination of the increasing power of new technology and the agreement on the privacy of user information that is sold, used, or collected for purposes that are disadvantageous to the user (Hoven, 2019). The adoption of ICT has increased the displacement of jobs through the automation of many tasks and the integration of machine-labor substitution (Brynjolfsson and McAfee, 2011). ICT tools such as specialized software for quantity surveying streamline the process of preparing Bills of Quantities, reducing manual errors and improving accuracy.

Quantity surveyors are important professionals in the construction industry as they prepare all necessary documents that is relation to the expenses and cost of a construction project, thus, they are constantly scrutinized and greatly criticized for the accuracy of data and information given and this is due to the traditional ways of communicating such as paper take-off, estimating and tendering which take time and paper wastage the adoption of ICT is needed (Shoesmith, 1995). As ICT is evolving, there is quantity surveying software that specializes in streamlining the process of preparing Bills of Quantities, reducing manual errors while improving accuracy as

ICT enables the automation of mathematical calculations involved in quantity surveying, reducing the time required for computation and minimizing the risk of errors in quantity calculations. ICT facilitates the integration of data from various sources, allowing for collaborative work among different project stakeholders (Alreshidi, Mourshed, and Rezgui, 2018). This enhances communication and coordination, leading to more accurate and comprehensive Bills of Quantities. ICT, data related to materials, costs, and quantities can be stored in centralized databases (Sinaeepourfard and Krogstie, 2020). This centralization ensures data consistency and enables easy retrieval and updating of information, contributing to the accuracy of the Bill of Quantities. ICT tools such as WINQS, QSCAD, and CATO (Computer Aided Taking-Off) allow for real-time updates and changes to the Bills of Quantities as the project progresses (Ranadewa). This ensures that the Bill of Quantities remains current and reflective of any modifications or variations in the construction process. Communication and collaboration among project teams are enhanced through ICT, allowing for seamless sharing of information, feedback, and revisions during the preparation of Bills of Quantities (Davidson, Fowler, Pantazis, and Sannino, 2020). ICT tools enable sophisticated cost estimation and analysis. Quantity surveyors can use software to simulate different scenarios, assess cost implications, and make informed decisions during the preparation of Bills of Quantities (Babatunde, Perera, and Ekundayo, 2019). ICT facilitates efficient document management, ensuring that all relevant documents, drawings, and specifications are easily accessible during the preparation of Bills of Quantities. This contributes to the completeness and accuracy of the Bill of Quantities. ICT supports quality control measures by providing tools for cross-referencing and validating data, helping quantity surveyors identify and rectify discrepancies or inconsistencies in the Bills of Quantities. The use of ICT accelerates the process of preparing

Bills of Quantities, leading to time savings (Oladapo, 2006). This efficiency is particularly crucial in fast-paced construction projects.

The implementation of ICT tools may involve initial costs for acquiring software, hardware, and training personnel (Remenyi, Money, Bannister, 2007). Small businesses or projects with limited budgets may find these upfront costs challenging. Technical issues, such as software glitches, hardware malfunctions, or network problems, can lead to downtime (Dauda, Nuhu, Abubakar, Abdullahi, and Maliki, 2021). This downtime can disrupt the workflow and potentially delay the preparation of Bills of Quantities. The use of ICT introduces concerns about data security (Gupta, Abdelsalam, Khorsandroo, and Mittal). Sensitive information related to project costs, quantities, and specifications must be safeguarded against unauthorized access, hacking, or data breaches. Overreliance on ICT tools may create a dependency, making quantity surveyors vulnerable to disruptions in case of software failures, compatibility issues, or changes in technology platforms (Ulucak and Yucel, 2022). The risk is that quantity surveyors may become overly reliant on technology and overlook the importance of manual checks and verification processes, potentially leading to errors. Introducing new ICT tools may require a learning curve for the staff involved in the preparation of Bills of Quantities. Resistance to change or challenges in adapting to new technologies can slow down the adoption process (Cresswell and Sheikh, 2013). Some ICT tools may have limitations in terms of customization to specific project requirements or industry standards. This can result in less flexibility in adapting the technology to unique project needs. Compatibility issues may arise when integrating different software or when exchanging data with other project stakeholders who use different ICT tools. This can lead to data inconsistencies and errors. Increased reliance on digital communication may lead to a loss of personal interaction among project team members. Effective communication in quantity surveying often involves

face-to-face discussions, and excessive reliance on digital channels may hinder collaboration. Rapid advancements in technology may render certain ICT tools obsolete over time (Ghaffarianhoseini andTookey, 2014). This poses a risk of investing in tools that may become outdated, requiring regular updates or replacements to stay current. While ICT tools are powerful for automation and efficiency.

1.2 Statement of the Research Problem

ICT use has benefited quantity surveying, increasing the efficiency of Bill of Quantities compilation and providing other advantages to quantity practices overall. The majority of issues that develop during the creation of the BOQ are caused by inaccurate or outdated data and information, therefore information and communication technology (ICT) has not only increased efficiency but also decreased the stress of maintaining practice-related information (Jalam and Dahiru, 2018).

Despite the benefits of ICT, the quantity surveying profession is slow to adopt it because of several factors, including high initial costs, a lack of knowledge and training on ICT for quantity surveying, low margins, high learning costs, and a fear of overspending. These factors are categorized into six main themes. These themes included risk-taking behavior, time dedication, financial considerations, perceptions of values, awareness, and knowledge, and strategic and tactical direction (Agyekum, Ayarkwa, And Acheampong, 2015).

There's a growing belief that our lives are becoming more stressful due to the rapid improvements in technology, which might negatively impact our well-being and performance (Tagurum *et al*, 2017).

Intensive use of ICT has harmed the mental health, symptoms of depression, and insomnia of the users (Thomee, 2012). Rimmington *et al*. (2015) studied the effects of ICT on the social

environment of a construction project team and project outcome, it was found that there is tension and conflict in human-electronic and human-human communication, that social skills are being eroded in the workplace, that there is less social interaction among team members, that information is passed more quickly and spontaneously due to ICT tools, and that there is a tendency to become sidetracked from the task at hand. These findings suggest that increased use of ICT will come at the expense of soft system communication protocol. The purpose of this study is to determine how ICT affects the Bill of Quantities preparation process.

1.3 Research Questions

1. What is the level of adoption of Information and Communication Technology in Bill of Quantities preparation?
2. What factors influencing the adoption of ICT in Bill of Quantities preparation?
3. What are the challenges faced by quantity surveyors in adopting ICT tools for Bill of Quantities preparation?

Aim and Objectives

This study aims to comprehensively examine the impact, challenges, contributions, and potential risks associated with the adoption of Information and Communication Technology in the Bill of Quantities preparation process within the field of quantity surveying.

1. Assessing the level of adoption of specific ICT tools in the Bill of Quantities preparation process;
2. Factors influencing the adoption of ICT in the preparation of Bill of Quantities; and
3. Examine the challenges confronted by quantity surveyors when adopting ICT tools for Bill of Quantities (BoQ) preparation.

1.4 Scope of the Study

This research will engage quantity surveyors in Benin City, to gather insights into their adoption levels, challenges influencing the adoption of ICT in the preparation of BOQ. It covers a range of ICT, including but not limited to cost estimation software, taking off software, BIM, CATO e.t.c. The study focuses on technologies that significantly impact the preparation of BOQ and the various software employed by construction professionals.

