Original Research

Proposed Strategy for Improving the Effectiveness of Total Quality Management Implementation at Construction Company in Indonesia: A Conceptual Model

Fauzi Mahdy*[1], Andri D. Setiawan[2]

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***Corresponding Author Email, a.d.setiawan@ui.ac.id**

1,2- Industrial Engineering Department, Faculty of Engineering, Universitas Indonesia, Jakarta,Indonesia.

Abstract
In Indonesia, the construction industry is one of the most important sectors for economic growth and can set high standards for the country's economic growth. Ensuring the quality of construction projects is crucial for their success, and this may be done using methods like Total Quality Management (TQM). This research takes a case of TQM implementation in "PT X" (pseudonym), one of the construction businesses in Indonesia founded in 1991. Although the company's Quality Management Systems (QMS) are already certified to ISO 9001:2015, it does not imply that their TQM has appropriately been used throughout the organization. Therefore, a strategy is needed to make an appropriate and effective implementation of the TQM. This research aims to use system dynamics modeling to develop the TQM implementation plan for the construction company effectively. The conceptual model is presented in the causal loop diagram (CLD) and system diagram. Multi-actor analysis is used to identify the boundaries, issues, and initial information. Customer/client satisfaction/focus, continuous improvement, re-work, communication, and project profit are the output indicators for this system. Twenty-two causal loop diagrams, comprising five balancing loops and 17 reinforcing loops, were therefore created to illustrate the essential elements required to enhance the TQM implementation process and make it more successful.

Keywords - Total Quality Management; Construction Industry; System Dynamics; Model Conceptualization; Causal Loop Diagram

INTRODUCTION

One of the key industries for growing a nation's economy is construction, which has the potential to set the standard for GDP growth in that nation. The building industry in Indonesia ranks fourth among all contributors to economic development, according to the Badan Pusat Statistik (BPS -Statistics Indonesia). In the last quarter of 2021, the construction industry contributed Rp 1.77 quadrillion (10.44%) [1].

The construction industry is non-linear and complicated. Consequently, one crucial aspect is causality [2], [3]. In the construction sector, maintaining quality is fundamental to attaining strategic competitiveness, employee empowerment, employee involvement, decreasing rework, continuous improvement, raising productivity, improving budget performance, and relatively better schedule performance [4]. The management of construction project quality has made use of a variety of quality management approaches, including the cost of quality, Kaizen, international standard organization codes (ISO), Six Sigma, top-down and bottom-up approaches, total quality management (TQM), others [5], [6].

The purpose of TQM, a quality management approach, is long-term success via customer satisfaction. The primary barriers to TQM implementation in developing nations are executive rigidity towards the quality management system (QMS), lack of commitment from top management, insufficient knowledge, low worker involvement, low worker empowerment, and strict behavior and attitude [2]. Construction companies' business objectives and target accomplishments are greatly influenced by TQM [7]. TQM is essential to the success of businesses that prioritize completing projects of the highest caliber. Thus, there are a lot of advantages to applying TQM in the construction industry [8].

The authors of this study used business in the "PT X" (pseudonym), one of the construction companies in Indonesia established in 1991. The company already has ISO 9001:2015 standards for Quality Management Systems (QMS). Due to the widespread application of ISO 9001 worldwide, businesses now compare it to TQM [9]. Most construction businesses believe acquiring an ISO 9001 certification is how they implement TQM [10]. According to Martínez-Costa et al. [11], organizations with ISO 9001 certification may find it easier to transition to TQM due to internal incentives. Additionally, because of the increased awareness of quality concerns, the value of staff training, and the promotion of continuous improvement, obtaining ISO 9001 is considered a good starting point for the move to Total Quality Management (TQM). Said in various ways, those who have already got ISO 9001 satisfy some TQM requirements [12].

However, this certification does not mean that the company has fully implemented Total Quality Management, let alone effectively. Moreover, although TQM can provide many benefits, it also requires a lot of investment. Consequently, implementing TQM is also an investment choice [13]. There are still specific issues with the efficacy of TQM implementation. Maintaining the cost of quality in a project is the means to manage the quality process in the construction industry. However, since the cost of quality is represented in a complex system, controlling it in a project can be challenging [14], [15]. Additionally, one of the quality issues was that the procedure was previously exclusively carried out by those who saw it as an administrative task [16].

The explanation above demonstrates how dynamic and complicated the TQM implementation is and how a system viewpoint is necessary to comprehend this complexity holistically. A comprehensive knowledge of this kind would offer insights on enhancing the efficient application of TQM. System Dynamics (SD) is one technique for analyzing and improving project performance since non-linear linkages and the project's feedback reactions usually cause conditions and performance to alter over time [17]. As a result, using system dynamics to analyze project performance could be an alternate approach [18].

To fill this gap, this study aims to develop a conceptual model using the Systems Thinking (ST) approach, which consists of Actor Analysis, System Diagram, and Causal Loop Diagram (CLD). The conceptual model, intended for the “PT X” company, is created to capture the components contributing to this complexity and pinpoint essential features required to increase the effectiveness of TQM implementation in a construction company.

Literature Review

The term "quality" has several definitions and connotations. Several writers have stated that quality is linked to satisfying operational, legal, and aesthetic requirements [19]. According to the construction industry, it may be summed up as the effective completion of the project's deliverables by the project specifications within the allotted time and budget [20]. When a process, product, or system is evaluated, its quality is determined by comparing it to established benchmarks of excellence, the demands of the product's end users and other stakeholders, and other relevant factors [21].

Total Quality Management (TQM) comprises three fundamental terms: management, quality, and total. Total means considering everyone, quality means satisfying their needs, and management suggests everyone's commitment. As a result, meeting quality criteria requires a collaborative approach rather than an isolated procedure [22]. Since quality, productivity, customer happiness, and profitability are essential to achieving quality inside an organization, TQM recognizes and controls the company's management to create desired performance changes [23].

