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# The moderating effect of project complexity on the relationship between organizational controls and cost estimation performance: A conceptual model

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**Abstract.** Cost overrun in construction projects is high and expected to rise. The improvement of cost estimation performance is vital as it provides a better chance for the construction projects to avoid cost blowouts. In this paper, an extensive literature review is conducted from online databases such as Web of Science, Scopus, and Google Scholar which focus on organization controls and its mechanisms to improve cost estimation performance in the construction industry. While many prior studies on cost estimation emphasized investigating cost estimation methods to improve the performance of cost estimation, less attention was given to organizational and project factors. Several studies have explored the effects of organizational control on performance but failed to include project complexity in the relationship between organizational controls and performance. Therefore, this paper conceptualizes the effect of organizational controls on cost estimation performance with project complexity as a moderator. This proposition suggests project complexity has advantages and disadvantages on organizational controls. Each control mechanism has its feature and effectiveness in high complexity projects. Hence, managers should select appropriate control mechanisms, such as input control and output control that have high effectiveness on the performance.

**Keywords:** Cost estimation performance, Organizational control, Input control, Behavior control, Output control, Project complexity

## 1. Introduction

Cost overrun is a common dilemma in the construction industry [1,2]. The causes of cost overrun can be due to poor management of project information, project cost, project schedule, underestimating project complexity and project risks, poor competencies and experience in project managers, and constraints from the government [3–6]. The Chaos Manifesto showed that only 39% of the construction projects were completed successfully, 18% were considered unsuccessful, and 43% of the projects were confronted with schedule and budget issues [7]. Since 28% of construction project failures globally were caused by the poor performance of cost estimation [8], this indicated that previous projects display low performance especially in estimating cost.

The accuracy of cost estimation is a very important factor to avoid significant losses. As Nakhleh (2019) asserted that strong financial levels of contractors and very competent management teams will



fail if the performance of cost estimation is poor. Although several factors of cost estimation performance that influence failed performance have been identified; which include poor cost and project information, low construction knowledge, and competencies of cost estimator, and changing government regulation [10–14], several cost estimation studies still focus on research that relates to cost estimation methods such as parametric, analogous, analytical, and intuitive approaches to determine cost estimation performance [15–20]. However, organizational factors have been overlooked in cost estimation literature. Thus, this study conceptualizes the impact of organizational controls on cost estimation performance with the presence of project complexity.

## 2. Theoretical Development

### 2.1 *Organizational Control Theory and Mechanisms*

Organizational control is defined as any type of control that managers utilize to direct attention, motivation, and encourage employees to take action to satisfy organization's objectives [21].

Organizational control theory identifies three types of organizational controls' mechanisms [22–25] that are usually applied to govern the appropriate behavior to attain targeted performance which are input control, behavior control, and output control.

Input control is defined as a control that emphasizes competencies, skills, and abilities required to perform a task and utilize these attributes as measures for selecting new employees [26]. In addition, input control also refers to information required to perform the cost estimation such as cost information and project information that have high accuracy and reliability [22]. Behavior control is referred to specific rules and procedures for executing the tasks which lead to the desired outcome when organizational members follow the rules [26]. Managers observe the behaviors or actions of the organizational members and reward them based on the degree to which the members followed the rules or procedures [26–28]. For example, a detailed procedure of technique may be viewed as a mechanism of behavior control as it shows the precise steps to be followed to improve the performance of organizational members [29]. Whereas, output control is defined as managers evaluate their employees' performance and reward them according to the completion of predefined objectives [26]. More specifically, employees who understand their objectives would adopt appropriate behaviors to complete the objectives. In cost estimation, competent cost estimators will behave accordingly to achieve their objectives.

Recently, academics and practitioners have explored and investigated the role of organizational controls and categorized them into five categories. The first category was related to control mechanisms that are developing within projects [30,31]. The next category is about the exploration of the factors influencing the selection of control mechanisms [26,32]. The impact of control portfolios in the development of system projects is the third category [33–35]. The fourth category is about the utilization of control mechanisms as mediator or moderator roles [36,37]. The last category is about the correlation between control and performance [29,38,39]. They were extensively explored for the first four areas of project control but the correlation between control and performance have contradicting arguments and are not clearly understood.

According to the shortcomings in organizational control literature, the purpose of this paper is to explore the impact of organizational controls on the performance of cost estimation with the role of project complexity as a moderator.

