

Evaluating the Selection of Construction Methods used on Building Projects using Performance Objectives

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Abstract

This paper examines the factors affecting the selection of construction methods and materials on building projects. This examination stems from the growing need for accommodation and housing, innovation and the use of new construction methods and modern building materials, to reduce the time required for construction, lowering the cost of construction and improve the quality of construction. Selection of appropriate construction methods for the project is a key determinant of high productivity. But usually, this selection process is executed without an efficient, systematic approach, affecting the productivity of projects. To provide appropriate and suitable solutions, the five most critical factors considered in selecting construction methods in building projects were identified through literature review and verified through an interview process with construction industry experts in five countries in the Middle East namely Iran, United Arab Emirates, Turkey, Egypt, and Qatar. For the purpose of this research, the most common construction methods and materials often found in the six main stages of building projects namely Foundation, Structure Framing, Wall, Roof, Floor, and Façade were selected. The level of usage and criteria for selecting the different construction methods and materials were determined by classifying and analyzing data provided by construction managers of 200 building projects with varying levels of education and experience in the study area i.e. in the Middle East. The results of the data analysis on the degree of usage and criteria for selecting different construction methods and materials demonstrate the significant role and impact of quality and time in the selection of construction methods among other factors. On the other hand, the cost and ease of construction have less impact while the availability of method and skill have the least effect on the selection of construction methods by construction managers of building projects.

Keywords

Building Project, Construction Method, Cost, Ease of Construction, Quality, Time

1. Introduction

One of the biggest problems and challenges in construction of projects building is a low level of productivity and efficiency of projects due to increasing cost and time overrun of projects. Currently, 58% of construction projects exceed scheduled time, and 15 out of 20 exceed their original approved budgets (Wambeke et al. 2011). Construction methods have a large impact on the productivity of construction project, and appropriate selection of construction methods is one of the key factors affecting the productivity of projects since deficient methods can decrease the productivity of projects (Ren et al. 2013).

Currently, the construction industry has been revolutionized and is experiencing massive changes with the rapid growth of technology and introduction of new building materials and modern construction methods resulting in the need for construction managers, as decision makers, to choose from available construction methods.

Choice of construction method could significantly impact on cost, time and quality of buildings (Monghasemia et al. 2015), therefore to achieve project performance objectives, adequate information, and knowledge that will help in making the best decision on proper construction methods is required. This

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research examines the factors affecting the selection of construction methods and materials on building projects. The focus of the study is in the construction of buildings because these are the most common types of construction projects with a wide variety of construction methods.

2. Overview of Construction Methods

The construction method is a technical procedure to transform construction resources (materials, workforce, and equipment) into constructed products (Ferrada and Serpell 2010). Construction planning and management techniques could not get their value if construction methodologies are not selected appropriately and are not the most optimal (Kandil et al. 2010). According to Haidar (2015), the construction methods adopted affects the work activities and the work sequence.

Each construction method has different specifications and aspects. With adequate knowledge and comprehensive data of each process, the most suitable construction method, complementing the objectives and condition of the project, can be selected. Information such as cost, time, quality, ease of construction, availability of method and skill helps construction managers in the selection and use of appropriate construction methods on construction projects (Unaipurwala and Russell 2002). The shorter time, lower cost and higher quality are the primary project objectives considered in the selection of construction methods (Monghasemi et al. 2015). According to Ferrada and Serpell (2014), it is important to evaluate other parameters such as the availability of materials in the market, the supply of skilled workforce, ease of transportation and ease of implementation that causes changes and impact on the project objectives. Selecting suitable construction methods depends on the realization of each method based on the main project objectives and other sub-influential factors which impact on the project objectives. Therefore, in this study, impact and effect of each primary and sub-influential factor on the choice of various construction methods and materials would be based on six common components in all buildings, regardless of the size and type of buildings examined. The six common building components comprise of the Foundation Structure framing; Roofing; Wall; Flooring and Façade.

3. Research Objectives

The primary purpose of this study is to evaluate and classify the various construction methods which are currently used to construct buildings. After that, compare these methods of construction and materials and establish the role and importance of project objectives/sub-influential factor in the selection of construction methods on building projects. Selecting appropriate construction methods based on Performance Objectives is a contemporary topic in construction management science that is progressing and expanding gradually. This technique involves evaluating, classifying and suggesting the most suitable construction method to the project conditions.

4. Research Method

The study made use of a sequential mixed-method research approach. The study employs the following procedure in comprehending the selection of construction methods currently adopted in the Middle East and in determining the relationship between the phenomenon under evaluation:

The first step of this research involves identifying common construction methods and materials which are currently employed on projects in the Middle East. For this, all information of methods that were identified in step one were gathered and classified based on data obtained from construction industry experts.

