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Construction Project Management: Analysis of the Root Causes of Change in Low-Income Housing Projects in Egypt

Laila M. Khodeir

Assist. Prof. ,Department of Architecture, Faculty of Engineering,
Ain Shams University, Cairo, Egypt
Drlailakhodeir80@gmail.com

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Abstract: Construction projects are vulnerable to unexpected changes that affect their success. However, these changes can seldom be eliminated through applying risk management strategies only. This study aims at accessing the root causes and impact of changes in Construction Projects in Egypt. The emphasis is made on low-income housing projects as a case study that represents a type of construction projects that is exposed to severe changes. To achieve this objective, a literature review was conducted to acquire the important knowledge about change management and a questionnaire was also done. The data collected included three selected projects tackling about twenty five change orders. The status of changes, root causes and the impact of such changes on the major projects constraints were analyzed in accordance with different phases of the projects. For the practitioners, the findings of this study offers an initiative to reduce changes that negatively affect project performance and increase the success of low-income housing projects in general.

Keywords: Construction Project Management, Cost, Schedule, Low-Income Housing Projects, Egypt.

1. Introduction

Though construction projects vary in their types, scale and complexity, they are all commonly accompanied with "changes", (Ming, S, 2013) . The complex and dynamic nature of such projects are the main aspects that urge the emergence of risks, uncertainties and, in turn, changes (Zhao, Z.Y., 2009). Accordingly, changes that occur in most construction projects are inevitable; they can come out at any phase of the project: pre-design, design or implementation phase. Each of these changes is a consequent of different sources and, in turn, engenders a number of considerable impacts (Karim, A., 1999). This research aims at revealing the current status and impact of changes and change management practices that are applied in low-income housing projects in Egypt. Additionally, it investigates the root causes of changes that occur in this projects and their correlation with both cost and time of the projects.

A. The Roots of Change Management Practices

According to the (PMBOK 2008), change management is not considered a separate project management knowledge area, instead it is a practice related to project management profession. The first attempts of understanding the roots of change management was in 1990, when the CII Benchmarking and metrics program published a research report about the impact of project changes on construction cost and schedule at the operation level, (CII 1990) .

The benchmarking in this report provided means to understand the drivers of project change and improve communication among project stakeholders. In 1995, the CII started to include change management practices in its database, which included 14 main elements (CII, 1995). In 2000, Sanders explored the impacts of change management practices on specific types of projects (Sanders, S.T., 2000).

However, in Egypt researches have rarely conducted statistical analysis to reveal the correlation between project management best practices and project performance and how to improve project performance. This study aims at accessing the status and impact of changes and change management practices that are applied in Construction Projects in Egypt. The emphasis is made on major low-income housing projects as a case study that represents a type of projects that is vulnerable to severe changes. Though rectifying changes from the early phases of project design are favored, this could hardly be achieved in case of such projects due to limited budget, public ownership and types of contracting. Construction projects data for this research are derived from both the institute of the development of Upper Egypt and the institute of the development of urban communities, as well as the Ministry of Housing.

B. Definition of Construction Changes

In general, project changes refer to changes that were mutually agreed upon by both the owner and the contractor (Zou, Y., 2008). There have been different attempts to define construction changes, one of which was offered by (Ibbs et al, 2001) who defined change as any sort of addition, deletions or just modifications to the scope of projects (Ibbs, C.W , 2001) Both (Park 2000) and (Arian & Low 2005) gave a more comprehensive definition; they defined changes as the differences or modifications that might occur in work state, processes, methods or contractual agreement from the original construction plan (Park, M,2002), (Arain, F.M.,2005).

C. Root Causes of Construction Changes

According to the construction industry institute (CII), 2007, the root causes of construction changes are either project development changes (PDC), or scope changes (SC), where the PDC represents the changes required to execute the original scope of work or to obtain the original process basis, and the SC refer to changes in the base scope of work or the process basis. (Arian & Low 2005) bounded reasons for such changes to differences in work quality, scope or uncertainties (Arain, F.M, 2005), while (Isaac and Nawon 2008) limited reasons of change to project delay, cost overruns and quality differences (Isaac, S,2008).