### 2.2 *Organizational Controls and Performance*

The direction of correlation between organizational controls and performance has contradictory results and remains equivocal [28]. Several studies reported the positive correlation between organizational control and performance but some studies also report otherwise [40] as shown in Table 1. Specifically, there were contradictory results for each organizational control (input control, behavior control, output control) on the performance. While some studies have discussed that behavior control has positively correlated with performance [29], others identified the correlation as negative [38]. On one hand, input control significantly correlated with performance [41,42], in another hand, a study indicated that the

correlation between input control and performance was insignificant [43]. Similar to output control where there was a significant and insignificant correlation toward performance. Sihag & Rijdsdijk (2019) reported a significant correlation between output control and performance but a study from Kim & Tiwana (2016) shown a negative correlation between output control and performance.

Consequently, more investigations and evidence are necessary to determine the relationship between organizational controls and performance. Framework by Ouchi (1979) indicated that the appropriate organizational control to be used depending on task programmability and outcome measurability. This aligns with contingency theory which indicates that there is no best of a single form of organization in all conditions [44]. This paper introduces a contextual variable based on contingency theory to examine the influence of each organizational control on the cost estimation performance. The discussion regarding the contextual and contingency theory is explained in the next section.

**Table 1.** Previous studies on organizational controls and performance.

Impact on Performance	Organizational Controls		
	<i>Input Control</i>	<i>Behavior Control</i>	<i>Output Control</i>
Positive	Saviour et al. (2017) Selase (2018)	Sihag & Rijdsdijk (2019)	Sihag & Rijdsdijk (2019)
Negative	Croitor & Adam (2020)	Sihag & Rijdsdijk (2019)	Kim & Tiwana (2016)

### 3. Moderating Variable

Based on the above discussion and contradicting findings from previous studies, it is possible to introduce a moderator variable to moderate the correlation between these variables. The introduction of moderating effect is to distinguish between two or more variables that have different characteristics which might be the cause of contradicting results in the literature [45].

In this paper, project complexity is introduced as a moderator to moderate the correlation between organizational controls and cost estimation performance. The previous studies regarding project complexity are presented in the next section.

#### 3.1 Project Complexity as a Moderator

The projects in the construction industry consist of high uncertainty and interdependent units [46]. The construction projects are likely to be more complex and not well understood than other projects because of several factors such as project size, interdependence, and interrelations between project tasks, project scope, stakeholder management, technology capability, project diversity, and ambiguity in the project [47]. Although some studies on project complexity do not associate project size with project complexity [46], many researchers found the correlation between project size and project complexity was in a positive direction [48]. Many researchers have different perspectives on project complexity. Some researchers related project complexity with project management and similar definitions [49]. Project complexity was usually used interchangeably with project risk and project difficulty [49]. Bosch-Rekveltdt (2008) developed a Technical, Organizational, and Environmental (TOE) framework by separating the project complexity into technical, organizational, and environmental complexities. After several years, He et al. (2015) added complexity of culture into the TOE framework as many construction projects consist of employees with different backgrounds.

Moreover, Lu et al. (2015) divided project complexity into two categories which were complexity in organization and job. Nguyen et al. (2015) focused on another perspective by adding infrastructural complexity, socio-political complexity, and scope complexity into existence complexities from previous studies such as organizational and environmental complexity. Project complexity undeniably is a primary factor in the performance of construction management and project management especially the performance of cost estimation [46].

Based on the previous studies on complex construction projects, the project complexity undeniably impacts performance especially cost estimation performance [46]. However, there was limited empirical evidence found about the impact of project complexity on the correlation between organizational controls and cost estimation performance.

The moderator effect of project complexity has been used on project performances such as new product development, environmental performance, crowdfunding performance, and performance of international development projects [54–57]. The authors used project complexity as a moderator to the correlation between project events and project performance. Onubi et al. (2019) also reported that project complexity moderates the correlation between green practices in terms of management performance in material, water, and environment. Although several studies have used project complexity or other complexities as a moderator on the relationship between various independent variables and performance variables at the project level, almost no study utilizes the moderator effect of project complexity on individual-level performance.

Usually, task complexity or job complexity acts as a moderator for achieving the individual performance level. For example, Salgado (2017) examined the impact of job complexity as a moderator on the link between personality and job performance. The results showed that the influence of each of the personality study on the job performance were contradicted as it depends on the job complexity. Therefore, the impact of organizational controls on cost estimation performance may depend on the level of project complexity. Hence, this paper proposes the following propositions.