The influence and significance of each affecting factor in selecting methods in building the project were determined through the data collected using 200 questionnaires completed by construction managers of 200 building projects in five countries namely Iran, United Arab Emirates, Turkey, Egypt and Qatar, with different levels of education and work experience as classified in Table 1 and Table 2.

Table1: Respondents work experience

Work Experience	Percentage
2-5	19%
5-10	35%
10-15	26%
15-20	11%
>20	9%

Table 2: Respondents education level

Education Level	Percentage
Vocational Degree	23%
Bachelor Degree	58%
Postgraduate Degree	19%

Tables 1 and 2 indicate that more than 80% of the respondents have more than five years of work experience in the construction industry, and more than 75% of respondents hold a university degree. The levels of education and work experience the respondent has in the construction sector are of relevance to the study because of the higher the education level and work experience of the respondent the better the credibility and reliability of the information provided via questionnaires which focus on their knowledge of construction management and materials.

5. The Validity and Reliability of Data

The reliability and internal consistency of the influencing factors were tested. For this, the Cronbach's alpha coefficient of each influencing factor and internal consistency ratio of overall influencing factors were calculated. Dependency among the five most influential factors is equal to 0.838, which indicates the high dependency between the five elements. Also, Cronbach's alpha coefficients of each factor were greater than 0.7 which indicates the sufficient reliability of each factor as illustrated in Table 3.

Table 3: Cronbach's alpha coefficient of each affecting factors

Factor	Cronbach's alpha
Cost	0.829
Time	0.783
Quality	0.762
Ease of Construction	0.768
Availability of method and skill	0.868

6. Data Presentation and Analysis

This research evaluates five factors, which affect the selection of construction methods on building projects. The data used in the evaluation was obtained from 200 construction managers working on building projects in the study area. The types of construction methods used distributed by projects and distribution of criteria for selection of each method is shown in Table 4.

Table 4: Distribution of construction methods and criteria for selection in research population projects

Method	No. of Project	Cost	Time	Quality	Ease of Construction	Availability of Method and Skill
Foundation						
Brick Formwork	54	50	40	5	45	25
Wood formwork	22	5	5	5	20	15
Cement Hollow Block (CHB) formwork	18	15	18	10	5	5
Steel formwork	106	85	100	80	50	20
Structure						
Welded steel frame structure	45	30	45	35	30	20
Bolted steel frame structure	56	45	55	40	50	15
Concrete frame structure	88	85	65	80	25	30
Light Steel Frame structure (LSF)	12	5	10	6	11	0
Roofing						
Steel Decking	76	65	75	70	30	25
Reinforced concrete slab (one/two way)	33	0	0	10	5	30
Hollow Core	26	15	25	20	10	5
Polystyrene inter-joist	29	20	25	10	10	5
Double Tee	22	20	15	15	20	5
Cobiax	14	0	10	10	5	0
Wall						
Clay hollow blocks	30	30	5	10	25	10
Cement hollow blocks	6	0	0	0	5	5
Autoclaved Aerated Concrete (AAC) block	58	45	50	55	35	20
Leca block	90	75	65	85	50	35
Silica block	16	10	8	15	9	0
Façade						
Brick façade	21	15	0	10	20	15
Stone façade	56	20	5	55	5	30
Glass façade	18	5	15	15	5	5
Steel façade	24	5	20	20	10	0
Composite façade	81	80	75	60	40	10
Flooring						
Stone flooring	42	10	15	40	15	25
Ceramic flooring	64	30	50	60	30	25
Parquet flooring	16	0	5	15	15	0
Laminate flooring	78	75	75	60	65	20

6.1 Prioritizing of the Influencing Factors Determining the Selection of Construction Methods

The importance and priority of each affecting factor in the different stages of the building projects based on the questionnaire survey results presented in Table 4 are measured and shown in Table 5.

Table 5: Affluence and priority of the affecting factors in the selection of construction methods in each stage of the building projects

Factor	Foundation		Structure		Roofing		Wall		Flooring		Façade	
	Affluence	Priority	Affluence	Priority	Affluence	Priority	Affluence	Priority	Affluence	Priority	Affluence	Priority
Cost	25.7%	2	24.2%	2	21.6%	3	24.7%	2	18.3%	4	23.2%	2
Time	27.0%	1	25.7%	1	27.0%	1	19.8%	3	23.0%	2	21.3%	3
Quality	16.6%	4	23.6%	3	24.3%	2	25.5%	1	27.8%	1	29.6%	1
Ease of Construction	19.9%	3	17.0%	4	14.4%	4	19.2%	4	19.8%	3	14.8%	4
Availability of Method and Skill	10.8%	5	9.5%	5	12.6%	5	10.8%	5	11.1%	5	11.1%	5

Table 6 presents the overall rate and priority of the affecting factors in the selection of construction methods based on the data collected. In the first three stages of Foundation, Structures, and Roofing, the first affected factor is time however in the other three stages, building quality is the most affected factor in the selection of methods. Table 6 al,so shows the influence and priority of each affecting factor on projects.