D. Impact of Projects Changes

Changes in construction projects have a direct impact on all project constraints including cost, time and scope. Project change cost performance is one of the most essential metrics that are used as a measure of project success (Williams, T. ,2000 and Eden, C., Williams,2005).

The issue of quantifying the impact of change on project performance is not an easy mission regarding the integrated nature of construction operations (Finke, M. , 1998).Nevertheless, there have been a number of attempts in measuring the impact of change. (Nassar, K. M.,2005) and (Serag, E.,, 2010) showed that changes can have significant negative impacts on projects costs, while (Kaming et al, 1997) showed the impact of changes on the schedule of the project and the increased re-work (Kaming, P., 1997). In general, cost and schedule are the biggest concerns in any construction project and are most vulnerable to project changes. Regarding the schedule of the project, change consumes floats on critical paths and, in turn, the total duration of the project changes. On the other hand, changes have significant impact on the overall costs of the project owing to its additive nature (Zou, Y., 2008).

E. The Significance of Efficient Change Management Practices

The implementation of change management in construction projects is crucial. Construction projects that adopt efficient change management practices include lower change costs when compared to their budgets (Zou, Y., 2008). According to construction industry institute, 2003, efficient project change management practices are the most influential element affecting cost savings in the majority of projects (CII, 2003). This practice has become one of the most important practices among other project management practices (Motawa, I., 2007), (Zou, Y.,2008). However, the efficiency of applying change management in construction projects is affected by a number of factors, including the nature of the project, its industrial type, the degree of the project's complexity, the size of the project, the method of contracting and the level of experience of participants (Bon-Gang H., 2011)

Managing changes in an inconsistent way can have many negative effects on construction projects (Motawa, I., 2007), In case changes are not mitigated through efficient methods, they will affect the success of any construction projects.

2. Methodology And Data Presentation

In order to achieve the research objective, the selected research methodology comprised a literature review, an open interview and a questionnaire. A literature review was conducted to acquire the important knowledge on change management practices. The data collected included three selected projects, where the status of changes and root causes were analyzed in accordance with the different phases of the projects. An analysis of the impact of such changes and their equivalent management strategies on the projects constraints, including cost and time in particular was also performed.

A. Data Collection and analysis

The analysis of data was performed on two phases:

Phase one included using a questionnaire to conduct personal interviews with representatives from 10 major Egyptian construction companies working in the construction of low-income housing projects. The objective of this questionnaire was to get their feedback on specific issues, namely:

- Determining Common types of change that occur in low-income construction projects.
- Analyzing and ranking root causes of schedule changes.
- Analyzing and ranking root causes of Cost changes.

The design of the questionnaire was composed of both structured and non-structured types of questions. Structured Questions were answered by numbers from 0 to 4, where 1 = unimportant, 2 = slightly important, 3 = important, 4 = very important and 5 = critical.

Phase two: this phase included open interviews with representatives from the Ministry of Housing, the Institute of Development of Upper Egypt and the Institute of Development of Urban Communities. The objective of such interviews was to provide the basic data about the three major low-income housing projects that were furtherly analyzed in this research. This phase included a complete analysis of the types of changes in each change order and the root causes in each of the discussed case studies. A total number of 30 different change orders were analyzed, 6 changes were excluded because of lack of data about their cost and the rest 24 change were analyzed.

The analysis of each change order included gathering the following data:

- Type of change (classified according to phase 1)
- Root causes of change (classified according to phase 1)
- Cost of change per specific work item.
- Overall cost of change.
- Original cost amount.

