

# Adoption of Technological Cost Data Management in the Tanzania Building Construction Industry

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**Abstract**—Proper management of cost data ensures the availability of reliable cost data which increases accuracy in providing estimates in the building construction industry. This study explores how cost data is being managed in the Tanzania building construction industry. It will investigate the current perception of cost data management as well as the adoption of technological cost data management. It aims at realising the benefits, barriers, and ways to implement technological cost data management. The research involved the use of a questionnaire survey to collect data from quantity surveyors in the Tanzania building construction industry. The study revealed that majority of the quantity surveyors in the industry were not happy with how cost data is being managed and called for improvements to be done. Technological cost data management was considered as a positive way forward. Easy access to cost data, provision of reliable cost data and fast access to cost data were revealed as the key benefits of technological cost data management while poor technology, lack of finance and lack of awareness on benefits were the key barriers.

**Index Terms**—cost data management, building construction industry, technology, quantity surveyors, Tanzania

## I. INTRODUCTION

Cost data accuracy is very crucial in the building construction industry as it ensures the level of confidence in decision making. The building construction industry faces criticism globally for high costs and unpredictability due to inconsistent cost data and is challenged to innovate and reduce costs [1]. To have access to reliable cost data there is a need to properly manage the cost data so that they can be easily accessible.

Proper management of cost data ensures the availability of reliable cost data which increases accuracy in providing estimates in the building construction industry [2]. The Tanzania building construction industry lacks reliable cost data [3], which is essential for the provision of accurate estimates. The use of technology in cost data management is highly encouraged as the cost of collection, storage and manipulation reduce dramatically and data exchange is made easy [1]. Ref. [4] depicted that data access in the construction industry is getting worse and participants are slow in adapting to technological ways.

This study is aimed at exploring how cost data is being managed in the Tanzania building construction industry. Reliable cost data are essential in improving the Tanzania building construction industry's long-term financial outlook by accelerating whole life costing undertaking and thus ensuring value for money is attained in an asset's life.

The study will investigate the current perception of cost data management as well as the adoption of technological cost data management. It will further look at the benefits as well as the barriers to technological cost data management. The study will suggest ways to implement technological cost data management in the Tanzania building construction industry. This study is timely as the Tanzania government is investing greatly in increasing data connectivity to embrace the use of technology in all sectors in the country.

This study will focus on quantity surveyors' perspectives as they are considered cost experts entrusted with keeping building construction projects within budget and ensuring value for money is attained. Ref. [5] considers quantity surveyors as experts of information on all stages of building cost, thus, they are more engaged in cost data management and are more equipped with the knowledge and techniques to manage them.

## II. COST DATA MANAGEMENT

Cost data management can be defined as the process of systematically collecting, processing, and storing cost data for future use. Failure to manage cost data properly often leads to lack of reliable cost data, which influences accuracy [2] while providing estimates in the building construction industry. The use of accurate cost data generated from reliable sources ensures that objective, rather than subjective decisions are made in the industry [6].

The use of technology in cost data management is highly encouraged in the construction industry. In Hong Kong quantity surveying firms, technology has been highly used [7]. The use of technological cost data management system is seen as the best way to improve efficiency in the building construction industry [8], however, most developing countries including Tanzania are yet to adopt

it. Therefore, failing to fully grasp what technological cost data management has to offer, thus refurbishing the building construction industry with easy and fast access to reliable cost data.

Ref. [1] encourages the use of technology in cost data management as the cost of collection, storage and manipulation reduce dramatically and data exchange is made easy. In Tanzania, the Architect and Quantity Surveyors Registration Board (AQRB) has been responsible for providing the industry with a breakdown of building rates in cost per square meter for different building categories; industrial, agricultural, commercial, educational, residential, recreational, and medical/social services. This is useful for preliminary cost estimates when there is not enough information to produce a more detailed estimate. Ref. [9] portrays that the unavailability of cost data is one of the key obstacles to the utilization of non-traditional cost estimate models. Reliable cost data is needed to ensure accuracy and success in building construction cost estimates [10]. Ref. [11] attests that much emphasis should be on having a single source of cost data, to facilitate benchmarking.

#### *A. Importance of Cost Data*

Historical data is used in preparing cost estimates in the building construction industry. Accurate cost estimates are considered a key factor for a successful project [10], therefore there needs to be reliable cost data to refurbish cost estimates. The cost data to be used in cost estimates needs to be properly managed, making it accurate, up to date and reliable to yield correct results.