Numerous studies about the application of Total Quality Management (TQM) in construction companies can be found in the literature on construction management. Implementing TQM in the construction industry may lead to increased client satisfaction, a significant increase in market share, and an improvement in organizational standing [24]. Furthermore, construction TQM creates a positive work environment where all staff members enjoy achieving high-quality construction performance, focus on customer satisfaction, and strive to improve construction projects' general productivity and efficiency [21].

TQM is recognized as a highly valued method of project quality management. It has demonstrated the ability to attain differentiation while minimizing nonconformity, complexity, and nonlinearity. Furthermore, due to rapid development and rivalry, "Quality" is a strategic weapon for higher profit margins and corporate profitability for enterprises and corporations worldwide [10].

Construction companies need to support TQM activities to fulfill customer requests and deliver more excellent value through the company's operations, quality understanding, and solutions. TQM has been proposed in several studies as a way to gain a competitive and strategic edge that can boost productivity and efficiency in the building industry [8]. Businesses that adhere to TQM principles have a competitive advantage over their rivals [25]. Since TQM is a top-down method, company employees will demonstrate superior craftsmanship and more quality-oriented work if senior management of the organization has a more assertive quality-oriented attitude [26].

Quality is the primary factor determining whether a construction product or service is excellent or inferior. Understanding how a building product satisfies its intended specifications is necessary for this. Creating a skilled construction team comprising suppliers, main contractors, and petty contractors is a major step toward building a quality culture in developing nations' construction industries. They would be responsible for implementing a true QMS and important quality practices [27].

A modeling approach and methodology called System Dynamics (SD) is used to organize, analyze, and comprehend complex challenges and problems. In 1950, system dynamics was created to enhance comprehension of the industrial process; nevertheless, it evolved to be utilized in policy analysis and design [28]. A system's behavior over a certain period, defined by its constituent parts and their connections, determines how complex the system is [29]. It is feasible to forecast how a system will behave, function, and react by comprehending its behavior [30].

Conversely, System Thinking (ST) relies on causal linkages and feedback between system components. It involves "systematic" or "holistic" thinking, which is predicated on discovering links and similarities between seemingly unrelated ideas [2], [31]. Thus, some research present views that differ from ST and SD. While SD consists of a mathematical reproduction of the problem to elucidate the past and understand the future, ST consists of a mental model depicting the problem (conceptual model) [2]. A Causal Loop Diagram (CLD), which is included in both ST and SD, is used to evaluate complicated situations using feedback processes [31], [32].

The SD approach is a simulation method that shows correlations between variables in actual complicated systems and helps solve real-world problems. Three components make up the SD method: the system, the computer, and the SD model. To arrive at an ideal value or trend, the computer iteratively executes the model [33]. However, the author of this study developed the model just for utilizing the system diagram and CLD. Furthermore, it is anticipated that the model conceptualization used in this work will be improved to create a better system dynamics model, complete with a stock-flow diagram (SFD) and simulations to provide more information and a better understanding of the behavior of the systems for future research.

Several literatures support the idea that strict TQM organization is necessary to ensure success at every stage of the project's life cycle [8]. All organization's staff members need to understand that they are part of a larger team and have a responsibility to help carry out TQM successfully [34]. To become a leading company in the construction area, implementing TQM necessitates a paradigm shift in the business's quality culture [35]. Additionally, prior research revealed that achieving organizational and quality management objectives is the primary emphasis of behavioral components of management style or human factors [36]. To put it briefly, earlier research concentrated on identifying crucial success criteria for putting Total Quality Management (TQM) into practice. However, it did not define systems thinking or a complex model of TQM in construction and systematically organized their relative effect and related causal links.

METHODOLOGY

The conceptual model for this study is drawn using the Causal Loop Diagram (CLD), a system thinking modeling technique. The research will attempt to develop a conceptual dynamic system model of Total Quality Management (TQM) implementation for an in-depth analysis of its effectiveness. It will use a construction company that has already obtained ISO 9001:2015 as a reference. After that, it will analyze and suggest some policy measures to improve the effectiveness of TQM in the project that the company executes.

First, the literature review aims to identify the factors associated with the construction industry's TQM implementation key and the connections between the variables derived from expert opinion and relevant theories. The issue owner's policy interventions to accomplish the goal and outside variables influencing the problem owner's aims are then examined using actor analysis. According to this, model conceptualization converts the goals of the issue owner and policy interventions into the model's output and policy variables, respectively [37].

TABLE 1
ACTOR ANALYSIS

No	Actor	Problem Perception	Objective	Interest	Cause of Problem
1.	Company BOD	Get complaints from clients or users regarding the project's completion time, but there is no internal input or feedback regarding the TQM implementation process.	It was ensured that the company finished the services or projects in an efficient way to reach the targeted net profit.	Company profit and customer satisfaction can still be maintained.	Absence of feedback and information regarding the internal TQM implementation efforts.
2.	Shareholder/ Principle	Divergences exist in the quality level of project completion and services across all regional projects.	To provide customers or users with the company's value, ensure that every division entity follows the TQM process and delivers the works and services at a specific degree of quality standard.	Create a TQM program to help the business retain its positive reputation in the construction industry and provide valuable services to clients.	Not enough knowledge of the project's diversions (type, size, and customers' or users' cultures).
3.	Company Top Managers / Division Business Manager	Company adaptation is still being struggled with to expand the business line and improve quality in all regional initiatives.	-Developing point of view clients about how important maritime area maintenance and construction is. -Improve human capital capabilities in order to be able to communicate well with stakeholders and project handling so that it can at least be in line with the requirements needed.	It is creating the market for some specific project business division with enough recourses for related customers / users.	Too much cost for enlarging the market while maintaining the project requirement in some business lines.
4.	Project Manager	The TQM implementation process isn't operating efficiently. Occasionally, the user finishes a project by ignoring the checklist and concentrating solely on the tasks on the task list.	Success project in delivering construction task with the minimum BOQ (Bill Of Quantity) that is agreed upon by company management and aligned with customer requirements.	Completing the project on schedule, under budget, and without any mistakes or customer rejection.	Projects handled by the team frequently differ from what the template TQM implementation specified.
5.	QC & QA Team	The effectiveness and validity of the TQM implementation data record are insufficient to warrant evaluation for a quality analysis. QC cannot verify whether TQM was carried out correctly or technically.	Strong discipline among the project team and reviewer to adhere to the TQM Implementation Process.	Track the TQM procedure for every project recorded in the system and inform management of any findings.	Lack of technical expertise makes it impossible to guarantee the TQM's advancement in credibility.
6.	HSSE (Health, Safety, Security & Environment) Team	Although TQM has been adopted as HSSE culture, it hasn't operated effectively.	-Complete document and report to support TQM Implementation audit. -Finish the project safely without any accidents.	HSSE culture in the work environment should be further improved and intensified according to the company's ISO 9001:2015 certification.	Lack of information and feedback from HSSE Team findings.
7.	Engineers	The project team may not fully comprehend every TQM		Success in delivering projects with minimum standard quality based on	-Certain construction projects are not

