

Investigating the Causes of Variation Orders in Egypt: Perspective of Medium and Small-Sized Companies

Investigando las Causas de las Ordenes de Cambio en Egipto: Perspectiva de las Empresas de Tamaño Medio y Pequeño

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Abstract

Variation orders became one of the major issues presented in construction projects. The nature of work in the construction industry is complex and difficult. Thus, variation orders are expected to occur in every project due to its nature. The purpose of this study was to investigate the causes of variation orders in construction projects in Egypt according to the perspective of professional parties working for medium and small-sized construction companies. The main method used for data collection was a questionnaire survey with experts working in the Egyptian construction industry, where 62 participants from 18 construction companies were invited to take part in the study, and 51 of them accepted the invitation. The findings showed the top-ranked causes of variation orders according to small and medium-sized construction companies were poor communication, omissions in the design, financial limitations of the owner, additional work requested by the client, and the contractor's desire to gain more profits. Thus, a proper understanding of the causes of the problem can help establish a suitable criterion for reducing variation orders in construction projects in Egypt. The contribution of this study lies in the fact that only a very limited number of research explored the perspective of medium and small-sized construction companies in Egypt. The study can be useful for other countries with similar working conditions and still suffering from the adverse impact of variation orders.

Keywords: *Construction Projects; Causes of Variation Orders; Small and Medium Size Construction Companies; Construction Sector in Egypt.*

Resumen

Las órdenes de cambio se han convertido en uno de los principales problemas observados en los proyectos de construcción. La naturaleza del trabajo en la industria de la construcción es compleja y difícil. Por lo tanto, es de esperar que las órdenes de cambio ocurran en cada proyecto debido a su naturaleza. El propósito de este estudio fue investigar las causas de las órdenes de cambio en proyectos de construcción en Egipto considerando la perspectiva de los profesionales que trabajan para empresas constructoras de tamaño medio y pequeño. El principal método utilizado para la recolección de datos fue una encuesta de cuestionario aplicada a expertos que trabajan en la industria de la construcción egipcia. Se invitó a 62 participantes de 18 empresas constructoras a participar en el estudio, de los cuales 51 aceptaron la invitación. Los hallazgos revelaron que las principales causas de las órdenes de cambio para las empresas constructoras de tamaño mediano y pequeño fueron la comunicación deficiente, omisiones en el diseño, limitaciones financieras del propietario, trabajo adicional solicitado por el cliente y el deseo del contratista de obtener más beneficios. La comprensión adecuada de estas causas puede ser útil para establecer un criterio adecuado para reducir las órdenes de cambio en los proyectos de construcción en Egipto. Este estudio contribuye al mejorar el muy limitado número de investigaciones que han explorado la perspectiva de las empresas constructoras de tamaño mediano y pequeño en Egipto. De igual forma, puede ser útil para otros países con condiciones de trabajo similares y que aún sufren el impacto adverso de las órdenes de cambio.

Palabras clave: *Proyectos de construcción, causas de orden de variación; pequeñas y medianas empresas constructoras; sector de la construcción en Egipto.*

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1. Introduction

The construction process involves the combination of various organizations, professions, and individuals. This process contains design production, data documentation, financial estimations, contract procurement, and site operations (Eigbe, 2016). However, projects are vulnerable to variability in weather conditions, soil, and site circumstances. These conditions indicate the reason why the building sector is prone to variations or changes in specifications, designs, quantities, drawings, and plans (Eigbe, 2016). These variations take place after awarding the project and during the construction stage (Ismail et al., 2012).

Construction projects would inevitably deviate from the actual drawings, designs, and specifications that are established by the designer due to the nature of the work. Furthermore, construction projects are unique in various aspects, but changes are common in almost every construction work (Eigbe, 2016). A variation is defined as a change or an alteration to the quantity, quality, or design of works conducted in the project as shown in the bill of quantities or contract drawings. It can include the substitution, addition, or omission of any work from the project's plans.