1.5 Justification of the Study

The significance of this study lies in addressing critical aspects of the adoption of Information and Communication Technology (ICT) in the Bill of Quantities (BoQ) preparation process within the field of quantity surveying. For quantity surveyors to be more effective overall, they must comprehend how the use of ICT affects the accuracy and efficiency of BoQ preparation (Rathnayake, 2021). The knowledge gathered from this research can help develop procedures that increase output while lowering mistakes. Analyzing the challenges and barriers faced by quantity surveyors in adopting ICT tools provides valuable insights into the practical hurdles hindering the full integration of technology (Rogers, Chong, and Preece, 2015) (Abubakar, Ibrahim, and Kado, 2017). Addressing these challenges can lead to more effective strategies for implementation. Examining how the utilization of ICT contributes to the overall performance of quantity surveyors and the construction industry helps in understanding the broader impacts (Oesterreich and Teuteberg, 2016). This knowledge can guide industry stakeholders in leveraging technology for positive outcomes. Identifying potential risks and concerns associated with increased reliance on technology is crucial for developing risk mitigation strategies (Shiferaw, Tesfaye, Kassie, and Abate, 2014). Understanding these challenges allows for the development of measures to ensure data security, system reliability, and the overall success of ICT adoption. Evaluating the degree of ICT implementation in the BoQ preparation process

provides a baseline for understanding the current state of technology adoption (Sadeghineko and Tong, 2022). This knowledge informs future strategies for incorporating emerging technologies and tools. The findings of this study can inform decision-makers, policymakers, and industry leaders about the impact of ICT on quantity surveying practices. This knowledge is essential for making informed decisions on resource allocation, training programs, and technological investments.

This research contributes to the academic understanding of the intersection between ICT and quantity surveying. It provides a basis for further studies, discussions, and advancements in the field, fostering continuous improvement, and innovation, and offers practical implications for quantity surveyors, guiding them on effective ways to leverage ICT tools in BoQ preparation. It provides insights into best practices, potential pitfalls, and strategies for optimizing the use of technology in their professional roles.

1.6 Definition of Terms

Information and Communication Technology (ICT): The acquisition, processing, storage, and dissemination of vocal, pictorial, textual, and numerical information by a microelectronics-based combination of computing and telecommunications.

Digital Divide: The gap between those with access to Information and Communication Technologies (ICT) and those without, which can exacerbate social and economic inequalities.

Automation: The use of largely automatic equipment in a system of operation.

Bills of Quantities (BoQ): A document in construction projects that provides an itemized list of the work and materials required for a construction project, including their quantities and prices.

Data Security: Measures taken to protect data from unauthorized access, data breaches, or other cyber threats.

Digital Communication: Communication using electronic devices and technology, such as email, instant messaging, and video conferencing.

Risk Mitigation: The process of identifying, assessing, and prioritizing risks, and taking steps to minimize or control the impact of these risks.

ICT Implementation: The process of integrating and using Information and Communication Technology tools and systems in a specific context, such as the preparation of Bills of Quantities.

Compatibility Issues: Problems that may arise when different software or systems are unable to work together or exchange data seamlessly.

Learning Curve: The time and effort required for individuals or organizations to become proficient in using new technologies or tools.

Obsolete: No longer in use or no longer useful, typically because it has been replaced by something newer or more advanced.

Soft System Communication Protocol: The set of rules or conventions governing communication in a non-technical or human context.

CHAPTER TWO

LITERATURE REVIEW

2.1 Preamble

The integration of various technologies for the acquisition, processing, storage, and dissemination of information related to construction projects is referred to as Information and Communication Technology (ICT) in the context of quantity surveying (Mutesi and Kyakula, 2011). This encompasses both hardware and software components that enable communication, data management, and automation within the field.

Within the construction industry, the hardware components of ICT may consist of computers, servers, mobile devices, and networking infrastructure. On the other hand, the software components involve applications specifically designed for quantity surveying tasks, such as Building Information Modeling (BIM) software, cost estimation tools, and specialized quantity surveying software (Wu, Wood, Ginige, and Jong, 2014).

2.2 Evolution of ICT in the Construction Industry

The construction industry has witnessed a progressive transition from traditional paper-based methods to more sophisticated digital solutions, thanks to the evolution of ICT. Initially, basic computer programs were utilized for tasks such as cost estimation. However, as technology

advanced, construction professionals, including quantity surveyors, now have access to more advanced tools that streamline various processes (Chan and Owusu, 2022).

A significant development in this regard is the incorporation of BIM, which enables the creation of detailed digital representations of construction projects. This has greatly improved collaboration, visualization, and data sharing among project stakeholders (Ghaffarianhoseini et al, 2017). Furthermore, the advent of cloud computing has facilitated remote access to project data and real-time collaboration.

.2.2.1 Importance of ICT in Quantity Surveying

The significance of ICT in quantity surveying lies in its capacity to enhance efficiency, precision, and collaboration throughout the project lifecycle. Quantity surveyors play a vital role in managing project costs, and ICT tools empower them to handle intricate calculations, automate repetitive tasks, and communicate effectively with other team members (Porwal and Hewage, 2013). Moreover, ICT in quantity surveying also facilitates the creation and management of Bills of Quantities (BoQ). Digital tools enable real-time updates, instant data sharing, and seamless collaboration among stakeholders involved in the preparation and analysis of BoQs. The integration of ICT has become essential for maintaining competitiveness in the construction industry and adapting to the evolving demands of modern project management (Walker, 2015).

2.3 Adoption of ICT in the Construction Industry

The construction industry has witnessed the adoption of Information and Communication Technology (ICT) due to various trends that are shaping the way professionals approach project management, collaboration, and decision-making. One prominent trend is the growing utilization

of Building Information Modeling (BIM), which involves the creation and management of digital representations of a construction project's physical and functional characteristics. BIM facilitates collaborative work, improves communication among stakeholders, and enhances overall project efficiency.

Another significant trend in the construction sector is the emergence of cloud computing. This technology allows project data to be stored, accessed, and shared in real-time from any location with an internet connection, thereby revolutionizing collaboration. Cloud-based project management tools, document sharing platforms, and collaborative software have become essential components of modern construction practices (Won and Hwang, 2022).

Furthermore, there is an increasing adoption of mobile technology among construction professionals, including quantity surveyors. This enables them to access project information and communication tools while on the move. Mobile applications for cost estimation, project scheduling, and data collection contribute to improved efficiency and flexibility in project management (Khan, Ullah, et al. 2023).

2.3.1 Successful ICT Implementation in Construction

Various case studies demonstrate the successful utilization of ICT in the construction sector, illustrating the favorable influence it has on project results (Wong, 2007). The integration of BIM into projects has proven to be particularly effective, resulting in enhanced coordination, decreased errors, and improved communication among stakeholders. Noteworthy instances include the implementation of BIM in large-scale infrastructure projects, where it has played a crucial role in managing intricate construction processes.

Furthermore, the implementation of project management software has also contributed to the success of construction projects. Case studies provide evidence of how these tools streamline communication, task management, and resource allocation, ultimately leading to better project control and timely completion.

2.3.2 Factors influencing to ICT Adoption in Construction

Despite the advantages, the integration of ICT in the construction sector encounters various obstacles and difficulties. One notable challenge is the resistance to change within traditional construction practices (Vass and Gustavsson, 2017). Construction professionals may be accustomed to conventional methods and may be hesitant to embrace new technologies due to a lack of awareness, understanding, or fear of disruptions.