Building construction stakeholders, specifically quantity surveyors use cost data for the following reasons: approximate estimates for proposed schemes, cost planning during design, contract estimating for tendering purposes, agreement of variations in final accounts, calculation and settlement of contractors' claims, loss adjustment valuations, maintenance management [15]. Cost data is essential to quantity surveyors for future project cost forecasts, different projects cost comparisons, contractor's unit rate negotiations, monitoring and controlling of construction cost and design cost planning [11].

To attain value for money in building construction it is essential to look at whole life costs of building rather than focusing on capital cost only. However, for whole life costing to be applied there is a tremendous need for reliable and accurate cost data. Whole life costs consist of the following cost elements: non-construction costs, income, externalities and life cycle costs (construction, operation, maintenance and end of life) [3]. To implement whole life costing all the needed costs needs to be readily available.

#### *B. Importance of Technological Cost Data Management*

Cost data are essential for future project cost forecasts, different projects cost comparisons, contractor's unit rates negotiations, monitoring and controlling of construction costs and design cost planning [11]. To attain value for money in building construction, it is essential to look at the

whole life costs of building rather than focusing on capital costs only. Management of cost data in a technological way has multiple advantages in the building construction industry.

**Easy access to cost data:** this entails having to gain access to cost data without much hustle by building construction professionals. The use of technology will facilitate cost data to be accessed through mobile devices, therefore, making it more convenient for practitioners to access them. Improving cost estimating in the building construction industry requires the storage of all cost data in one database to ensure easy accessibility and maintainability [16].

**Reliable cost data:** One of the key aspects of managing cost data technologically is its ability to provide cost data with no ambiguity thus the cost data will be from reliable sources and will have been screened before being released to the public. This can be well seen in the case of BCIS in the U.K. To attain value in building construction projects there is a need for current, accurate and reliable cost data as this will ensure to know exactly where the costs lie when adding value [17].

**Fast access to cost data:** The use of technology to manage cost data will ensure that there is no wastage in time used in searching for cost data, rather building construction professionals will have quick access to the cost data they need.

**Benchmarking:** This is the process of measuring something and using that as a standard by which others are judged [18]. Technological cost data management will ensure that industry practitioners have a platform to compare and reference their cost data. It will help overcome the tendency of overestimation and underestimation in building construction costs, however, there is a need for the collection of ample cost data to achieve it [19].

**Uniformity:** cost data management through technology will ensure there is adequate consistency in cost data among building construction professionals. There is a need for connectivity between construction professionals to achieve data-driven design and construction and forward-thinking companies aim to build into their goals through technology [20]. This will allow accuracy and little difference in estimates as all the industry practitioners will have similar cost data.

#### *C. Barriers to Technological Cost Data Management*

Proper management of cost data ensures that there is reliable cost data for present and future use in the building construction industry. Despite the benefits that cost data management entails, it still faces barriers that impede it. Online services are considered the most reliable source of cost data by providing cost data fast and easily [5]. They enable access to cost data from remote places through mobile devices which saves time and money. However, online services are impeded by barriers that make their adoption hard.

**Finance:** To have an online service like BCIS, a substantial financial investment needs to be committed. Online services are the most expensive to run compared to other sources of cost data. The high cost associated with

IT applications is one of the barriers that impede the adoption of technology in the construction industry [21]. This will include costs for the servers to store the cost data to the persons responsible for analysing the data, therefore a large financial investment is needed to make it all possible.

**Poor technology:** One of the key aspects of technological cost data management is the availability of reliable technology. Information technology investment in the construction industry has been neglected [22], leaving practitioners to rely on local ways to manage cost data. Thus, poor technology in terms of connectivity in building construction, especially in developing countries is one of the major hindrances in adopting technological cost data management. In Tanzania 6% of the country's population lacks connectivity to any mobile network while 30% of land area has no coverage at all [23], thus government intervention to try and expedite the availability of data connectivity.

**Lack of awareness on importance:** To be able to embrace the use of technology in cost data management there is a need to understand its importance [24] in the construction industry. Although the benefits of computing and communication technology are apparent to many in developed countries who have incorporated them into their lives, they are not so apparent to people in developing countries [25]. Therefore, practitioners in the building construction industry particularly in developing countries need to understand the significance of adopting technology in cost data management for them to embrace it and be willing to share cost data.