Table (1): Sources of change in Construction Projects. Source: Author after (Ibbs, C.W , 2001)and (Hwang, B.G.,2009)

Source of change			
	Project- related (IP)	Organizational – related (IO)	Stakeholder-related (IS)
Internal (I)	Uncertainties (IP1)	Change in management (IO1)	Design errors (IS1)
	Increase of project complexity (IP2)	Lack of efficient communication (IO2)	Omissions (IS2)
	Inaccurate cost estimation (IP3)	Lack of integration between departments (IO3) (Ibbs, C.W , 2001)	Modification of the drawings (IS3)
	Shortage of resources (IP4)		Poor project scope definition (IS4)
	Change of financial status of any party of the project (IP5)		Inadequate pre-project planning (IS5)
			Inadequate project change management (IS6)
			Poor communication among owners, designers and constructors (IS7) (Hwang, B.G.,2009)
External (E)	Natural unpredicted (EP1)	Government intervention (EO1)	Economical and legal (ES1)
	Inclement weather (EP2)	Statutory requirements	Changes in taxes and interest rates.
		Strict rules and regulations (EO2)	Uncertain inflation
			Implementation of new laws (ES2)

The three selected case studies represent a prototype of low-income housing projects that were allocated in different governorates in Egypt. The first project lies in Cairo, (Manshiyat Nassir) and the two other projects lie in Aswan in South Egypt. Although the three projects differ in their scale, they were all intended to house either people living in slum areas (project 1) or homeless people as a result of natural catastrophes (project 2, 3). The analysis of the case studies was based on a number of steps, starting with Identification of change in each project, analyzing type and root causes of changes and finally discussing impact of such changes on both time and cost of each project.

B. Selection of Case Studies

The three selected case studies represent a prototype of low-income housing projects that were allocated in different governorates in Egypt. The first project lies in Cairo, (Manshiyat Nassir) and the two other projects lie in Aswan in South Egypt. Although the three projects differ in their scale, they were all intended to house either people living in slum areas (project 1) or homeless people as a result of natural catastrophes (project 2, 3). The analysis of the case studies was based on a number of steps, starting with Identification of change in each project, analyzing type and root causes of changes and finally discussing impact of such changes on both time and cost of each project.

C. Measurement of Impact of Change

The research relied on two baselines selected to study the impact of the changes in the selected construction projects based on (Zou Yi, 2008) & Construction industry institute 1998) & (Hsieh, T. Y., 2004) as follows:

a. Cost Change Baseline: this is also named the change cost factor. It is represented by the total cost of changes as a fraction of the actual costs and is used to measure performance of project change cost.

b. Time Change Baseline: this is also named the change time factor. It is calculated by comparing the actual time of executing the project relative to the estimated one.

3. The Process Of Change Management

The process of change management seeks to predict the possible changes, identify them and plan for future changes. It comprises four basic steps: identification of change, evaluation of change, implementation of change and the lessons learned or planning for change.

A. Identification of Change

The identification of changes in a project is the initial process in managing changes. The process involves the determination of sources of change, which could either be internal or external (Love, P.E., 2002). Both sources of projects' change include aspects that are project-related, organization-related or stakeholder-related. Table (1) explains the sources of change that are related to each of the previously mentioned aspects.

B. Impact of Project Change

Elaboration of the impact of project change is considered crucial. This process includes determining the degree to which the project will be affected by the detected change. Like risks, change can have both positive and negative effects on the main constraints of the project: cost, scope, time and quality. According to (Ibbs et al, 2001), changes were named after their impact into beneficial changes and determinal changes , (Ibbs, C.W , 2001) Though the beneficial changes are of advantage to the project on the long run and are therefore encouraged, the determinal changes are not favored as they reduce value going to the owner. Table (2) summarizes most of the negative impacts that are caused by changes. It also highlights a number of suggested response actions to each expected change.

Table (2): Negative impacts caused by change in construction projects. Source: Author after (Ming, S, 2013) ,(CII, 1995). (Zou, Y., 2008). (Ibbs, C.W , 2001) and (Arain, F.M, 2005)

Change	Description	Suggested Action
Increase in project cost	Major additions to the original work scope (Arain, F.M, 2005)	Use contingency sum in the contract.
Recruiting new professionals	Occurs in complex technological projects. (CII, 1995). Determining which process is needed to deal with such changes.	Engage specialized professionals to facilitate changes. (Arain, F.M, 2005)
Increase in overheads	This is to ensure that the proposed changes are properly communicated and documented to all stakeholders.	More overhead expenses will be necessary for the legal documentation for agreed changes (Arain, F.M, 2005)
Quality degradation	Includes cutting corner due to frequent changes	Compensate losses without affecting quality.
Decrease in labor productivity	Mostly resulted from working overtime thus deteriorating the productivity of workers (Ming, S, 2013)	
Delay in procurement process	This could be a result of project changes that might acquire new materials or equipment (Arain, F.M, 2005)	
Rework and demolition during construction phase	The most potential effect that can occur (Zou, Y., 2008).	Can be improved by recognizing the impact of rework.
Safety conditions	Health and safety of the workers specially when there is a new equipment or construction method.	
Delay in completion of schedule	The most frequent effect that can occur.	