Financial considerations, such as the initial costs of implementing ICT infrastructure, software, and training, present a significant barrier, particularly for small and medium-sized enterprises (SMEs) with limited budgets (Sallem, Mohd, et al, 2017). Furthermore, concerns regarding data security, interoperability issues, and the requirement for skilled personnel contribute to the challenges associated with the adoption of ICT in the construction industry.

2.4 ICT Tools in Quantity Surveying

BIM software serves as a collaborative platform that facilitates the seamless creation, management, and sharing of comprehensive digital models of construction projects (Sibaii, 2020). This software empowers quantity surveyors by allowing them to extract crucial information related to quantities and costs directly from the model. Various specialized cost estimation software, such as CostX, Revit with CostOS, PriMus, iTWO costX, BuildSoft Cubit,

and Sigma Estimates, play a vital role in the work of quantity surveyors. These tools integrate historical cost data, material prices, and labor rates, enabling accurate estimates and supporting informed decision-making in construction projects (Morovvati, 2021). Additionally, tailored software specifically designed for quantity surveying tasks is essential as it automates calculations and enhances overall efficiency in processes like Bills of Quantities preparation.

2.4.1 Specific ICT Tools for Bill of Quantities Preparation

WINQS is a specialized software for quantity surveying that focuses on optimizing the process of preparing Bills of Quantities. It offers a range of features, including automated calculations, real-time updates, and collaborative functionalities, which enhance accuracy and efficiency for all project stakeholders (Bucur, 2012). QSCAD, on the other hand, caters to the specific needs of quantity surveyors during BoQ preparation by providing tools for quantity take-off, cost estimation, and seamless integration with Building Information Modeling (BIM) models (Adekunle, Samuel, et al., 2022). Similarly, CATO (Computer Aided Taking-Off) is designed to automate the quantity take-off process, significantly improving the speed and precision of measuring quantities from drawings (Wu, Song, et al., 2014).

CostX is a widely used tool in the construction and infrastructure sectors that combines BIM and 2D estimating capabilities to facilitate the preparation of Bills of Quantities. It enables accurate quantity takeoff and cost estimation (Babatunde, Solomon, et al., 2019). Another tool, iTWO, costX, integrates BIM and estimating functionalities to extract quantities directly from 3D models, aiding in the creation of detailed Bills of Quantities (Alsharqawi, 2016). PriMus is a software solution that supports BIM-oriented preparation of Bills of Quantities and offers

features for 2D and 3D takeoff. It also integrates seamlessly with various BIM authoring tools (D'Amico, Fabrizio, et al., 2020).

BuildSoft Cubit is a software solution designed specifically to estimate and prepare Bills of Quantities (BoQ). By supporting the takeoff process, it enables users to generate detailed and accurate BoQs. This software solution has been recognized for its effectiveness in streamlining the estimation process (Pei, Zhang, Li, and Lei, 2022).

CostOS, on the other hand, is a parametric estimating tool that can be customized to suit BoQ preparation requirements. It offers a range of features that allow users to estimate costs based on project parameters and historical data. This tool has been widely acknowledged for its ability to provide accurate cost estimates (Kehily, Woods, and McDonnell - 2013).

While SharpCloud is not specifically designed as a BoQ tool, it serves as a collaborative project management and communication tool. It can be effectively utilized in conjunction with other estimating tools to facilitate collaborative project planning and communication. This integration enhances the overall efficiency of the estimation process (Pei, Zhang, Li, and Lei, 2022).

In addition, Benchmark Estimating Software is a cloud-based solution that encompasses various aspects of estimating, including BoQ preparation. It offers a comprehensive platform for collaboration and seamlessly integrates with other project management tools. This software solution has been recognized for its ability to streamline the estimation process and improve project efficiency (Top, Ozcan, et al. 2011).

Furthermore, these software solutions, namely BuildSoft Cubit, CostOS, SharpCloud, and Benchmark Estimating Software, each offer unique features and capabilities that contribute to

the estimation and BoQ preparation process. Their integration with other tools and emphasis on collaboration enhance project efficiency and accuracy.

2.5 Challenges Faced by Construction Professionals in the Adoption of ICT in Quantity Surveying

The integration of Information and Communication Technology (ICT) tools in the field of quantity surveying frequently entails substantial initial expenses. The procurement of software and hardware, as well as the provision of training to staff, can place a burden on the budget, especially for small enterprises or projects with limited financial means. Small and medium-sized businesses (SMEs) may encounter difficulties in allocating funds for the upfront costs linked to the implementation of ICT tools. This financial limitation serves as an obstacle to the widespread embrace of technology in the realm of quantity surveying (Agyekum and Ayarkwa, 2015).

2.5.1 Training and Skill Development

The implementation of new ICT tools may necessitate the need for quantity surveyors and other relevant personnel to partake in training sessions, leading to a period of learning and adaptation. This initial phase of adjustment can temporarily affect productivity and may encounter opposition from individuals who are accustomed to conventional approaches. Given the rapid progression of technology, it is imperative for quantity surveyors to continuously enhance their skills and remain up-to-date with the latest advancements in ICT. Consequently, organizations should allocate resources toward ongoing training programs to ensure the proficient utilization of these new tools (Ibironke, Ekundayo, and Awodele, 2011).

2.5.2 Data Security and Privacy Concerns

ICT tools play a significant role in the field of quantity surveying, as they are frequently used to manage and manipulate sensitive information pertaining to project costs, quantities, and specifications. It is of utmost importance to prioritize the security and privacy of this data, safeguarding it against unauthorized access, hacking, or data breaches. This concern is highlighted by Anifowose, Alabi, and Mangwat (2018) who emphasize the critical nature of ensuring the protection of such information. However, it is crucial to avoid excessive reliance on ICT tools without implementing adequate measures for data security, as this can pose a potential risk. To mitigate this risk, quantity surveyors should adopt robust risk management strategies to effectively safeguard confidential project information from potential cyber threats.

2.5.3 Resistance to Change and Cultural Factors

The adoption of new ICT tools in quantity surveying may face resistance due to the deeply ingrained traditional practices. To overcome this resistance, effective change management strategies and a cultural shift towards embracing technology are necessary (Gajendran and Brewer, 2012). The acceptance of ICT within quantity surveying firms can be influenced by the organizational culture. A culture that values innovation and continuous improvement is more likely to support the successful integration of technology into daily practices.

2.5.4 Reliability and Compatibility Issues

Technical difficulties, such as software glitches or malfunctions, can result in periods of inactivity. The dependability of ICT tools becomes paramount in sustaining the smooth operation of tasks, and it is imperative for organizations to acknowledge and mitigate the risks linked to

potential interruptions (Amadi, 2022). Quantity surveyors may encounter obstacles when incorporating diverse software or sharing information with other project participants who utilize varying ICT tools. Guaranteeing compatibility is vital to avoid discrepancies and mistakes in data.

2.6 Strategies for Overcoming Challenges

To address the learning curve associated with new ICT tools, it is crucial to implement continuous training and education programs. This will ensure that quantity surveyors and related staff are up to date with technological advancements and can enhance their proficiency in using these tools. By designing training modules that are specifically tailored to the needs of quantity surveyors, the learning process can be expedited. These modules should focus on practical application, highlighting the use of ICT tools in real-world quantity surveying scenarios. By establishing partnerships with educational institutions, the integration of ICT training into academic programs can be facilitated. This collaborative approach will ensure that new entrants into the quantity surveying profession are equipped with the necessary digital skills.