	implementation; in some instances, TQM aspects may not be pertinent to project requirements, hence adding to the team's workload.	Complete the project and provide the services required to meet project expectations without facing rejection or a construction service failure or fault.	what clients desired and meeting project expectations.	appropriate for the TQM approach. -Insufficient understanding of TQM procedures. -Project schedule pressure.

To have a deeper understanding of the issue, the feedback connection between the variables in CLD is further examined using a system thinking approach. This study used Vensim to develop the CLD. The arrows with positive or negative polarity symbols that show a causal influence or vice versa show the link between the variables. A causal loop is created when the link creates a feedback loop. Reinforcement loops and balancing loops are the two different kinds of causal loops. A reinforcing loop is one in which a change on one side of the loop causes the reaction to alter more strongly. A balancing loop is one in which, in the event of a change on one side, the response will be in the other direction, creating equilibrium for the change [30], [31], [41], [42].

A system diagram is used to explain the whole process and strategy for enhancing the efficacy of TQM implementation once the system process has been developed. The system diagram displays the issue owner and the objectives they have set for themselves, together with all the stakeholders involved in the industry's growth, the operation of the system, and the policy interventions meant to affect the system's output. The framework facilitates the identification and comprehension of the essential components of a business model, including important resources, procedures, and stakeholders, as well as the ways in which these components' interactions might provide value to the organization [37], [42].

RESULT AND DISCUSSION

I. Actor Analysis

Identification of the systems' interests is a necessary component of the problem analysis process. It is uncommon for the problem owner to have the necessary resources to address the issue from their point of view without considering the opinions of all stakeholders. As a result, actor analysis is used in this study to understand the viewpoint, goals, and causes of the problem from the standpoint of each stakeholder [43]. According to [44], actors may be divided into three groups: those directly impacted by the issue and its resolution, those formally participating in the policy intervention, and those involved in putting the resolution into action.

In this study, there are some actors at "PT. X" company that have major problems with the implementation of TQM in the construction sector project. Based on [18] and interviews with some experts, an actor analysis of this problem is represented in Table 1.

II. Conceptual Model – System Diagram

The System Diagram is used to visualize the issue scenario and its complexity as shown in Figure 1. To gain a full understanding of a complicated system, it is necessary to construct a problem. System inputs, outputs, objectives, policy interventions, problem owners, stakeholders, and CLD as a system model are some of the aspects that make up the system diagram [37], [44]. External elements that the issue owner cannot or finds difficult to alter are inputs into the system. The issue owner's intervention is represented by policy variables, and the pattern structure is defined by CLD, which also visualizes the cause-and-effect link between variables or elements in the TQM implementation. Measured outputs serve as objective benchmarks and indicators of how well TQM is being used.

The TQM implementation improvement issue has been assigned to the board of directors, who represent the top management of the business [18]. As a result, the board of directors is the problem owner of this issue. Therefore, the objective is to enhance TQM for construction projects. Five indicators of output—customer/client satisfaction/focus, continuous improvement, rework, communication, and project profit—can be used to show this. Continuous improvement brought about by high levels of customer/client satisfaction/focus. Then, reworking any work that the client rejects and improving the communication rate from internal or external projects are two ways to satisfy them. Rework not only increases project costs and decreases profit margins but also takes longer to complete, increasing the possibility of project length overruns and decreases client satisfaction. As a result, the problem owner is concerned with communication, project profit, and rework in addition to continuous development and customer satisfaction.

The problem owner may implement some policy steps, based on the expert's interview results. The policy will only be considered a TQM process, without altering another associated business process, such as the project execution process, because this research focuses on improving TQM implementation. As a result, the endogenous and exogenous category parameters inside the systems will establish the model boundaries [32]. As stated in [45], an endogenous variable exists inside the system and is simultaneously affected by and has an influence on it. A variable that affects the system yet is not affected by it is called an exogenous variable. Another variable that considers the problem owner's policy measure while acting in the system is the policy variable. Thus, the policy interventions are attitude & behavior towards TQM, expert workforce, and mutual reciprocity as shown in Figure 1.