4. FINDINGS

This part of the paper discusses the main findings extracted from both phases of analysis. The questionnaire was applied on representatives from ten major construction companies and the open interview with representatives from the Ministry of Housing, the Institute of Development of Upper Egypt and the Institute of Development of Urban Communities.

In addition, findings of the analysis of change orders in the three selected low-income housing projects were demonstrated.

A. Phase (1): Findings of Questionnaire

From the analysis of the results of the questionnaire on ten construction companies, the common key changes that manager practitioners agreed upon are presented in table (3).

Table (3): Identification of key changes in low-income housing projects.

Code of Change	Key Change Types[1]
Ch1	**Scope changes (compression of project scope)**
Ch2	**Rework and demolition during construction phase (Addition of project activities)**
Ch3	**Rework and demolition during construction phase (c. replacement of project activities)**
Ch4	**demolition of project elements**
Ch5	**Safety conditions (vandalism and theft of construction equipment)**
	Decrease in labor productivity
Ch6	**Delay in completion of schedule (rephrasing of project)**
Ch7	**Quality degradation**
Ch8	**increase in project cost (unexpected conditions of site, unforeseen soil type…etc)**
Ch9	**Delay in completion of schedule (Regarding site constrains and unforeseen conditions)**

According to the findings of the applied questionnaire, the weighting of the major causes of schedule changes in low-income housing projects is illustrated in figure (1). In addition, the weighting of the major causes of cost changes in low-income housing projects is illustrated in figure (2).

These findings represent a preliminary indicator of the key root causes of schedule and cost changes in low-income housing projects.

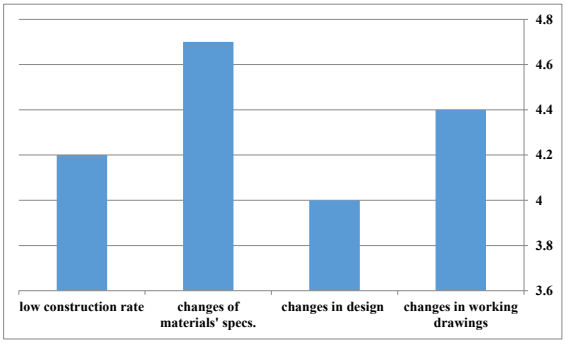

Figure (1): the weighting of the key causes of schedule changes in low-income housing projects

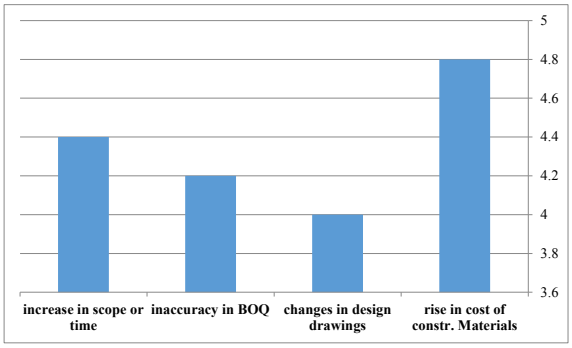

Figure (2): the weighting of the common causes of cost changes in low-income housing projects.

B. Findings of the Interviews and Case Studies

This part of the research highlights the major findings of the interviews that were applied on representatives from the Ministry of Housing, the Institute of Development of Upper Egypt and the Institute of Development of Urban Communities and the analysis of the change orders involved in the three selected case studies. The analysis of the case studies included three main phases: identification of change, impact of change and classification of change.

B.1. Identification of Change in the Case Study Projects

Different changes that occurred throughout the implementation of each of the three case study projects were identified.