Changes are inevitable in construction projects and their operations. The presence of a variation order can have a severe impact on a project's goals and objectives. (Ibbs, 2012) confirmed that changes in the project might impact the success of the project for both the contractor and the owner. Therefore, adequate management of variations in the project is significant to mitigate the impact of modifications. (Bottari, 2014) stated that there should be proper and effective management of changes in the project to ensure the mitigation of all risks. Change management can aid in enhancing the efficiency of the overall operation of the project. Another critical measure is to adequately understand the causes and impacts of variation orders.

The next section discussed some of the recent studies that investigated the context of variation orders in many developed and developing countries. This is followed by the methodology that explains the methods of data collection and analysis before the demonstration of the results. Lastly, the study ended with a summary and recommendations for future studies.

2. Literature review

After reviewing the literature regarding the causes of variation orders in Egypt, there has been a lack of sufficient studies about the perspective of medium and small-sized construction companies. Therefore, this study investigated the origins of variation orders in the construction sector in Egypt focusing on these construction companies. (Table 1) shows the top-ranked causes of variation orders in many developing countries. These causes were changes in specifications, lack of references from previous projects, changes in the scope of work, changes in the design, poor communication, conflict regarding contract documents, design errors, changes in materials, omissions in the design, lack of specific material in the market, financial limitations of the owner, weather conditions, additional work requested by the client, not involving all parties in the design, changes in site conditions, unclear scope of work, contractors desire to gain more profits, and late approval. This set of causes will be used in the questionnaire survey to explore the causes according to medium and small-sized construction companies in Egypt.

Table 1. Causes of variation orders in developing countries

Causes of Variation orders	Eigbe (2016)	Gokulkarthi (2015)	Adu and Opawole (2019)	Alnuami et al (2010)	Mohammad et al (2017)	Hassan et al (2020)	Mohammad and Hamzah (2019)	Saki and Yeom (2022)
Changes in specifications	√		√		√			
Lack of references from previous projects				√				
Changes in the scope of work	√	√	√		√		√	
Changes in the design	√			√				√
Poor communication								√
Conflict regarding contract documents							√	
Design errors	√		√			√		
Changes in materials	√				√			
Omissions in the design			√			√		
Lack of specific material in the market	√	√		√				
Financial limitations of the owner	√		√			√	√	√
Weather conditions	√							
Additional work requested by the client				√				
Not involving all parties in the design		√						
Changes in site conditions								√
Unclear scope of work			√					
Contractors desire to gain more profits						√		
Late approval								√

Many studies explored the causes of variation orders in construction projects. (Eigbe, 2016) presented the causes of this problem

in the construction industry in Nigeria. The study depended on a questionnaire survey with multiple members working in the construction

sector to determine the causes and effects of variation orders. The participants in the survey were contractors, and designers that had more than 10 years of total experience in this field. The findings demonstrated that most construction companies neglect the involvement of any methods that are used to prevent variations in the project. Two main parties were responsible for most variation orders in projects, which were consultants and owners. Moreover, some of the significant causes of this problem were unclear specifications, changes in the scope of work, changes in the design by the consultant, design errors, changes in materials, lack of specific materials in the market, financial limitations, improper procurement procedure, and weather conditions.

(Gokulkarthi, 2015) determined some of the issues that are encountered in the project which may result in having variation orders. A questionnaire survey was adopted to discover these findings. Some of the concerning factors were consistent changes in the project's plans, followed by not involving all parties in the design and use of materials that were not available in the market. Finally, contractors were mentioned to be the critical source of changes in construction projects according to this study. (Adu and Opawole, 2019) concentrated on the perception of stakeholders mainly in the southern part of Nigeria. The study explored the causes and effects of change orders, and the data was gathered through a questionnaire survey with 117 contractors, 138 clients, and 93 consultants. Results revealed that the top concerning factors were changing the scope of work, omission, and error in the design, changes in specifications, financial difficulties of clients, and improper project objectives. The conclusion confirmed the similarities of perspectives of contractors, clients, and consultants regarding the potential causes of variation orders in construction works. The study recommended adequate scheduling of activities to prevent issues in the project that might impact the quality, cost, and time.