2.6.1 Addressing Data Security Concerns

It is of utmost importance to implement strong data encryption measures in order to protect sensitive project information. This guarantees that data pertaining to costs, quantities, and specifications remains confidential and is shielded from unauthorized access. It is crucial to comply with data protection regulations and industry standards, including privacy laws and guidelines, in order to minimize the risks associated with data breaches and unauthorized use of project data. By conducting regular security audits and assessments, vulnerabilities in the ICT

infrastructure can be identified. This proactive approach enables quantity surveyors to address potential security concerns before they become more serious.

2.6.2 Creating a Culture of Innovation and Adaptability

Strong leadership support is crucial in fostering a culture of innovation. Leaders in quantity surveying firms should take the lead in promoting the use of ICT tools, highlighting the long-term benefits and encouraging a forward-thinking mindset. By providing incentives for innovative practices, quantity surveyors are more likely to embrace new technologies (Olatunji - Journal of information technology in construction, 2011). Recognizing and rewarding individuals and teams who successfully integrate ICT tools can also inspire others to do the same.

Creating open communication channels within the organization is essential for promoting the exchange of ideas. This inclusive approach allows quantity surveyors to express their concerns, share their experiences, and actively participate in the decision-making process regarding the adoption of ICT. These strategies aim to address challenges related to training, data security, and organizational culture, ultimately creating an environment that is conducive to the successful integration of ICT in quantity surveying practices.

2.7 Unexplored Aspects of ICT in Quantity Surveying

The current study may have only scratched the surface when it comes to examining the intersection of ICT tools in quantity surveying and sustainability practices in construction. There

is still much to be discovered about how technology can contribute to environmentally conscious decision-making and green construction. Additionally, the social implications of adopting ICT, particularly in terms of engaging stakeholders and involving the community in construction projects, may not have received enough attention. Further investigation is needed to understand the impact of ICT on social dynamics within the construction sector. Moreover, the ethical considerations surrounding the use of ICT tools in quantity surveying may not have been given sufficient emphasis. It is crucial to explore issues such as data privacy, responsible AI use, and the ethical implications of automation in decision-making processes.

2.7.1 Emerging Trends and Future Directions

The potential applications of block-chain technology in quantity surveying may not have been extensively covered in the literature. It is an emerging trend that requires further attention to investigate how block-chain can enhance transparency, security, and efficiency in managing construction data.

The exploration of AI and ML in the construction industry may not have been thoroughly examined. Future research could focus on how AI and ML can improve predictive modeling, risk analysis, and decision support systems within quantity surveying (Rane, 2023).

The study may not have adequately addressed the evolving dynamics of human-machine collaboration in quantity surveying. A promising area for future exploration is understanding how quantity surveyors collaborate with AI systems and automated tools in decision-making processes. While existing literature offers valuable insights into the impact of ICT on quantity surveying, there are still notable gaps and emerging trends that require further investigation. These unexplored aspects include the integration of ICT with sustainability practices, the social

implications of ICT adoption, and ethical considerations (Gill, Xu, Ottaviani, Patros, and Bahsoon, 2022). Future research directions involve exploring the applications of blockchain, the integration of AI and ML, and the dynamics of human-machine collaboration within the field of quantity surveying.

2.8 Model for Understanding ICT Adoption in Quantity Surveying

The Innovation Diffusion Theory serves as a conceptual framework for comprehending the adoption of ICT in the field of quantity surveying. By drawing upon this theory, researchers can explore how ICT tools are adopted and spread within a professional setting. This theory takes into account various factors, including the attributes of the innovation, communication channels, social systems, and time, thereby offering a comprehensive model for understanding the process of adoption.

To further assess the ease of use and usefulness of specific ICT tools for quantity surveyors, the Technology Acceptance Model (TAM) can be integrated into the conceptual framework. This model aids in identifying the factors that influence the decision-making process when adopting new technologies, providing valuable insights into the psychological and behavioral aspects of ICT adoption.

Considering the organizational context, the Organizational Readiness Framework plays a crucial role in assessing the readiness of quantity surveying firms to adopt ICT. This framework takes into account factors such as organizational culture, leadership support, and the availability of

resources. By understanding the organizational context, researchers can establish a solid foundation for successful implementation of ICT in quantity surveying.

2.8.1 Variables Influencing Successful ICT Implementation

The successful implementation of ICT in quantity surveying firms is influenced by several critical variables. One such variable is the degree of support from leadership within these firms. When leaders demonstrate a strong commitment to integrating ICT tools, it fosters a culture of innovation and facilitates the allocation of resources for implementation. This was highlighted by Gichoya (2015)

Another important variable is the level of training and skills development provided to quantity surveyors. Adequate training programs that address the specific needs of users contribute to a smoother adoption process and enhance the effectiveness of ICT tools.

The availability of financial resources within quantity surveying firms is also a key variable. Sufficient budget allocation for acquiring ICT tools, infrastructure development, and training programs significantly influences the success of implementation efforts. Aksorn and Hadikusumo (2008) emphasized the importance of financial resources in this regard.

Additionally, the perceived ease of use of ICT tools by quantity surveyors is a psychological variable that influences adoption. Tools that are perceived as user-friendly and easy to integrate into existing workflows are more likely to be embraced by professionals. This was noted by Addy, Adinyira, and Ayarkwa (2018).

Furthermore, the existing organizational culture within quantity surveying firms is a crucial variable. A culture that values innovation, embraces change, and promotes continuous improvement is more conducive to successful ICT implementation.

To understand the adoption of ICT in quantity surveying, a conceptual framework that integrates theories such as Innovation Diffusion Theory and Technology Acceptance Model can be used. This framework considers variables such as leadership support, user training, financial resources, perceived ease of use, and organizational culture. It provides a structured approach to analyzing and guiding the adoption of ICT tools in the quantity surveying profession (Gichoya, 2015).

CHAPTER THREE

RESEARCH METHODS

3.1 Preambles

In this study, the research methods employed in conducting the study on the impact, challenges, contributions, and potential risks associated with the adoption of Information and Communication Technology (ICT) in the Bill of Quantities (BoQ) preparation process within the field of quantity surveying are outlined.

3.2 Area of the Study

This study is situated within the realm of quantity surveying, specifically focusing on the incorporation of Information and Communication Technology (ICT) in the preparation of Bills of Quantities (BoQ). The research is conducted in Benin City, Nigeria, targeting quantity surveyors practicing in this geographical area. Benin City serves as an appropriate setting due to its vibrant construction industry and the presence of a significant number of quantity surveyors engaged in various projects. By focusing on this specific location, the study aims to gather insights that are contextually relevant and applicable to the local quantity surveying profession.

The choice of Benin City facilitates a targeted examination of the adoption, challenges, and contributions of ICT in BoQ preparation within a distinct geographic and professional context.

3.3 Research Design

This study will employ a quantitative research design to investigate the adoption of Information and Communication Technology (ICT) in the Bill of Quantities (BoQ) preparation process within the field of quantity surveying. The quantitative approach will involve the use of structured surveys administered to quantity surveyors practicing in Benin City, Nigeria. The surveys will be designed to gather numerical data on the level of adoption of ICT tools in BoQ preparation, factors influencing adoption, and perceived challenges faced by quantity surveyors.

Surveys will be distributed electronically or through paper-based forms, depending on participants' preferences and accessibility. The data collected will be analyzed using statistical methods to identify patterns, trends, and relationships among variables related to ICT adoption in BoQ preparation.

By focusing exclusively on quantitative methods, this study aims to provide objective and quantifiable insights into the extent of ICT adoption among quantity surveyors in Benin City, Nigeria, without the subjective interpretation inherent in qualitative approaches.