III. Conceptual Model – Causal Loop Diagram (CLD)

This study used Vensim to develop the CLD. Figure 2 shows the CLD that has loops in the strategy for improving the effectiveness of TQM implementation in the construction industry. The CLD consists of 22 loops, consisting of 17 causality reinforcing loops and 5 causality balancing loops, where loops R1, R2, R3, R4, R5, R6, and B1 are the base model of the CLD

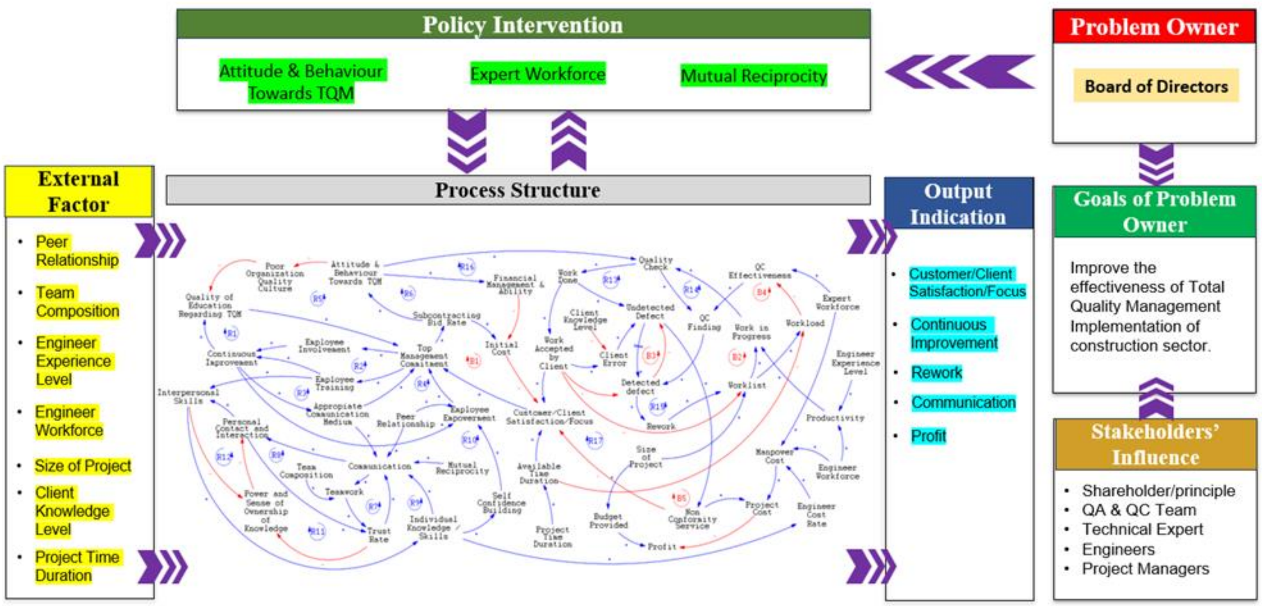

FIGURE 1
DIAGRAM OF TOTAL QUALITY MANAGEMENT IMPLEMENTATION EFFECTIVENESS IMPROVEMENT FOR CONSTRUCTION INDUSTRY
(THE ENLARGED PICTURE OF PROCESS STRUCTURE IS PROVIDED IN FIGURE 2)

according to TQM key implementation research [2]; loops R7, R8, R9, R11, and R12 are the base model of the CLD according to tacit knowledge sharing study [33]; loops R13, R14, R15, B2, B3, and B4 are the base model of the CLD according to project quality management system effectiveness study [18]; lastly loops R10, R16, R17, and B5 are obtained due to the combination of the three base models. Several variables have been modified based on adjustments from the actor analysis results. Each loop is elaborated subsequently.

1. **Knowledge of TQM (Reinforcing Loop R1)**
   The findings of Reinforcing Loop R1 (shown in Figure 3) suggest that an increase in top management commitment stimulates employee involvement and

has a significant impact on the continuous improvement of construction projects. Furthermore, the quality performance of construction companies has increased because of continuous ongoing development and refined quality of education regarding TQM [2].

2. **Employee Collaboration Towards Quality Policy Making (Reinforcing Loop R2)**
   Construction projects continuously improve when top management is more committed and employees participate in policy and decision-making, according to the findings of Reinforcing Loop R2 (as seen in Figure 4). Additionally, when the level of continuous improvement increases, the lines of communication between the major players are also enhanced. As a result, TQM adoption and construction project quality performance both naturally improve [2].
3. **Effective Communication and Coordination Mechanism (Reinforcing Loop R3)**

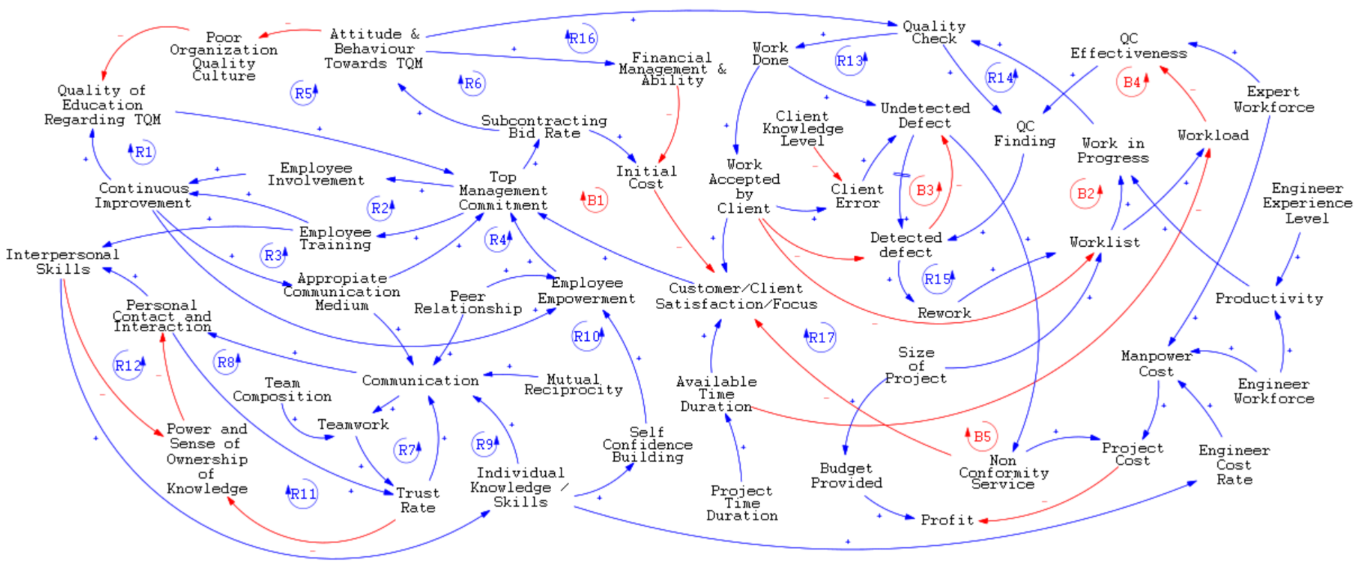

FIGURE 2
CAUSAL LOOP DIAGRAM (CLD)