**Willingness to share cost data:** One of the key aspects that pose a threat to technological cost data management is the reluctance of building construction professionals to share cost data. It is no secret that the building construction industry is known for its reluctance to change [26]. The reasons for reluctance to change are, that everyone in the industry seems to want to stick to the same habits or culture they are used to. The construction industry is stagnant when it comes to technology compared to other industries [24]. And another reason is the lack of willingness of building construction professionals to step up and initiate change. One of the ways to overcome resistance to change is the embarrassment of new technologies. Thus, all building construction professionals need to embrace what technology offers. This can be done by running different workshops showing how technology can help ease their day-to-day activities.

### III. METHODOLOGY

In-depth knowledge was gained from the literature review, by going through different sources such as conference proceedings, books, journal articles and electronic sources. A knowledge gap and existing knowledge were revealed through this. This study is descriptive and follows a quantitative research strategy [27]. It's descriptive as it describes the cost data management in the Tanzania building construction

industry [28]. The questionnaire survey was adopted, where quantity surveyors were considered, as they are key personnel engaged in cost data in the building construction industry in Tanzania. The questionnaire survey embraced the use of both web and mobile internet self-completed questionnaires [29], thus web links to the questions were sent to the respondents. Questions were derived from the literature review to address the research objectives, while the scales used were adapted from previous research [5]. The use of an internet questionnaire was adopted to facilitate reaching many respondents in numerous geographical zones in Tanzania. Stratified probability sampling was employed to categorize them into two strata: class one contractors and consulting firms. This technique is considered free from bias as it ensures a sample that correctly reflects the population being studied [29]. Purposive random sampling was later used to select respondents from each category or strata; thus, a researcher is sure to get information from a sample of the population that one thinks knows most about the subject matter [30].

According to the Tanzania building construction industry, there are 140 class I contractors registered with the Contractors Registration Board [31] and there are 134 quantity surveying consulting firms registered with the Architect and Quantity surveyors Registration Board [32].

Equation 1 was used to determine the sample size for the study [29]. The study considered a level of confidence of 80% ( $z = 1.28$ ), a margin of error ( $e$ ) of 10%, a percentage belonging ( $p$ ) of 50% and a percentage of not belonging ( $q$ ) of 50%, which brought a minimum sample size ( $n$ ) of 40.96. Equation 2 was then used to attain an adjusted minimum sample size for each group from the minimum sample size as seen in Table I. A total of forty-two (42) questionnaires were returned out of sixty-three (63) which were distributed, equivalent to 66.67%. In contractors, 22 responded out of 32 which is equivalent to 68.75%, and in consultants, 20 responded out of 31 which is equivalent to 64.52% (Table I). Ref. [33] depicts that a response rate of 30-40% is good and that over 50% is considered excellent.

$$n = p \times q \times \left[ \frac{z}{e} \right]^2 \quad . (1)$$

Where:

$n$  is the minimum sample size required.

$p$  is the percentage belonging to the specified category.

$q$  is the percentage not belonging to the specified category.

$z$  is the  $z$  value corresponding to the level of confidence required.

$e$  is the margin of error required.

$$n' = \frac{n}{1 + \left( \frac{n}{N} \right)} \quad (2)$$

Where:

$n'$  is the adjusted minimum sample size.

$n$  is the minimum sample size.

$N$  is the total population.

TABLE I. POPULATION, SAMPLE SIZE AND RESPONSE RATE

Quantity Surveyors	Population	Sample size (n') / Distributed	Responded	Response percentage (%)
Class I Contractor	140	32	22	68.75%
Consulting Firms	134	31	20	64.52%
Total	274	63	42	66.67%

Data analysis entails closely related operations, undertaken to summarize the collected data and organize them to address the research objective [28]. Data collected through questionnaires were analysed using Statistical Package for Social Sciences (SPSS) and Relative Importance Index (RII), in which charts and tables were used to present the interpreted data. The Relative Importance Index (RII) is calculated as follows [3].

$$RII = \frac{1}{5} \times \frac{\sum_1^5 FiRi}{\sum_1^5 Fi} \times 100 \quad (3)$$

Where:

RII - is the average weighted perceived significance.

Ri - is the response type on the Likert scale, "i" ranging from 1 to 5 on the Likert scale.

Fi - is the frequency or the total number of respondents choosing response type "i" on the Likert scale, with "i" ranging from 1 to 5 as earlier described.