3.4 Target Population

The target population for this study comprises quantity surveyors practicing in Benin City, Nigeria. Quantity surveyors are professionals specializing in cost estimation and management within the construction industry, making them key stakeholders in BoQ preparation. By focusing on quantity surveyors in Benin City, the study aims to capture insights from professionals actively engaged in construction projects within this geographic area. The inclusion of quantity surveyors with varying levels of experience and expertise ensures a diverse representation of

perspectives and opinions on the adoption of ICT in BoQ preparation. This targeted approach allows for a comprehensive examination of the research questions within the specific context of Benin City's quantity surveying community.

3.5 Sampling Techniques and Sampling Size

A purposive sampling technique is employed to select participants for this study. Purposive sampling allows for the deliberate selection of participants who possess relevant knowledge and experience in BoQ preparation and ICT adoption within the quantity surveying field. The sample size is determined by reaching data saturation, where additional participants do not yield new information or insights. This approach ensures that the study captures a diverse range of perspectives and experiences while maintaining a manageable sample size for in-depth analysis. By utilizing purposive sampling, the study aims to gather rich and meaningful data that address the research objectives effectively.

3.6 Data Needs and Sources

To address the research objectives effectively, structured questionnaires will serve as the primary data collection instrument. These questionnaires will be meticulously designed to gather quantitative data on various aspects of ICT adoption in the Bill of Quantities (BoQ) preparation process among quantity surveyors in Benin City, Nigeria.

The structured questionnaires will include closed-ended questions with predefined response options, allowing for standardized data collection and facilitating quantitative analysis. The questions will cover key topics such as:

Level of Adoption; Assessing the extent to which quantity surveyors utilize specific ICT tools in BoQ preparation;

Factors Influencing Adoption; Exploring factors such as cost, accessibility, training, and perceived benefits influencing the adoption of ICT tools;

Challenges Faced; Identifying common challenges encountered by quantity surveyors in adopting and implementing ICT tools in BoQ preparation; and

Perceived Benefits; Examining the perceived benefits and advantages of using ICT tools in BoQ preparation, such as increased efficiency, accuracy, and productivity.

The structured questionnaires will be designed to ensure clarity, simplicity, and relevance to the research objectives, thereby maximizing response rates and data quality

3.7 Research Instrument

The primary research instruments utilized in this study are interview guides for semi-structured interviews and discussion guides for focus group discussions. These guides are carefully designed to cover key topics related to the adoption of ICT in BoQ preparation, including levels of adoption, influencing factors, challenges, and contributions. The interview guides provide a structured framework for conducting in-depth interviews with individual participants, ensuring that all relevant aspects of the research are explored. Similarly, the discussion guides offer a flexible format for guiding group discussions among participants, facilitating open dialogue and

The primary research instrument for this quantitative study will be structured questionnaires designed to gather data on the adoption of Information and Communication Technology (ICT) in the Bill of Quantities (BoQ) preparation process among quantity surveyors in Benin City, Nigeria. These questionnaires will consist of multiple-choice and Likert scale questions covering demographic information, the level of ICT adoption, factors influencing adoption decisions, challenges faced, and perceived benefits of using ICT tools in BoQ preparation. Pre-testing will be conducted to ensure the clarity, relevance, and comprehensibility of the questionnaires before

administering them to the target population. Data collected through the questionnaires will be analyzed quantitatively to identify patterns, trends, and relationships in the adoption of ICT among quantity surveyors.

3.8 Method of Data

The data collection method for this quantitative study will involve administering the structured questionnaires to quantity surveyors practicing in Benin City, Nigeria. The questionnaires will be distributed electronically through email or online survey platforms, as well as in paper format to those who prefer traditional methods. Participants will be provided with clear instructions on how to complete the questionnaires and will have the option to respond at their convenience. The structured questionnaires will gather quantitative data on various aspects of ICT adoption in BoQ preparation, including the frequency of ICT tool usage, factors influencing adoption decisions, challenges faced, and perceived benefits. Participants' responses will be collected and compiled for subsequent quantitative analysis to determine patterns, trends, and relationships in the data regarding the adoption of ICT among quantity surveyors in Benin City.

3.9 Method of Data Analysis

The quantitative data collected through the structured questionnaires will be subjected to statistical analysis to derive meaningful insights into the adoption of Information and Communication Technology (ICT) in the Bill of Quantities (BoQ) preparation process among quantity surveyors in Benin City, Nigeria.

Initially, the collected data will be organized and cleaned to ensure accuracy and consistency. Descriptive statistics such as frequencies, percentages, means, and standard deviations will be calculated to summarize the demographic characteristics of the participants and the key variables

related to ICT adoption, including the level of adoption, factors influencing adoption decisions, challenges faced, and perceived benefits.

Subsequently, inferential statistical techniques such as correlation analysis, chi-square tests, and regression analysis may be employed to examine relationships between variables and identify significant associations or predictors of ICT adoption in BoQ preparation. These statistical analyses will provide quantitative evidence to support or refute hypotheses regarding the factors influencing the adoption of ICT among quantity surveyors.

The findings of the data analysis will be presented using tables, charts, and graphs to facilitate interpretation and visualization of the results. Additionally, appropriate statistical software such as SPSS or Excel will be utilized to conduct the data analysis efficiently and accurately.

Overall, the method of data analysis will involve systematic procedures to analyze and interpret the quantitative data collected through the structured questionnaires, leading to meaningful conclusions and insights into the adoption of ICT in BoQ preparation among quantity surveyors in Benin City as shown in table 3.1.

Table 3.1: Research Objectives and Method of Analysis

S/N	Objectives	Data Type	Method(s) of Analysis	Software
1	The level of adoption of ICT tools in the bill of quantities preparation process	Ordinal	Mean Item Score	Excel
2	Factors influencing the adoption of ICT in the preparation of BOQ	Ordinal	Mean Item Score	Excel
3	Challenges encountered by quantity surveyors in the adoption of ICT tool	Ordinal	Mean Item Score	Excel

for BOQ preparation

Questionnaires	Frequency	Percentage
Number Distributed	115	100%
Total Number Collected	62	56.52%

CHAPTER FOUR

RESULTS AND DISCUSSION OF FINDINGS

4.1 Preamble

Analysis is a systematic and scientific approach to reaching a conclusion by examining data. Hence, this section therefore outlines and explains the analysis of data collected from the respondents through questionnaire. In order to make the research work more meaningful and understandable the data was therefore used to facilitate ideal and proper analysis as shown in Table

Table 4.1 Response Rate

4.2 Data Analysis

This section shows the characteristics of respondent. It indicates their profession, Academic Qualification, and Professional experience of the respondents have been questioned for the study and it is shown in Table 4.2.

Table 4.2 Summary of Background Information of Respondents were respondent.

Category	Description	Frequency	Percentage
Academic Qualification	ND	9	15%
	HND	18	29%
	B.Sc/B.Tech /PGD	29	47%
	M.Sc/M.Tech	4	6%
	PhD	2	3%
	Total		62
Years of Experience	5 below	45	72%
	6 to 10	9	15%
	11 to 15	6	10%
	more than 15	2	3%
	Total		196

Based on the above analysis, it can be concluded that the data provided by the respondents can be relied upon for the purpose of the analysis.