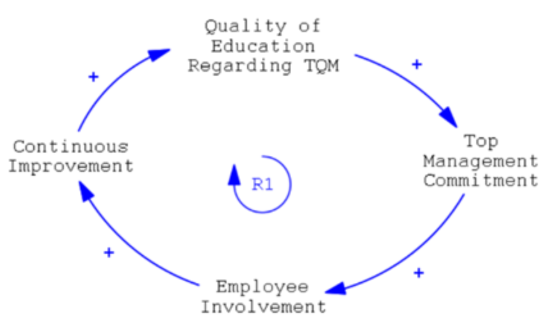

FIGURE 3
REINFORCING LOOP R1

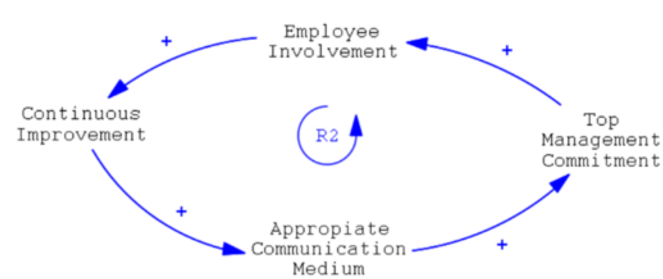

FIGURE 4
REINFORCING LOOP R2

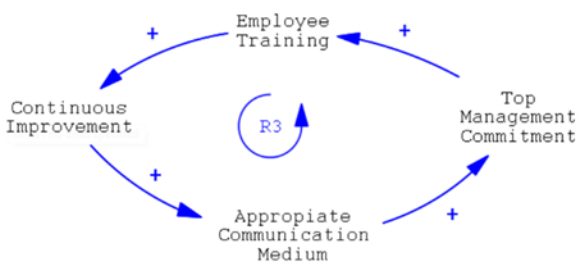

FIGURE 5
REINFORCING LOOP R3

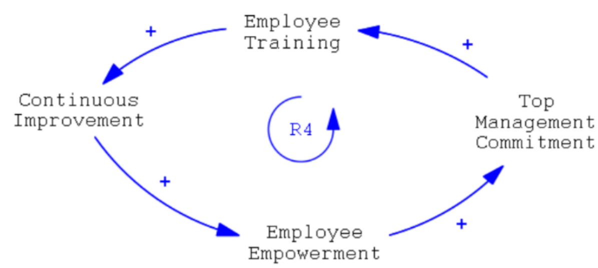

FIGURE 6
REINFORCING LOOP R4

Reinforcing Loop R3, shown in Figure 5, suggests that employee training and technical knowledge are increased in response to a notable rise in top management commitment. Thus, there is potential for a beneficial effect on continual progress. Any healthy construction organization's ability to communicate effectively is critical to its success [2].

4. **Effective Employee Empowerment (Reinforcing Loop R4)**

Reinforcing Loop R4, shown in Figure 6, suggests that higher levels of top management commitment advance professional development for staff members and continuous improvement of construction projects. Additionally, as construction processes and operations are continuously improved, staff morale and a quality-focused mindset rise, which lowers rework and promotes the TQM idea [2].