This paper suggested a comprehensive coding system for each change order. This system includes the identification of each change based on its type (CH1, CH2…., etc.), its source (internal/external (I/E) and being project-related (Pn), organization-related (On) and stakeholder-related (Sn), where n represents the number of source of change that is extracted from table (1).

Thus, different changes that occurred in case study projects were coded and documented in Table (4). In addition, the change cost factor and change time factor for each type of change in the discussed low-income housing projects were calculated.

Table (4): Summary of the analysis of change in the case studies

s	Code of Change	Change cost factor	Change time factor
1	P1CH1EO1	-16.7%	-16.7%
2	P1CH2IS5	308%	33%
3	P1CH1EP1	55.2%	50%
4	P1CH5IS7	100%	100%
5	P1CH3IS4	10%	100%
6	P1CH6IS5	5%	67%
7	P1CH9IP1	62%	50%
8	P2CH1EO1	52%	67%
9	P2CH2IS7	17%	25%
10	P2CH4IS7	5%	20%
11	P2CH4IO2	29%	33%
12	P2CH2IO3	41%	60%
13	P3CH2IS4	2%	33%
14	P3CH5IP1	60%	67%
15	P3CH7S7	15%	25%
16	P3CH8IS5	23%	50%

With the aid of both change cost factor and change time factor previously calculated, an assessment of the impact of each change on the time and cost of each project was performed. Figures (3), (4) and (5) respectively show the findings of the impact of change in each of the three case studies. It is obvious from figure (3) that two main types of changes occurred in project (1) allocated in Manshiyat Nassir; the first one is rework and demolition during construction (CH2) and the second is lack of safety conditions regarding vandalism and theft of equipment (CH5). The root causes for both types of changes were found to be inadequate pre-project planning, poor project scope definition and poor communication with future inhabitants.

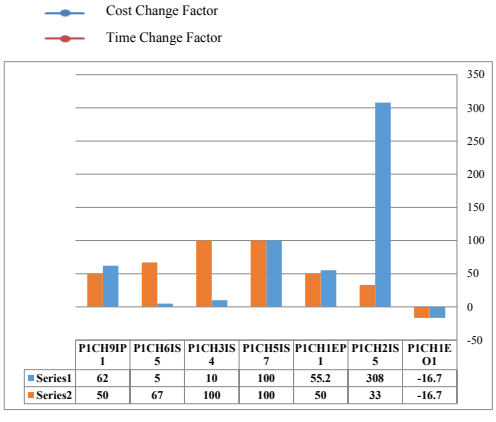

Figure (3): The impact of change on project (1)

From Figure (4), it is obvious that two main types of changes occurred in project (2) allocated in Aswan; the first one is scope changes (CH1), the second is rework and demolition during construction (CH2). The root causes of changes in this project were found to be government intervention, lack of integration between different departments and subcontractors and lack of efficient communication among different stakeholders.

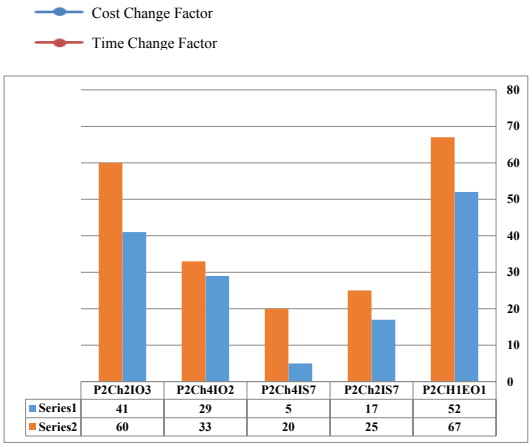

Figure (4): The impact of change on project (2)

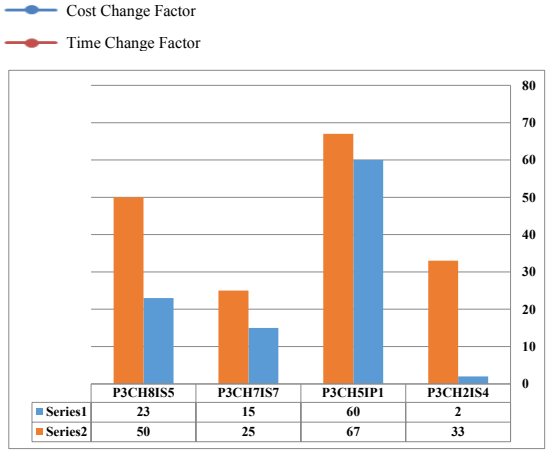

Figure (5): The impact of change on project (3)

In project (3) allocated in Aswan too, the two main types of changes were Safety conditions (CH5) and unexpected site- conditions (CH8). The root causes of changes in this project were uncertainties and inadequate pre-project panning.