4.2.1 Academic Qualification

The academic qualifications of the study's participants provide insights into how respondents' educational backgrounds may affect their responses. The respondents' academic qualifications are classified into five categories: ND, HND, B.Sc/B.Tech/PGD, M.Sc/M.Tech, and PhD. The

data indicates that 16% of participants hold ND qualifications, totaling 10 individuals, while 32% of respondents possess HND qualifications, totaling 20. The B.Sc/B.Tech/PGD category represents the highest proportion, with 52% of participants, comprising 32 individuals. Additionally, 8% of respondents hold M.Sc/M.Tech qualifications, totaling 5, while the PhD category accounts for 3% of participants, with a frequency of 2.

4.2.2 Years of Working Experience

This section explores the range of years of working experience of the study's participants. It is important to analyze how the level of experience influences their perspectives on the research questions. The respondents' years of working experience are categorized into four groups: 5 years or below, 6-10 years, 11-15 years, and more than 15 years. The data reveals that a significant proportion of participants, 80%, have 5 years or below of experience, with a frequency of 50, while the 6-10 years category represents 13% of respondents with a frequency of 8. The 11-15 years category comprises 10% of respondents, with a frequency of 6, and the more than 15 years category accounts for 3% of respondents, with a frequency of 2. The 11-15 years category comprises 17% of respondents, with a frequency of 33.

4.3 Level of Adoption of Specific ICT tools in the Bill of Quantities Preparation Process

Respondents were asked to give their Level of Adoption of Specific ICT tools in the Bill of Quantities Preparation Process selection on a scale between 1 and 5 and the results are shown in Table 4.3 below.

Table 4.3 Level of adoption of ICT tools in the Bill of Quantities preparation process

Variables	MIS	Rank
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PlanSwift	4.92	1
AutoCAD	4.91	2
Microsoft Excel	4.89	3
Building Information Modeling (BIM)	4.45	4
Google Sheets	4.25	5
Microsoft Project	4.09	6
Microsoft Access	4.07	7
Microsoft Teams	3.98	8
Autodesk BIM 360	3.76	9
QuickBooks	2.99	10
CostManager	2.9	11
CostOS	2.34	12
Bluebeam	2.21	13
WinQS	2.17	14
CostX	2.12	15
Procurify	2.09	16
Procore	1.98	17
Buildertrend	1.94	18
Deltek Risk	1.32	19
ProEst	1.29	20

Plan-Swift is the most utilized tool, ranking first in adoption among respondents, indicating its extensive employment in the BOQ preparation process due to its comprehensive features for digital takeoff and estimating. Auto-CAD secures the second position in adoption, being widely used in drafting and design, facilitating the creation of detailed drawings and plans, making it a preferred choice among Quantity Surveyors for quantification of materials and resources in the BOQ. Microsoft Excel maintains a solid position in the adoption ranking, coming in third, owing to its versatility and familiarity, serving as a staple tool for organizing, calculating, and analyzing

data relevant to the BOQ. BIM holds the fourth position in adoption, indicating a significant level of utilization among respondents, thanks to its advanced modeling and visualization capabilities, along with its ability to extract detailed quantity information directly from digital models. Google Sheets maintains a respectable position in adoption, rounding up the top five, with its collaborative features making it a convenient choice for QS professionals working on estimating projects, contributing to its usage in the BOQ preparation process. Pro-Est ranks lowest in adoption among the listed ICT tools, indicating limited usage in the BOQ preparation process. Its low adoption may be attributed to factors such as its perceived lack of comprehensive features or unfamiliarity among respondents. Despite its ranking, Pro-Est may still hold potential value for certain specific tasks within quantity surveying, but its overall adoption remains low compared to other tools listed in the study. Pro-curify ranks among the least used tools in the BOQ preparation process, suggesting limited adoption among respondents. Its low ranking may be indicative of factors such as perceived inefficiencies or a lack of familiarity among Quantity Surveyors. Deltek Risk is among the least utilized tools according to the adoption ranking, indicating minimal usage in the BOQ preparation process. This suggests that respondents may not prioritize its functionalities or find them essential for their quantity surveying tasks. CostOS ranks low in adoption, signifying its limited usage among respondents for BOQ preparation. This suggests that respondents may prefer other tools over CostOS due to factors such as usability, features, or integration capabilities. Bluebeam is listed among the least used tools in the BOQ preparation process, implying that it is not widely adopted among Quantity Surveyors. The reasons for its low adoption could include factors such as limited awareness, perceived limitations in functionality, or preference for other software solutions. WinQS is ranked low in adoption among the listed ICT tools, indicating its limited usage in the

BOQ preparation process. This suggests that respondents may not consider WinQS as essential or effective compared to other tools available for quantity surveying tasks.

4.4 Factors that influenced the adopt ICT tools in the Bill of Quantities preparation process

Respondents were asked to give their opinion on nine factors that influence the adopt ICT tools in the Bill of Quantities preparation process selection on a scale between 1 and 5 and the results are shown in Table 4.4 below.

Table 4.4 Factors influenced the adopt ICT tools in the Bill of Quantities (BoQ) preparation process

Variables	MIS	RANK
Technical support and training availability	3.64	1
Flexibility to customize or adapt to specific project needs	3.21	2
Innovation and futureproofing features	2.92	3
Reputation and reviews of the software or vendor	2.91	4
Userfriendliness and ease of learning	2.87	5
Compatibility with other software or platforms	2.83	6
Integration with existing systems or workflows	2.56	7
Regulatory compliance	2.41	8
Scalability for future growth	2.27	9
Pressure from clients or stakeholders	2.12	10
Industry standards and requirements	1.97	11
Enhanced accuracy	1.83	12
Alignment with sustainability or green building initiatives	1.68	13
Cost-effectiveness	1.54	14

This factor holds the highest influence on adoption of ICT tools according to the respondents. Adequate technical support and training opportunities can significantly enhance awareness by providing professionals with the necessary knowledge and skills to understand and adopt these technologies effectively. Respondents also emphasized the importance of flexibility in smart building technologies. Solutions that can be tailored to suit specific project requirements are highly valued, indicating that customization plays a significant role in raising awareness and adoption. The emphasis on innovation and futureproofing suggests that professionals are attentive to the longevity and adaptability of smart building technologies. Features that demonstrate forward-thinking design and capabilities contribute to increased awareness and interest among stakeholders.

Trust in the reputation and reviews of software or vendors is another influential factor. Positive feedback and a reputable track record can instill confidence in professionals, encouraging them to explore and engage with smart building technologies.

Compatibility with existing systems and platforms is crucial for seamless integration. Professionals prioritize solutions that can work harmoniously with their current technological ecosystem, indicating a preference for interoperability and ease of adoption.

4.5 Challenges faced when integrating ICT tools into the Bill of Quantities preparation

Respondents were asked to give their opinion on Challenges faced when integrating ICT tools into the Bill of Quantities preparation selection on a scale between 1 and 5 and the results are shown in Table 4.5 below.

Table 4.5: Challenges faced when integrating ICT tools into the Bill of Quantities preparation

Variables	MIS	Rank
Resistance from team members	2.86	1
Lack of training or expertise	2.57	2
Resistance from management	2.43	3
Compatibility issues with existing systems	2.29	4
Security concerns	2.29	4
Data accuracy and consistency	2.14	5
Limited customization options	1.97	6
Integration complexity	1.84	7
High implementation costs	1.71	8
Technical difficulties	1.58	9
Disruption of existing workflows	1.45	10
Difficulty in finding suitable ICT tools	1.32	11

The top-ranked factor affecting the adoption of smart building technologies is resistance from team members. This resistance could stem from various sources, including reluctance to change established processes, skepticism about the benefits of new technologies, or concerns about job security. Overcoming this resistance may require effective change management strategies and clear communication about the advantages of adopting smart technologies. The second-ranked factor is the lack of training or expertise among team members. This highlights the importance of providing adequate training and professional development opportunities to ensure that employees have the skills and knowledge necessary to utilize smart building technologies effectively. Investing in training programs can help address this barrier and increase adoption rates.