(Tunde et al., 2015) explored the causes of variation orders in the Nigerian construction industry. The research was more concerned with variations that have a direct impact on the project's cost and time. The findings of this study showed that the top factors were critical impacts of variation orders on the project, these factors are the increase in the total cost of the project, cash flow problems, decrease in contractor's profits, degradation of quality, and delay in logistics. The study stressed that changes in the project would usually result in delays, and cost overruns, and can even result in the total abandonment of the project. On the other hand, (Alnuami et al., 2010) explored the main causes and impacts of having a change order in the Omani construction sector, especially in public projects. The results have shown that the main concerns were the lack of references from previous projects, additional work requested by clients, changes in the project's design, and lack of materials to be used in the project.

(Mohammad et al., 2017) explored the potential sources and impacts of variation orders in terrace housing projects in Malaysia. The data was gathered using observations and document analysis from 61 previous housing projects. The findings revealed the top causes to be changes in the scope of work by the owner, adjustments in materials, changing specifications of work by the owner, and changes in the design by the consultant. On the other hand, the effects of variation orders were mainly time and cost overruns. The study concluded with the fact that the owner was the main party responsible for most change orders. Furthermore, (Hassan et al., 2020) investigated the same problem but in Kurdistan.

The data was obtained using a questionnaire survey with 223 participants and statistical variables were derived from the collected information. The researcher also analyzed 40 construction projects between 2007 and 2013 to estimate the impact of variation orders on time and cost overruns. The top-ranked factors were the financial problems of the owner, the use of the same designs in different regions, omissions and errors in the design, and contractors' desire to gain more profits.

(Mohammad and Hamzah, 2019) reviewed the roots of variation orders in Malaysia specifically in terraced housing projects. The extensive literature review focused on studies conducted in Malaysia and other countries. The most common causes were changes in the scope of work, owner financial issues, changes in the design by the consultant, and conflicts regarding contract documents. The study also mentioned that the owner was the main party responsible for most variation orders. (Saki and Yeom, 2022) identified the reasons for variation orders in Tanzania and focused on road infrastructure projects. Data was obtained through a questionnaire survey and the relative importance index (RII) was used to analyze the data. The most critical situations that resulted in variation orders were poor communication, financial issues, lack of equipment, weather conditions, approval delays, differing site situations, improper coordination, and design changes.

(Ezeldin and El Sarag, 2018) focused on determining the causes of variation orders in the construction sector in Egypt and its time and cost impact. 19 causes of variation orders were gathered using a literature review and then evaluated their probability of occurrence, time impact, and cost impact using a questionnaire survey. The survey participants encompassed 87 contractors, clients, and consultants. A database encompassing 42 variation order scenarios was introduced to help project managers estimate the occurrence of variations to account for them in their budget.

(Balbaa et al., 2019) explored the roots of variation orders of residential projects in Egypt. A well-structured survey was distributed among 250 contractors, project managers, consultants, and clients, but only 153 surveys were received. The top-ranked causes of variation orders in residential projects in Egypt were changes in economic status, poor coordination between parties, and contractors' financial troubles. (Elshaboury et al., 2020) discussed the same context to rank the most significant causes of variation orders in the Egyptian construction industry. The perception of owners, contractors, and consultants about the causes of variation orders was obtained using a questionnaire survey. Findings showed the key parameters causing variation orders in Egypt including delay in the completion of projects, and changes in economic status.