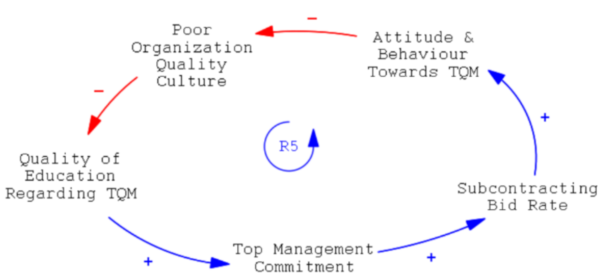

FIGURE 7
REINFORCING LOOP R5

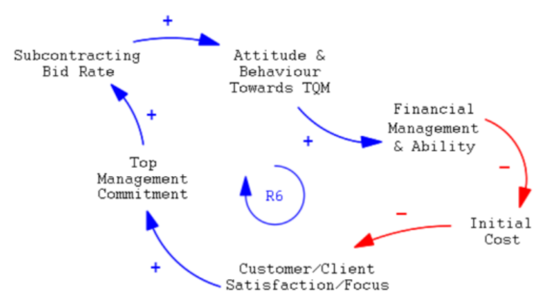

FIGURE 8
REINFORCING LOOP R6

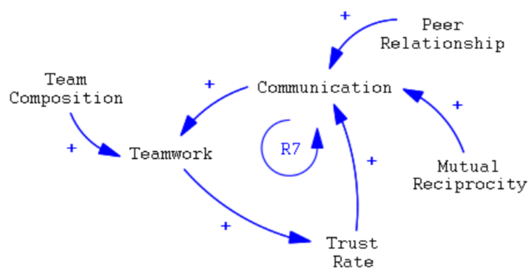

FIGURE 9
REINFORCING LOOP R7

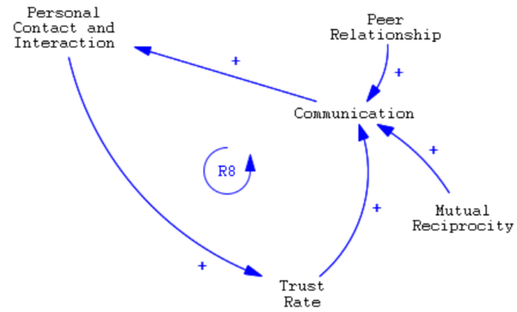

FIGURE 10
REINFORCING LOOP R8

5. **Attitude Towards Adaptation (Reinforcing Loop R5)**
Top management and the subcontracting bid rate have a linear connection, according to the findings of Reinforcing Loop R5 (as seen in Figure 7). A progressive increase in the subcontracting bid rate is observed with a rise in senior management commitment. A low-cost vendor's choice is the basis for the subcontracting bid rate, a novel method of contract awarding. The project's overall quality may be harmed by this approach. The attitude and conduct of the client or customer toward TQM increase as the subcontracting bid rate rises. As a result, the culture of low organizational quality is diminished. Education, training, and quality practices in TQM implementation improve as low organizational quality trends decline.
6. **Financial Management & Ability Towards Adaptation (Reinforcing Loop R6)**
Financial management and ability is one of the key problems based on the actor analysis. Reinforcing Loop R6 (as seen in Figure 8) shows a progressive decrease in the initial cost with a rise in financial management and ability. After the initial cost goes low, it will increase customer satisfaction/customer focus, top management commitment, and subcontracting bid rate. The attitude and conduct of the client or customer toward TQM increase as the subcontracting bid rate rises. As a result, the financial ability of the company will increase because the attitude and behavior towards TQM will increase, too.
7. **Effective Teamwork with Communication Loop (Reinforcing Loop R7)**
Reinforcing Loop R7, as seen in Figure 9, implies that improved communication fosters a sense of shared purpose and teamwork, which in turn builds trust among project team members. Peer relationships and reciprocity are external components that enhance communication [33]. Similarly, team composition favorably complements teamwork from the outside.
8. **Communication Towards Personal Contact and Interaction (Reinforcing Loop R8)**
Reinforcing Loop R8, shown in Figure 10, further suggests communication has a direct and beneficial impact on personal contact & interaction, which in turn raises the trust level among project team members [33].

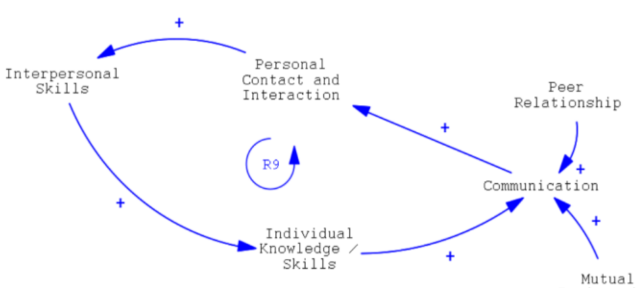

FIGURE 11
REINFORCING LOOP R9

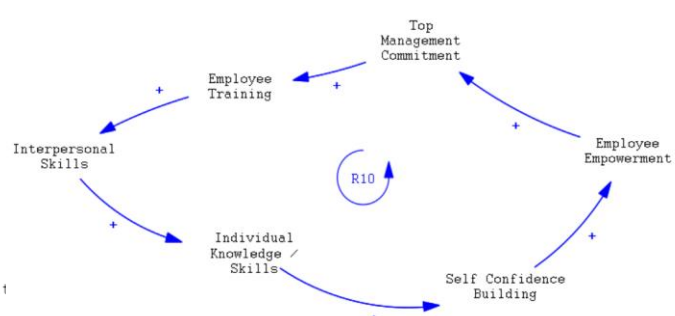

FIGURE 12
REINFORCING LOOP 10

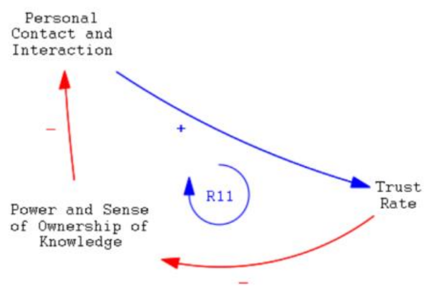

FIGURE 13
REINFORCING LOOP 11

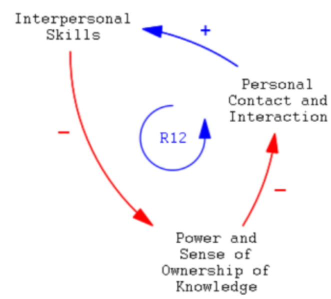

FIGURE 14
REINFORCING LOOP 12

9. **Individual Knowledge/Skills with Communication Loop (Reinforcing Loop R9)**
According to the results of Reinforcing Loop R9 (shown in Figure 11), there is a positive correlation between communication and increased interpersonal contact and interaction. More interpersonal skills via more face-to-face engagement and communication lead to growth in individual knowledge and abilities. Positive peer relationships and reciprocity externally enhance communication.

10. **Top Management Commitment Towards Tacit Knowledge (Reinforcing Loop R10)**
Reinforcing Loop R10 (shown in Figure 12) suggests that an increase in top management commitment leads to an increase in expertise development or employee training, which, as a result, increases interpersonal skills, individual knowledge/skills, and self-confidence building positively and simultaneously. As a result, employee empowerment increases and leads to increases in top management commitment.

11. **Trust Towards Sense of Ownership of Knowledge (Reinforcing Loop R11)**
Reinforcing Loop R11, shown in Figure 13 illustrates how a rise in trust is correlated with a decline in power and a sense of knowing ownership. There will be more in-person interactions and communication when there is less authority and a sense of knowledge ownership. On the other hand, a rise in interpersonal communication and engagement will boost trust within the project team. As a result, it was determined that this loop was reinforcing.