Resistance from management ranks third in influencing the adoption of smart building technologies. Management buy-in and support are essential for successful technology adoption initiatives. Convincing management of the benefits of these technologies and addressing any concerns they may have is crucial for overcoming this barrier.

Compatibility issues with existing systems tie for the fourth rank with security concerns. Integrating new technologies with existing systems can be challenging, especially if compatibility issues arise. Addressing these compatibility issues through careful planning, testing, and potentially investing in interoperable solutions can help mitigate this barrier. Security concerns also rank fourth and are likely related to apprehensions about data privacy, cybersecurity threats, and potential vulnerabilities associated with smart building technologies. Implementing robust security measures, complying with industry standards and regulations, and providing training on cybersecurity best practices can help alleviate these concerns and promote adoption.

These findings underscore the importance of addressing organizational and technical barriers to the adoption of smart building technologies. By addressing resistance, providing adequate training, gaining management support, and ensuring compatibility and security, organizations can increase the likelihood of successful adoption and realize the benefits of these innovative technologies.

4.6 Discussion of Finding

The analysis of data collected from construction professionals provides valuable insights into various aspects of specific ICT in the preparation of BOQ including adoption levels, influencing factors, and the challenges faced in adoption of these tools.

4.6.1 Level of Adoption of Specific ICT Tools

The findings reveal varying levels of adoption of ICT tools in the Bill of Quantities (BoQ) preparation process such as PlanSwift emerges as the most utilized tool, indicating extensive employment due to its comprehensive features for digital takeoff and estimating. While AutoCAD secures the second position, widely used in drafting and design, facilitating detailed drawings and plans. Excel maintains a solid position, owing to its versatility and familiarity, serving as a staple tool for data organization and analysis. BIM holds a significant level of utilization, thanks to its advanced modeling and visualization capabilities. Google Sheets ranks fifth, with its collaborative features making it a convenient choice for QS professionals. However, certain tools like ProEst and Procurify showed lower adoption rates, possibly due to perceived limitations or lack of familiarity among respondents.

4.6.2 Factors Influencing Adoption of ICT Tools

Several factors influence the adoption of ICT tools in the BoQ preparation process such as Technical Support and adequate technical support and training opportunities significantly enhance awareness and adoption. Tailoring solutions to specific project requirements is highly valued, emphasizing the importance of customization. Professionals prioritize technologies with forward-thinking features, indicating their attention to longevity and adaptability. Trust in software/vendor reputation and positive reviews influences adoption decisions. Seamless integration with current systems is crucial for adoption, highlighting the preference for interoperability.

4.6.3 Challenges When Integrating ICT Tools

Resistance to change from team members is the top challenge, necessitating effective change management strategies. Insufficient training and expertise hinder smooth integration,

emphasizing the importance of skill development. Integrating new technologies with existing systems poses challenges, requiring careful planning and testing. Apprehensions about data privacy and cybersecurity threats hinder adoption, necessitating robust security measures.

These findings underscore the importance of addressing organizational and technical barriers to the adoption of smart building technologies. By addressing resistance, providing adequate training, gaining management support, and ensuring compatibility and security, organizations can increase the likelihood of successful adoption and realize the benefits of these innovative technologies.

CHAPTER FIVE

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Preamble

This study presents a comprehensive summary of the findings, conclusions drawn from the analysis, and recommendations based on the research conducted on the adoption of ICT tools in the Bill of Quantities (BoQ) preparation process in the construction industry.

5.2 Summary of Findings

The research findings indicate a spectrum of adoption rates among different ICT tools. PlanSwift emerges as the most widely utilized tool, indicating its extensive employment in the BoQ preparation process due to its comprehensive features for digital takeoff and estimating. AutoCAD secures the second position in adoption, being favored for drafting, design, and quantification tasks. Microsoft Excel maintains a solid position, serving as a staple tool for data organization and analysis. Building Information Modeling (BIM) holds a significant level of utilization, attributed to its advanced modeling and visualization capabilities. Google Sheets, with its collaborative features, also maintains a respectable position in adoption, especially among QS professionals working on estimating projects. However, certain tools such as ProEst and Procurify showed lower adoption rates, possibly due to perceived limitations or lack of familiarity among respondents.

Several factors have been identified as influential in the adoption of ICT tools in the BoQ preparation process. Adequate technical support and training opportunities were highlighted as key factors that significantly enhance awareness and adoption. Professionals emphasized the importance of flexibility and customization in smart building technologies, indicating a preference for solutions that can be tailored to suit specific project requirements. The emphasis on innovation and futureproofing suggests that professionals are attentive to the longevity and adaptability of ICT tools. Trust in the reputation and reviews of software or vendors was identified as another influential factor, instilling confidence in professionals and encouraging exploration and engagement with ICT tools. Compatibility with existing systems and platforms emerged as crucial for seamless integration, indicating a preference for interoperability and ease of adoption.

The research identified several challenges faced when integrating ICT tools into the BoQ preparation process. Resistance from team members was identified as the top challenge, stemming from reluctance to change established processes or concerns about job security. Lack of training or expertise among team members hindered smooth integration, emphasizing the importance of skill development initiatives. Compatibility issues with existing systems and security concerns were also significant barriers to adoption, requiring careful planning, testing, and implementation of robust security measures.

5.3 Conclusions

The comprehensive analysis of the data collected from construction professionals provides valuable insights into the adoption of Information and Communication Technology (ICT) tools in the Bill of Quantities (BoQ) preparation process. Based on the findings, several conclusions can be drawn:

5.3.1 Diverse Adoption Patterns

The research reveals diverse adoption patterns among ICT tools used in the BoQ preparation process. While some tools, such as PlanSwift and AutoCAD, are extensively employed due to their comprehensive features and familiarity among Quantity Surveyors, others, like ProEst and Procurify, show lower adoption rates possibly due to perceived limitations or lack of awareness.

5.3.2 Influential Factors:

Various factors influence the adoption of ICT tools in the BoQ preparation process. Adequate technical support, training opportunities, flexibility, and customization options emerged as key factors that enhance awareness and adoption. Additionally, trust in software/vendor reputation, compatibility with existing systems, and user-friendliness play crucial roles in facilitating adoption.

5.3.3 Challenges in Integration:

The research identifies several challenges faced when integrating ICT tools into the BoQ preparation process. Resistance from team members, lack of training or expertise, compatibility issues with existing systems, and security concerns are significant barriers that need to be addressed. Overcoming these challenges requires effective change management strategies, investment in training programs, careful planning, and implementation of robust security measures.

5.4 Recommendations

Based on the conclusions drawn from the research findings, the following recommendations are proposed to enhance the adoption of ICT tools in the Bill of Quantities preparation process

5.4.1 Investment in Training Programs:

Construction firms should invest in training programs to enhance the technical skills and expertise of their employees in utilizing ICT tools effectively. Providing comprehensive training can help mitigate resistance and facilitate smooth integration.

5.4.2 Enhanced Technical Support

Software vendors should prioritize providing adequate technical support and training opportunities to users. Offering ongoing assistance and guidance can enhance user experience and increase adoption rates.