3. Methodology

The methodology of this research was based on using quantitative data to understand the basic causes of variation orders. The main tool used for data collection was a questionnaire survey with experts working in the Egyptian construction industry; 62 participants from 18 construction companies were invited to take part in the study, 51 of them accepted the invitation and the rest declined. Companies were selected according to their number of employees. All of them were classified to be small and medium-sized construction companies.

The tool adopted for data analysis was the relative importance index (RII). A numerical analysis was conducted using the RII method as shown in (Equation 1). The paramount motive behind selecting this tool was mainly due to its efficiency in ranking factors and pointing out the most critical causes of variation orders (Saki and Yeom, 2022). The job descriptions of the respondents varied between multiple titles. Around 60% of them were engineers (site and office), 32% were managers (construction and project managers), and the remaining 8% included supervisors and site inspectors. The knowledge and experience of respondents in the Egyptian construction sector was one of the essential demands. All respondents had at least five years of total experience in this field. All questions in the survey were essential and participants were aware of the content and the topic. The analysis showed that around 43.7% had at least ten years of experience, 33.2% had between five to seven years of experience, and 23.1% had five years of experience. Each participant had to evaluate the factors according to their impact which can range from 1 to 5 according to the severity.

(Equation 1): Relative importance index (RII)

$$RII = \frac{\sum W}{A * N} \quad (1)$$

Where:

RII: relative importance index

N: overall number of responses

W: weight chosen for each factor ranging between 1 to 5 (5 is extremely significant cause of variation orders and 1 is no cause of a variation order).

A: is the highest score used in the equation (5 in this case)

4. Results

This section introduced the results of the data collection which concentrated on estimating the major factors that lead to variation orders in the construction sector in Egypt. The weight ranges from 1 until 5 where 1 means the lowest rate of occurrence of this cause of variation orders, and 5 means the highest rate of occurrence of variation orders. Each participant was provided a thorough introduction about the questionnaire survey and their role in the study. The following sections present the relative importance index for the causes of variation orders in the construction sector in Egypt.

4.1 Causes of variation orders

Each respondent selected a certain weight for every cause of the variation orders. The total weight was calculated for all causes before estimating the RII. (Table 2) shows the collected sum of weight from the questionnaire survey and the RII of each cause of variation orders.

Table 2. The relative importance index for the causes of variation order

Cause of variation orders	Sum of W	N	A	RII
Changes in specifications	187	51	5	0.733
Lack of references from previous projects	145	51	5	0.369
Changes in the scope of work	191	51	5	0.749
Changes in the design	195	51	5	0.765
Poor communication	204	51	5	0.8
Conflict regarding contract documents	165	51	5	0.647
Design errors	155	51	5	0.608
Changes in materials	186	51	5	0.729
Omissions of work from the design	207	51	5	0.812
Lack of specific material in the market	113	51	5	0.443
Financial limitations of the owner	210	51	5	0.824
Weather conditions	125	51	5	0.49
Additional work requested by the client	208	51	5	0.816
Not involving all parties in the design	188	51	5	0.737
Changes in site conditions	201	51	5	0.788
Unclear scope of work	192	51	5	0.753
Contractor's desire to gain more profits	203	51	5	0.796

The top-ranked causes of variation orders for small and medium-sized construction companies were poor communication, omissions in the design, financial limitations of the owner, additional work requested by the client, and the contractor's desire to gain more profits as shown in (Figure 1).

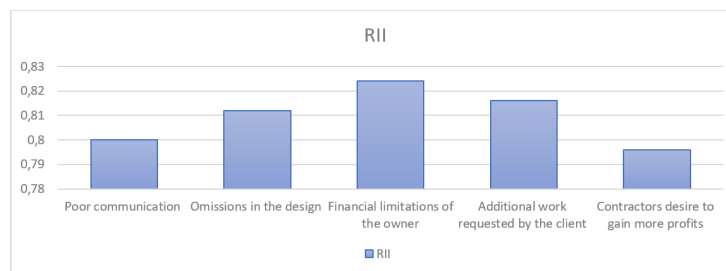


Figure 1. Top causes of variation orders according to small and medium-sized construction companies in Egypt

5. Discussion

The findings of the study revealed the top-ranked causes of variation orders according to participants working with small and medium-sized construction companies were financial limitations of the owner (RII=0.824), additional work requested by the client (RII=0.816), omissions of work from the design (RII=0.812), poor communication (RII=0.8), and contractor's desire to gain more profits (RII=0.796).