#### IV. ANALYSIS AND DISCUSSION

##### A. Current Cost Data Management

To understand the perception of the respondents on how cost data is being managed, they were asked to rank the statement that they are happy with how cost data is being managed, as highly agree, agree, neutral, disagree and highly disagree. This was aimed at gathering perceptions from the quantity surveyors on how they felt about the current cost data management. The results as seen in figure 1 revealed that 2.4% highly disagreed, 42.9% disagreed, 47.6% were neutral and 7.1% agreed.

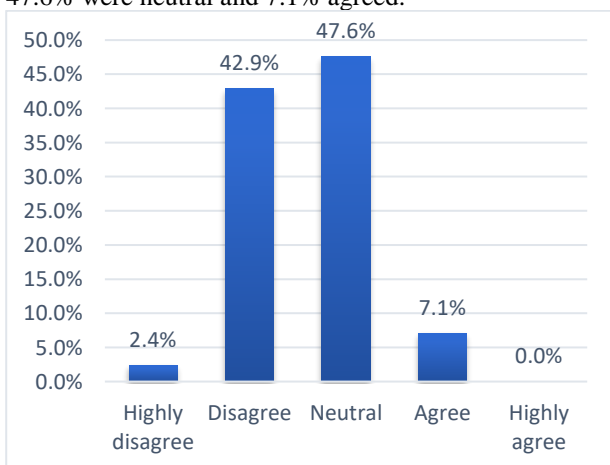


Figure 1. Happy with current cost data management

Although majority of the respondents were neutral, the results show a high percentage of respondents disagreed

with being happy with the current management of cost data. It can be perceived that those that were neutral were unsure of what they felt about the current cost data management. These results detect that there is a need for change in how cost data is currently being managed.

##### B. Improved Way of Cost Data Management

To understand the perception of the respondents on the improvement of how cost data is being managed, they were asked to rank the statement 'There should be an improved way of cost data management' by showing their level of agreement. This was done to realize if the respondents thought it was imperative to have an improved way of cost data management. The results as seen in figure 2 revealed that 4.8% were neutral, 23.8% agreed and 71.4% highly agreed.

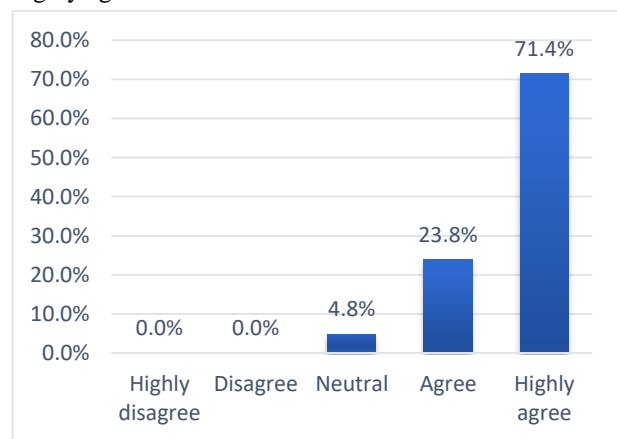


Figure 2. Improved way of cost data management

The results portray that the respondents agree that there is a need to have an improved cost data management system and are not in favour of how cost data is currently being managed.

##### C. Technological Cost Data Management

Apart from having an improved cost data management system, the respondents were also asked to rank on having a technological cost data management system. This was aimed at realizing that the respondents agreed that the improved cost data management system should be technologically focused. The results as seen in figure 3 revealed that 2.4% highly disagreed, 2.4% were neutral, 38.1% agreed and 57.1% highly agreed.

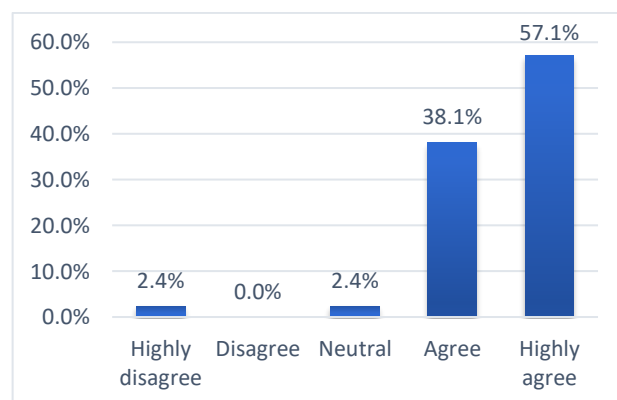


Figure 3. Technological cost data management

The results, clearly show that most of the respondents agree that there should be technological management of cost data.