The overall impact of change in the three case studies was illustrated in figure (6). The figure ensures that Project (1) was the most subjected to change in both its overall cost and its actual time schedule.

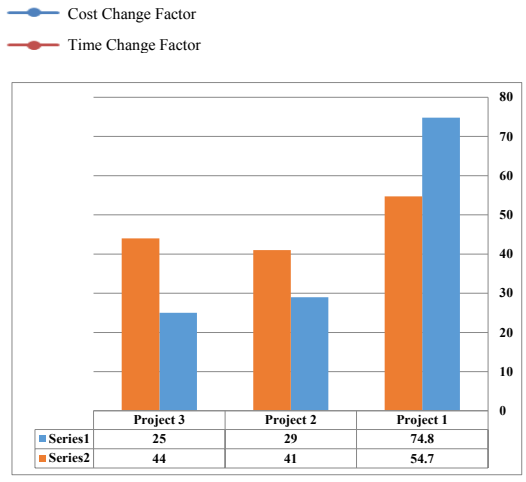

Figure (6): The overall impact of change on the case study project

C. Classification of Detected changes in the case studies

This part of the findings is concerned with the classification of identified changes in the case study low-income housing projects according to a number of factors:

- Rate of occurrence in the case studies.
- Sources/root causes of change.
- Degree of Impact on cost and time constraints.

The classification of detected changes according to their rate of occurrence is clearly shown in figures (7), (8). These indicate the most occurring changes in the case studies.

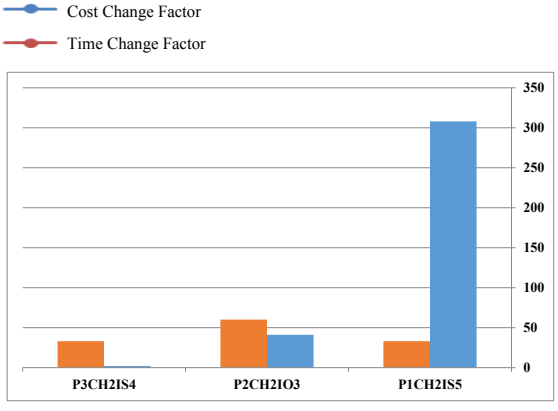

Figure (7): the most occurring changes in case studies

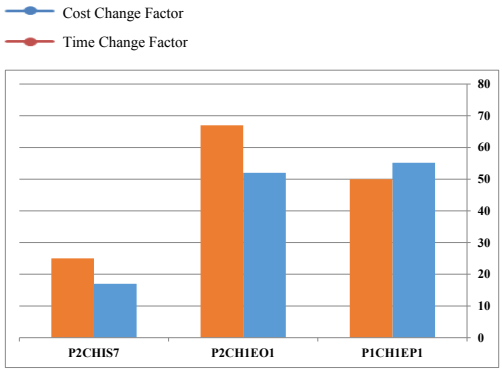

Figure (8): the second most occurring change in all case studies.

The classification of detected changes according to their Sources/root causes of change, whether internal or external, is clearly shown in figures (9), (10). These indicate the most common sources of changes in the case studies.