5.4.3 Customization and Flexibility

Developers of ICT tools should focus on enhancing customization options and flexibility to meet the diverse needs of construction professionals. Tailoring solutions to suit specific project requirements can enhance adoption and user satisfaction.

5.4.4 Awareness Campaigns:

Construction industry associations and professional bodies should conduct awareness campaigns to educate stakeholders about the benefits of adopting ICT tools in the BoQ preparation process. Increasing awareness can help overcome resistance and promote the adoption of innovative technologies.

5.4.5 Collaboration and Interoperability

Software developers should prioritize interoperability and seamless integration with existing systems and platforms. Collaborative efforts between different software providers can facilitate interoperability and enhance user experience.

By implementing these recommendations, construction firms, software vendors, and industry stakeholders can overcome barriers to adoption and realize the full potential of ICT tools in streamlining the Bill of Quantities preparation process, leading to improved efficiency, accuracy, and productivity in the construction industry.

5.5 Recommendations

Organizations should invest in comprehensive training programs to enhance employees' skills and knowledge in utilizing ICT tools effectively. Stakeholders in the construction industry should prioritize compatibility and interoperability when selecting ICT solutions to ensure seamless integration with existing systems. Management should actively support and encourage the adoption of ICT tools by fostering a culture of innovation and providing resources for implementation. Continuous monitoring and evaluation of ICT adoption initiatives are necessary to identify and address emerging challenges and opportunities.

5.5 Areas for Future Research

While this study provides valuable insights into the adoption of ICT tools in the Bill of Quantities (BoQ) preparation process, there are several avenues for future research that can further advance knowledge in this area.

5.5.1. Longitudinal Studies

Conducting longitudinal studies to track the adoption and usage patterns of ICT tools in the BoQ preparation process over an extended period. Longitudinal research can provide deeper insights into the factors influencing adoption trends and how they evolve over time.

5.5.2. Qualitative Research

Supplementing quantitative data with qualitative research methods, such as interviews or focus groups, to explore the underlying reasons behind adoption decisions, challenges faced, and strategies for overcoming barriers. Qualitative research can provide rich, nuanced insights into the complexities of ICT adoption in the construction industry.

5.5.3. Comparative Studies

Conducting comparative studies to compare the adoption of ICT tools in the BoQ preparation process across different regions, construction sectors, or organizational types. Comparative research can help identify contextual factors that influence adoption patterns and strategies that are effective in different contexts.

5.5.4. Impact Assessment

Evaluating the impact of ICT adoption on key performance indicators such as project cost, time, quality, and sustainability. Assessing the tangible benefits and outcomes associated with ICT

adoption can provide empirical evidence of its value proposition and inform decision-making processes.

5.5.5. Technological Trends

Investigating emerging technological trends and innovations in the field of construction and their implications for the BoQ preparation process. Researching cutting-edge technologies such as artificial intelligence, machine learning, and augmented reality can help anticipate future trends and opportunities for innovation.

5.5.6 User Experience

Examining the user experience of construction professionals with different ICT tools used in the BoQ preparation process. Researching usability, user interface design, and user satisfaction can help identify areas for improvement and inform the development of user-centric ICT solutions.

5.5.7 Change Management Strategies

Exploring effective change management strategies for promoting the adoption of ICT tools in the construction industry. Researching organizational change processes, leadership strategies, and employee engagement initiatives can help organizations navigate the challenges associated with technology adoption.

5.5.8 Sustainability Integration

Investigating the integration of sustainability principles and green building initiatives into ICT tools used in the BoQ preparation process. Researching how ICT tools can facilitate sustainable construction practices, resource efficiency, and carbon footprint reduction can contribute to advancing sustainability goals in the construction industry.

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APPENDIX

SURVEY QUESTIONNAIRE

THE DEPARTMENT OF QUANTITY SURVEYING,

FACULTY OF ENVIRONMENTAL SCIENCES,

UNIVERSITY OF BENIN, BENIN CITY, EDO STATE, NIGERIA.



**IMPACT OF INFORMATION AND COMMUNICATION TECHNOLOGIES ON THE
PREPARATION OF BILL OF QUANTITIES IN BENIN CITY**

Dear Respondent,

I am writing to invite you to participate in a research study that aims to investigate The Impact of ICT tools on the Preparation of BoQ . This study is part of a research project towards the award of a BSc in Quantity Surveying at University of Benin. Your participation is entirely voluntary, and you have the right to withdraw from the study at any time. The data collected will be kept confidential and anonymous and will only be used for academic purposes.

If you have any questions or concerns about the study, please do not hesitate to contact the Name of Researcher: Kelly Ighofimoni

Phone Number: 08084050733

Email Address: ighokelly170@gmail.com

QUESTIONNAIRE

CONSTRUCTION PROFESSIONALS

SECTION 1: DEMOGRAPHIC DATA OF RESPONDENT

Please tick the box with the appropriate response. Tick one box only for each question.

1. Years of Experience in Construction Industry:

Less than 1 year 1-5 years 6-10 years 11-15 years More than 15 years

2. Academic Qualification

ND HND B.Sc/B.Tech /PGD M.Sc/M.Tech PhD

Which of the following ICT tools do you currently utilize in your Bill of Quantities (BoQ) preparation process?

1 (Rarely) 2 (Occasionally) 3 (Moderately) 4 (Frequently) 5 (Always)

S/N	ICT Tools	1	2	3	4	5
1	Microsoft Excel					
2	Google Sheets					
3	Building Information Modeling (BIM)					
4	CostX					
5	WinQS					
6	Procore					
7	Autodesk BIM 360					
8	Revit					
9	AutoCAD					
10	Buildertrend					
11	PlanSwift					
12	Bluebeam					
13	CostOS					
14	QuickBooks					
15	Microsoft Teams)					
16	ProEst					
17	CostManager					
18	Deltek Risk)					
19	Procurify					
20	Microsoft Access					
21	Microsoft Project					

2 What factors influenced your decision to adopt ICT tools in the Bill of Quantities (BoQ) preparation process using the following 5point Likert Scale on the following:

1: Strongly agree 2: Agree 3: Neutral 4: Disagree 5: Strongly disagree

No.	Factors	1	2	3	4	5
	Costeffectiveness					
	Time savings					
	Enhanced accuracy					
	Availability of suitable software					
	Industry standards and requirements					
	Pressure from clients or stakeholders					
	Integration with existing systems or workflows					
	Scalability for future growth					
	Userfriendliness and ease of learning					

	Technical support and training availability					
	Flexibility to customize or adapt to specific project needs					
	Compatibility with other software or platforms					
	Regulatory compliance					
	Reputation and reviews of the software or vendor					
	Innovation and futureproofing features					
	Alignment with sustainability or green building initiatives					

3. Challenges face by Quantity surveyors when integrating ICT tools into the BoQ preparation process?

What challenges do you face when integrating ICT tools into the BoQ preparation process using the following 5point Likert Scale on the following:

1: Strongly agree 2: Agree 3: Neutral 4: Disagree 5: Strongly disagree

No.	Challenges	1	2	3	4	5
	Technical difficulties					
	Resistance from team members					
	Lack of training or expertise					
	Compatibility issues with existing systems					
	Security concerns					
	Integration complexity					
	Data accuracy and consistency					
	Limited customization options					
	High implementation costs					
	Resistance from management					
	Disruption of existing workflows					
	Difficulty in finding suitable ICT tools					