The findings of this study are different from the causes of variation orders in other countries. (Eigbe, 2016) focused on the construction sector in Nigeria and indicated that changes in the scope of work, design errors, and changes in the design by the consultant as the top factors in this country. Another study in Nigeria was presented by (Adu and Opawole, 2019) which also showed the causes of variation orders according to the point of view of stakeholders. It revealed alike parameters including changes in the scope of work and omission and error in the design. Furthermore, the construction sector in Oman is comparable to the Egyptian construction sector and shares the same working conditions.

(Alnuami et al., 2010) determined the key roots of variation orders in public projects in this country. The results showed some of the causes that were faced in Egypt such as requesting additional work by the client. The Malaysian construction sector wasn't an exception as changes in the design by the consultant and changing the scope of work were one of the main causes of variation orders.

It is clear from the findings that drawings are the crucial part of the project that might be the source of most variation orders. That could be in the form of either changes in them, or the identification of possible errors that may result in abandoning the original aspects that were agreed with the contractor. Another important factor was requesting additional work by the owner as both companies have ranked this factor to be quite significant. Most of the studies in the literature review were mainly concerned with the construction sector in general, but a very limited number of studies mentioned the possibility of having various causes of variation orders among small and large construction companies. This study showed the significant difference between small and medium-sized construction companies and the causes of variation orders among larger organizations. The financial limitation of the owner is at the top of this list as many clients that are working with small and medium-scale construction companies might be financially vulnerable and result in significant changes in the project. Communication can be one of the vital elements in any construction project. Parties should consider the significance of coordination and communication during all project phases. This can aid in reducing the occurrence of changes and variation orders in construction projects, where the influence of their occurrence may be extremely severe on the project and its performance.

6. Conclusion

The technological advancement and constant improvement in construction methods and practices are increasing the difficulty of construction projects. Therefore, the rate and probability of risks increase in complex and uncertain working environments. Orders became a common feature of construction projects due to the difficulty of completing the project according to the original plan and scope of work. This study focused on determining the potential causes of variation orders in the construction sector in Egypt according to the perspective of small and medium-sized companies.

The reasons for problems in project delivery involve things that affect every step of the process and require the participation of clients, designers, and contractors. Some issues are tied to specific stages, like problems with the design phase. However, other problems, such as poor communication or not enough money, affect the project at every stage. This underscores the need for a comprehensive approach to address both stage-specific obstacles and overarching challenges, ensuring effective coordination and successful project outcomes across all facets of the delivery process.

An adequate understanding of the cause can be key to indicating the proper measures to be taken by construction parties to deal with variations. This paper discussed the potential factors that must be considered in the Egyptian construction industry according to the point of view of experts working for construction companies in Egypt. A key parameter that was well considered was the different perspectives of parties about the problem. All participants must consider the significance of preparing for the project before the construction stage.

Adequate site analysis and investigation can be made after awarding the project. Consultants are advised to revise the drawings and ensure they are aligned with the specifications and requirements of the owner. Moreover, parties should devote additional time to the design stage. Most of the variation orders are in the design, hence, extra care should be given by construction parties to ensure the accuracy and competency of the design. Future studies are recommended to explore the perspective of small and medium-sized construction companies due to their incomparable capabilities with larger companies. The experience and knowledge of managing variations in construction projects vary between organizations. Hence, the causes of variation orders are not the same, and further investigation is required to cover small and medium size companies in many countries.

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