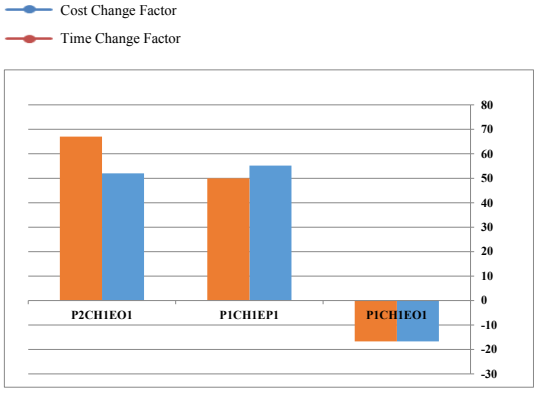

Figure (9): the most common external sources of change

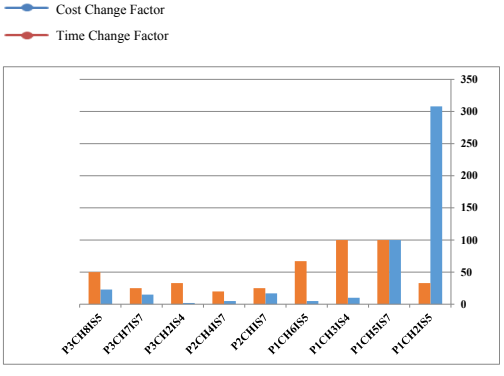

Figure (10): the most common internal sources of change .

The classification of detected changes according to their degree of impact on both cost and time of projects is clearly shown in figures (11), (12) respectively. They indicate the most common sources of changes in the case studies. Figure (13) summarizes the top changes that are most influential in low income housing projects according to their overall impact on both time and cost of the project.

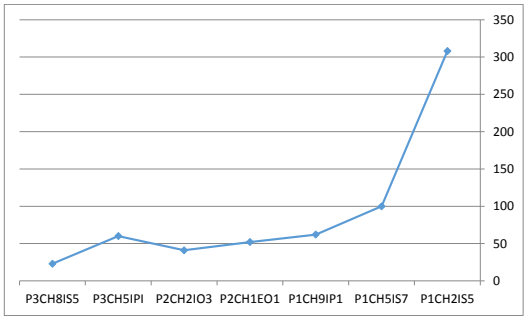

Figure (11): the top changes that have most impact on cost

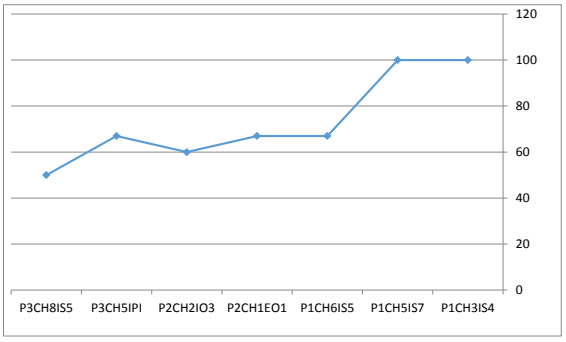

Figure (12): the top changes that have major impact on schedule.

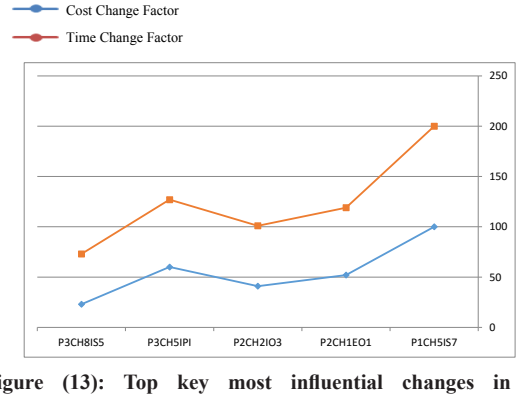

Figure (13): Top key most influential changes in low income housing projects

5. CONCLUSION

Conclusions of this paper are divided into two main sections: 1- Conclusions extracted from phase (1) of the research: questionnaire of practitioners.
2- Conclusions extracted from phase (2): interviews and case study analysis.

According to practitioners working in the field of construction of low-income housing projects, the key changes that have most impact on schedule changes are respectively: changes in the specifications of the finishing materials during construction phase, changes in the final working drawings owing to scope omissions or governmental interventions, low rate of construction as a result of security issues, vandalism or unplanned decisions.