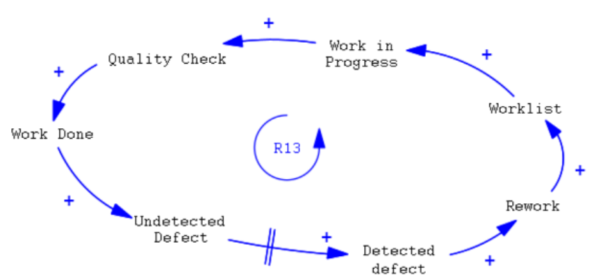

FIGURE 15
REINFORCING LOOP 13

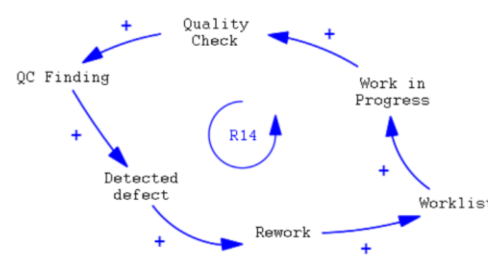

FIGURE 16
REINFORCING LOOP 14

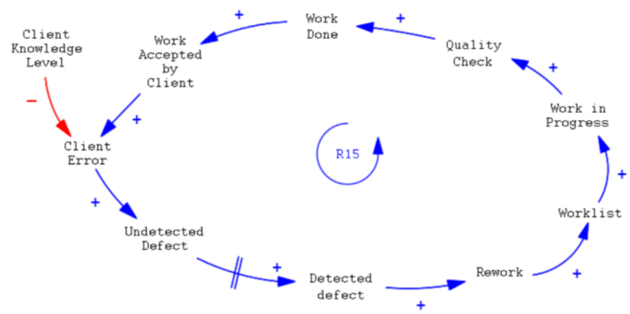

FIGURE 17
REINFORCING LOOP 15

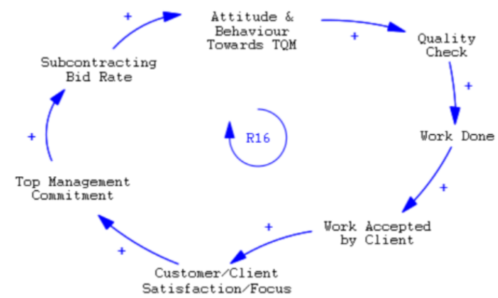

FIGURE 18
REINFORCING LOOP 16

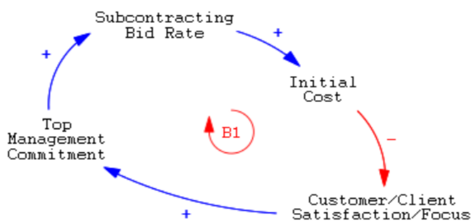

FIGURE 20
BALANCING LOOP 1

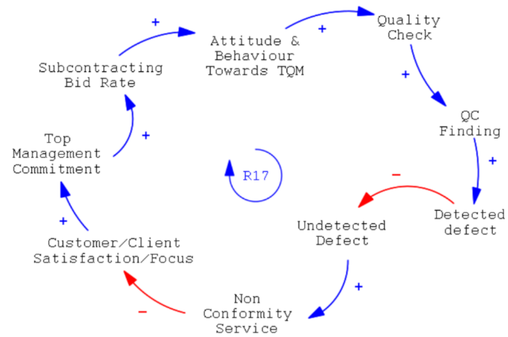

FIGURE 19
REINFORCING LOOP 17

12. **Interpersonal Skills Towards Sense of Ownership of Knowledge (Reinforcing Loop R12)**
Reinforcing Loop R12, shown in Figure 14, implies that a rise in interpersonal skills causes decreases in power and a sense of knowledge ownership. There will be more personal contact and interaction when there is less power and a sense of knowledge ownership. On the other hand, more personal contact and interaction will improve team members' interpersonal skills. Consequently, this loop was recognized as a reinforcing loop.