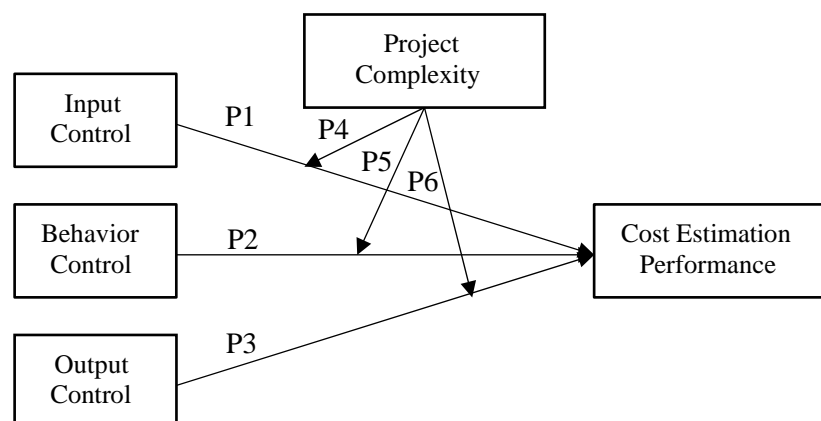
#### 4. Methodology

This paper's methodology utilized previous literature on the evaluation of cost estimation, project complexity, and organizational controls. The literature was obtained from online databases such as Web of Science, Scopus, and Google Scholar. The advanced search of the online databases was focused on cost estimation, project complexity, organizational controls, input control, behavior control, output control, and the construction industry. Moreover, only journal articles, conference papers, book chapters, and full-text documents were considered in this paper.

Consequently, this paper's limitation occurred from the limitation of the databases that previously mentioned as cost estimation related to information technology, manufacturing, engineering, and health industries were excluded. The references of organizational controls and project complexity only focus on literature from 2014 to 2021.

#### 5. Hypotheses Development

As mentioned in the section 2.2, there were inconsistent results regarding the relationship between organizational controls and performance. Thus, this paper offers the following propositions based on the conceptual framework as in Figure 1.



**Figure 1.** The conceptual framework

- P1:** Input control will positively associate with cost estimation performance.
- P2:** Behavior control will positively associate with cost estimation performance.
- P3:** Output control will positively associate with cost estimation performance.
- P4:** Project complexity will moderate the relationship between input control and cost estimation performance.
- P5:** Project complexity will moderate the relationship between behavior control and cost estimation performance.
- P6:** Project complexity will moderate the relationship between output control and cost estimation performance.

## 6. Discussion of Literature

The findings from an extensive literature review on cost estimation performance indicate that there was a lack of attention to use organizational controls as factors of cost estimation performance. Liu (2007) has categorized some cost estimation factors as organizational controls such as input control, behavior control, and output control but it lacks empirical evidence. In addition, the relationship between organizational control and performance has contradicted results as shown in the previous section. Consequently, project complexity has been introduced as a moderator because it is one of the critical factors of cost estimation performance and many previous studies have used project complexity as their moderator.

This paper provides new insight into the relationship between organizational controls and cost estimation performance especially in the introduction of project complexity as moderator. If all the propositional are accepted, all the controls will have a positive correlation with the cost estimation performance in low complexity of projects. This finding supports the statement that the implementation of organizational controls can improve performance and it is consistent with previous studies [29,38,42]. However, in high project complexity, only input and output controls will have a significant impact on the performance, but behavior control will have a low influence on the performance. This is because behavior control associates with work procedures, methods, and approaches that are rigid and inflexible to satisfy the demand of high complexity projects. This finding is consistent with Liu (2015) which behavior control has less impact on performance in high-risk complexity environments.

Practically, this research provides a better understanding for the manager in making a decision on which organizational controls to be used during cost estimation in high or low project complexity. Although all the organizational controls are effective in providing high performance in low complexity, the manager should understand the features of each control as different controls affect a different part of project cycles. As behavioral control is ineffective in high project complexity, the manager should replace other organizational control that has a similar effect on the project cycle with behavior control. The replacement is required to avoid the decrease in the performance when estimating the cost in high project complexity. Moreover, the manager can spend more effort with effective controls in estimating the cost in high complexity projects to manage company resources efficiently and effectively without wasting in ineffective control.

It is beyond the scope of this study to address the question of the impact of informal control such as clan control and self-control. Although, these controls have impacts on the performance at most of the project stage same as behavior control, many previous papers related to factors cost estimation indicate many factors that can be categorized as formal controls (input, behaviors, and output controls) Thus, this paper focus on the relationship of formal control and cost estimation performance. For future research, the researcher should investigate the impact of informal controls (self-control and clan control) on cost estimation performance in different project complexity. The researcher could also test the impact of each

of the controls when act simultaneously to determine which control combinations are the most effective to improve cost estimation performance.

## 7. Conclusion

Based on organizational control theory, this paper identified three appropriate types of controls (input control, behavior control, and output control) to utilize in context cost estimation. However, the results from previous studies regarding the impact of each control were inconsistent. The introduction of project complexity as a moderator will further provide explanations to the inconsistency in another context especially cost estimation. Ultimately, the framework may assist construction firms in making decisions regarding which controlling factors to give more attention to improve estimating effectiveness.

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