The key changes that have the strongest impact on cost changes are respectively: the rise in cost of construction materials due to changes in inflation rate and other financial issues, the increase of scope of some parts of the projects which induces an increase in time, the changes resulting from inaccurate bill of quantities or in the original designs owing to inaccurate documentation of stakeholders' requirements.

Conclusions extracted from interviews and case studies were performed on three phases:

- Identification of change
- Impact of change
- Classification of change.

Classification of change in low-income housing case studies was performed upon three main factors:

- Rate of occurrence in the case studies.
- Sources/root causes of change.
- Degree of Impact on cost and time of projects.

-The classification of changes in the case studies showed that CH (2), named rework and demolition during construction phase, was the most common change that occurred in all case studies. The second most common change was CH (1), named scope changes.

-The classification of the sources or root causes of change showed that the government intervention (EO1), which is an external source that is organizational-related, forms a major source of change, while project-related (EP1) natural unpredicted sources of change form a minor source. The most common internal sources of change were found to be stakeholder- related sources.

- The classification of detected changes according to their degree of impact on both cost and time of projects ended up with identifying the top key changes. These changes were in order: safety conditions and vandalism, Scope changes, Rework and demolition, unexpected conditions of site, and unforeseen soil type.

The root causes of such changes were mainly internal sources. Internal stakeholder-related sources included poor communication among different stakeholders and inadequate pre-project planning. Internal organizational-related sources included lack of integration between departments and external organizational-related sources included government intervention. Uncertainties represent the only internal source of change that was project-related.

In general, the conclusions extracted from both phases of this study offers an initiative to reduce changes that negatively affect project performance and increase the success of low-income housing projects in Egypt.

This initiative includes eliminating the top root causes of the most occurring changes in such projects according to both practitioners and real case studies analysis. In other words, it means improving communication among stakeholders from the planning phase of the project (communication between planners and end-users) and throughout the implementation phase (communication between contractors, subcontractors and managers). This initiative is thought to be an efficient tool that can help decrease the rework, demolition of parts of the project, and vandalism and theft of equipment

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ادارة مشروعات التشييد: تحليل الاسباب الجوهرية لحدوث تغيرات في محددات مشروعات الاسكان منخفض التكاليف في مصر

ليلى محمد محمد خضير

مدرس العمارة -كلية الهندسة - جامعة عين شمس - جمهورية مصر العربية

Drlailakhodeir80@gmail.com

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ملخص البحث. تتعرض المشروعات الانشائية للعديد من التغييرات غير المتوقعة والتي من شأنها التأثير على مدى نجاح تلك المشروعات. هذا ويصعب التخلص من تلك التغييرات من خلال تطبيق استراتيجيات ادارة المخاطر وحدها. تهدف هذه الورقة البحثية الى تقييم الاسباب الرئيسية لحدوث مثل هذه التغييرات ودرجة تأثيرها على مشروعات التشييد في مصر. وتركز الدراسة على مشروعات اسكان محدودي الدخل كاحد انماط المشروعات الأكثر عرضة لحدوث التغييرات بها. وقد تم استعراض الدراسات السابقة لاستخلاص اهم المعلومات المرتبطة بانماط التغيير في المشروعات الانشائية وطرق ادارة التغيير الى جانب تطبيق اسلوب الاستبيان على مجموعة من الخبراء والمختصين في مجال ادارة المشروعات السكنية. هذا الى جانب تحليل البيانات الخاصة بثلاثة مشروعات لاسكان محدودي الدخل والتي تضمنت حوالى خمسة وعشرون امر تغيير . وقد امكن البحث من تحليل اسباب حدوث التغييرات واثر تلك التغييرات على محددات ادارة المشاريع الخاصة باسكان محدودي الدخل. النتائج التي توصل لها البحث من شأنها مساعدة القائمين على مثل هذه المشروعات على تقليل الاثر السلبى للتغييرات الرئيسية التي تواجه مثل هذه المشروعات مما ينتج عنه تحقيق قدر أكبر من النجاح لتلك المشروعات الحيويه.

الكلمات المفتاحية: ادارة مشروعات التشييد، تكلفة المشروع، الجدول الزمنى للمشروع، مشروعات اسكان محدودي الدخل، جمهورية مصر العربية.