**D. Importance of Technological Cost Data Management**

In investigating to realize the understanding of respondents on the benefits of having a technological cost data management approach, they were asked to rank several benefits as extracted from literature. A 5-point ‘Likert’ scale questionnaire was used to rank the benefits with 1 representing the least significant and 5 representing the most significant [3]. As seen in Table II, the most significant benefit of implementing a technological cost data management is ‘Easy access to cost data’ with 91.90% followed by ‘Provision of reliable cost data’ and ‘Fast access to cost data’ both with 90.95% then ‘Benchmarking’ with 87.14%, and lastly ‘Uniformity’ was ranked as the least significant benefit with 80%.

TABLE II. BENEFITS OF FORMULATING A TECHNOLOGICAL COST DATA MANAGEMENT SYSTEM

Benefits	1	2	3	4	5	Response count	RII	Ranking
Easy access to cost data	0	1	1	12	28	42	91.90	1
Provision of reliable cost data	1	1	3	6	31	42	90.95	2
Fast access to cost data	0	0	2	15	25	42	90.95	2
Benchmarking	0	0	2	23	17	42	87.14	4
Uniformity	0	0	10	22	10	42	80.00	5

**E. Barriers to Technological Cost Data Management**

On investigating the limitations of technological cost data management in the Tanzania building construction industry, respondents were asked to rank several limiting factors. A 5-point ‘Likert’ scale questionnaire was used to rank the limitations with 1 representing the least significant and 5 representing the most significant. The results as seen in Table III revealed that the most significant barrier was the ‘Poor technology’ with 87.62% followed by ‘Lack of finance’ with 83.33% then ‘Lack of awareness on importance’ with 82.86% then ‘Willingness to share cost data’ with 79.05% and lastly ‘Lack of initiative from organization bodies’ with 71.90%.

TABLE III. BARRIERS TO FORMULATING A TECHNOLOGICAL COST DATA MANAGEMENT SYSTEM

Barriers	1	2	3	4	5	Response count	RII	Ranking
Poor technology	1	0	7	8	26	42	87.62	1
Lack of finance	0	1	9	14	18	42	83.33	2
Lack of awareness on importance	0	1	8	17	16	42	82.86	3
Willingness to share cost data	1	4	7	14	16	42	79.05	4
Lack of initiative from organisation bodies	0	3	18	14	7	42	71.90	5

Ref. [21] concurs with the findings that poor technology, lack of finance and lack of awareness on importance as the key barriers to technological cost data management and recommends conducting forums in the building construction industry to raise awareness of information technology and look for ways to adopt technology to change traditional industry cultures.

**V. CONCLUSION**

This study investigated how cost data is being managed in the Tanzania building construction industry. The study was conducted through a questionnaire survey as means of data collection from quantity surveyors in the industry. It aimed at investigating the current perception of cost data management and looking at the benefits as well as the barriers to technological cost data management.

It was revealed from the study that majority of the quantity surveyors were not happy with how cost data is being managed in the Tanzania building construction industry in which they called for improvements to be done. The results did reveal that they were in favour of adopting technological cost data management as a way forward to improve how cost data is being managed.

The survey results showed that easy access to cost data is the most significant benefit of having a technological cost data management approach followed by the provision of reliable cost data and fast access to cost data. On the barriers to technological cost data management in the Tanzania building construction industry, the study revealed that poor technology was the most significant barrier followed by lack of finance and then lack of awareness on importance.

The findings from this study depict that the building construction industry in Tanzania needs to adapt to a technological cost data management approach which will ensure there is provision of reliable, easy, and fast access to cost data. The approach will also help ensure there is uniformity among professionals in terms of their sources, as well as ensure that benchmarking is made possible.

Further research is recommended, which will focus on preparing a cost data management framework for the building construction industry in Tanzania. The cost data management framework should look at addressing the lessons learnt from this study particularly on overcoming the barriers and improving from current cost data management by adapting to technological cost data management. A suggestion of a centralised cost data management system modelled on, for example, BCIS is recommended but focusing on the Tanzania building construction industry.

**CONFLICT OF INTEREST**

The authors declare no conflict of interest.

**AUTHOR CONTRIBUTIONS**

Sylvester L. Manege conducted the research, analysed the data and drafted the manuscript. Craig J. Kennedy supervised the research. All the authors discussed the

results, commented on the manuscript and agreed on the final version.

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