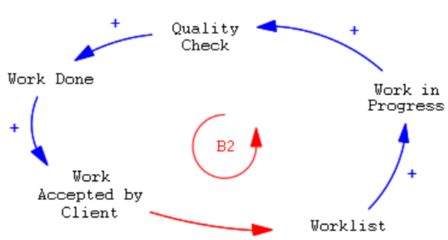

FIGURE 21
BALANCING LOOP 2

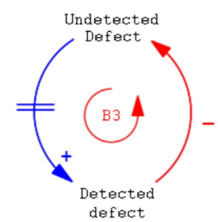

FIGURE 22
BALANCING LOOP 3

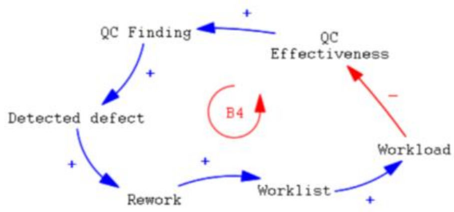

FIGURE 23
BALANCING LOOP 4

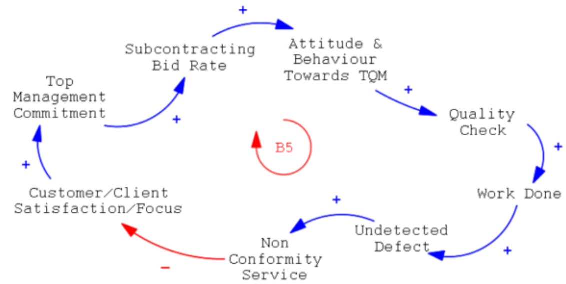

FIGURE 24
BALANCING LOOP 5

13. **Work Done Loop (Reinforcing Loop R13)**
Reinforcing Loop R13, shown in Figure 15, explains how variable work done might result in a longer worklist because of the creation of undiscovered defects. This defect is typically unknown/detected since the engineer thought the work was done. Usually, this flaw goes unnoticed since the engineer believed the job was completed. A design flaw, the use of incorrect material, or even a misinterpretation of the project specifications might all be considered defects. This undetected defect can be detected but takes some time, meaning the arrow has a delay symbol. Once the defect is found, this would be transferred to a rework and added to the worklist. The work in progress will also be added as the worklist has been added. More work in progress means more quality checks will be performed, which means more work will be completed [18].
14. **Quality Check Finding Loop (Reinforcing Loop R14)**
The results of Reinforcing Loop R14 (shown in Figure 16) illustrate how the creation of a discovered defect would cause variable quality check (QC) findings to increase the worklist. The work that has already been completed would be revised if the quality check procedure discovered any flaws in the product or service's design, such as a departure from the project requirements or an inability system. The work in progress has expanded with the increase in the worklist. As the work in progress increases, so will the quality check process, increasing QC findings [18].
15. **Client Error in Accepting Work (Reinforcing Loop R15)**
The findings of Reinforcing Loop R15 (shown in Figure 17) explain that depending on the client's degree of understanding, there is still a chance that the client may accept the job incorrectly. This potential to cause certain undiscovered defects may result in detectable defects if the defects are found or noticed, which will need some delay. This mistake becomes a rework that adds to the worklist. The worklist will grow, improving the quality check procedure once again and boosting the amount of work completed. Ultimately, the task is completed to the client's satisfaction, leaving an undiscovered defect and building a reinforced loop.
16. **Top Management Commitment Towards Quality Check Loop (Reinforcing Loop R16)**
Reinforcing Loop R16, shown in Figure 18, implies a connection between top management commitment and quality checks. As top management commitment increases, attitude and behavior towards TQM increase, and consequently, quality checks increase. When the work is done and accepted by the client, the client satisfaction/focus will improve and increase top management commitment.
17. **Non-Conformity Service with QC Finding Loop (Reinforcing Loop R17)**
Reinforcing Loop R17, shown in Figure 19, suggests that just like Reinforcing Loop R16, there are more quality check findings, which leads to more detected defects. When the defect is detected, this will decrease the undetected defect and subsequently decrease nonconformity service. As the nonconformity service decreases, client satisfaction/focus will improve and increase top management commitment. Therefore, this loop was recognized as a reinforcing loop.
18. **The Cost of Cutting Corners in the Construction Sector (Balancing Loop B1)**
Self-balancing loop B1 (as shown in Figure 20) deduced that as top management commitment increases, the subcontracting bid rate increases, leading to higher initial costs. As upfront costs increase, customer satisfaction and focus decrease. Customer delight can be achieved if anyone in the organization from either the lowest or highest position takes part wholeheartedly in completing the project while optimizing cost and taking time management into account. Since top management commitment is directly proportional to customer delight, this commitment increases customer client

satisfaction and interest in TQM increases. Consequently, loop B1 carries a strong and fast influence that is self-balancing [2].

19. **Work List to Work Accepted Loop (Balancing Loop B2)**
The way that the growth in work accepted by the client would balance the variable worklist is explained by Balancing Loop B2, which is seen in Figure 21. The rise will cause the work in progress to climb along with the worklist as it grows by the original number of worklists from the project specification and rework from detected defects. There will be more quality checks since more work is in progress, leading to more work being completed. The quantity of work completed will affect the increase in work that the client accepts. The worklists will decrease proportionately to the number of jobs the customer has previously accepted [18].
20. **Defect Loop (B2) (Balancing Loop B3)**
Balancing loop B3 (as shown in Figure 22) indicates two kinds of defects in every completed work project: undetected and detected. An undetected defect is a mistake that was made while doing the task, particularly in the case of building work. The detected defect indicates a mistake or error in the job. Typically, a recognized problem would be found during testing the completed work with the client who had the demand. The relationship between these two variables is that once an undetected defect is created, it will eventually be found and become a detected defect. However, while taking action to locate defects, such as testing, a fault already recognized may also uncover one that is not. The number of defects that are not discovered will decrease as more defects are found [18].
21. **Quality Check Effectiveness Loop (Balancing Loop B4)**
The self-balancing loop B4 (Figure 23) explains the efficacy of quality checks. The efficacy of the quality process is highly reliant on the project workload because it is a TQM procedure carried out by the engineer executing the project. One factor influencing the process of generating defect fixes from incorrect work is quality effectiveness. Rework is prompted by increased detected defects and QC findings. Rework entails adding more tasks to the worklist, which will raise the engineer's workload and decrease the efficacy of QC as the engineer will be more focused on completing the job because the available time is constantly limited.
22. **Non-Conformity Service with Work Done Loop (Balancing Loop B5)**
Self-balancing loop B5 (Figure 24) explains that this loop is almost the same as Reinforcement Loop 17 (as illustrated in Figure 19). Still, there is no QC finding after the quality check variable, and the work was considered complete. However, in reality, there are undetectable defects in the field, which leads to increases in nonconformity service. As a result, the more non-conformity service will impact the client satisfaction/focus, whose value will be reduced.

CONCLUSION T AND RECOMMENDATION

This research provides a conceptual model to increase the efficiency of Total Quality Management (TQM) implementation for construction companies. Model construction was aided by multi-actor analysis, system diagrams, and the Causal Loop Diagram (CLD). The multi-actor analysis gave insight into the players engaged with the TQM implementation. At the same time, the system diagram and CLD provided more insight into how these variables are interrelated and impact each other.

The system diagram also offers a deeper comprehension of the TQM implementation that fully supports sustainability. The system diagram also displays the process's goals, output indicators that match the objectives, and outside variables that might influence process uncertainty, stakeholder participation, and corporate system intervention. The conceptual model is generated by drawing a Causal Loop Diagram (CLD) to represent the causal relationship between variables or system parts. Five variables were selected as the systems' output indicators: customer/client satisfaction/focus, continuous improvement, rework, communication, and project profit. The connections among the system's variables that affect the output form 17 reinforcing loops and five balancing loops, which are derived from combining previous research on TQM key implementation [2], tacit knowledge sharing [33], and project quality management systems effectiveness [18]. Stakeholders' and the problem owner's interactions via the systems will impact the results about their ability to support and oversee the implementation of improved TQM properly.

The conceptual and business model verification tests are not subjected to any quantitative testing in this study. Consequently, further research must determine how the company's participation affected the system. For future study, the conceptual model is intended to be expanded into a stock-flow diagram (SFD) and run simulations for greater detail, especially for understanding the systems' behavior and examining the effect of policymaking in the construction sector. Quantitative research might model either new or current regulations to assess the efficacy of TQM adoption in a variety of potential future situations. Finally, study subjects in the future might contribute to a policymaking process that prioritizes safety above all else while also encouraging innovations.

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