Table 6: Influence and priority of affecting factors in the Selection of construction methods on projects

Factor	Influence	Priority
Quality	24.5%	1
Time	23.9%	2
Cost	22.9%	3
Ease of construction	17.6%	4
Availability of method and skill	10.9%	5

As shown in Table 6, quality is the most affected factor in the selection of construction methods in building projects, followed by time, cost, and ease of construction and the least affected is the availability of method and skill.

7. Discussion of Finding

The factors affecting the selection of construction methods in building projects are determined by the different impactful factors for each stage of the project as summarized in Table 7.

Table 7: Factors with the most effect on the selection of construction methods in each stage of building projects

Building Stage	Factors with the most effect		Remarks
	1 st	2 nd	
Foundation	Time	Cost	Required to construct faster because all other activities rely on the

			accomplishment of foundation (Critical Activity). Because of the significant cost of the foundation, cost is the most important factor in the selection of construction methods at this stage.
Structure	Time	Cost	Required to construct faster because all other activities rely on the accomplishment of structure (Critical Activity). Because of significant cost of the structure, cost is the most important factor in the selection of construction methods at this stage.
Roofing	Time	Quality	Required to construct faster because some activities rely on the accomplishment of the roof (Critical Activity). The roof is one of the essential structural elements in the building, and also the quality of flooring is dependent on the finishing quality of the roof.
Wall	Quality	Cost	Since the Interior quality of the building directly depends on the quality of walls and due to the quantity of wall structure required in buildings, project cost becomes an important factor at this stage in the selection of construction methods.
Façade	Quality	Cost	The exterior quality of the building is dependent on the quality of facade. As a result of the significant cost of the facade, cost is one of the important factors at this stage when considering the selection of construction methods.
Flooring	Quality	Time	The interior quality of the building depends on the quality of flooring. Variation time between different flooring methods are very broad therefore selecting a method with a shorter duration has a greater advantage.

The results of data analysis establish that the most influencing factor in the selection of construction methods is quality and this is due to the importance of quality to project owners, and therefore quality is the priority of construction managers when selecting building materials and methods. On the other hand, the new generation of building regulations and codes tend to increase the quality of buildings, therefore, choosing poor quality methods and materials could lead to additional cost and time due to failure to meet these building regulations or owners expectations.

The second factor that influences the selection of construction methods is time or duration of construction. Utilizing a process that has a shorter duration has two impacts on the project; first, it reduces the duration of the project and thereby decreasing the cost of the project by reducing the cost of labour and overheads of the project equivalent to amended time.

Furthermore, the study found that the third factor influencing the selection of construction methods is cost. Unlike time, the cost is a single dimension element and choosing the method or material with less cost will not guaranty or improve the other influencing factors. For instance, concrete framed structures, are cheaper than steel framed structures but the construction time is longer, the implementation process is more complicated, and because the method uses more labour in the construction process, this kind of framing structure would increase the cost. Also, the quality of concrete framed structures is lower than steel frame structures.

The fourth important factor influencing the selection of construction methods is the ease of construction. Using methods which are easier to construction will significantly reduce the duration and labour cost of that activity and thereby, reduce the time and cost of the project.

And the factor with the least priority is the availability of methods and skills. The data obtained provides evidence of the adequate supply of all methods and expertise in the construction market of the study area. A close examination of the data collected from questionnaire survey revealed that 83% of the selected methods are preferred because of the influencing factors of time and quality, while only 17% of methods are preferred due to the other three influencing factors.

8. Conclusion

Despite the new equipment and facilities, modern construction methods available in the research territory, a significant number of building projects are found to employ improper and inappropriate methods that do not compliment project objectives. Adopting inappropriate methods increases the cost and duration of projects, as well as decreasing the quality and lifespan of buildings. Therefore, it is necessary to provide a practical solution to solve these problems by examining the significance and priority of factors in the various project stages that influence the selection of construction methods and building materials. Knowledge of the factors affecting the choice of construction methods and building materials to use on construction projects will help engineers and construction managers towards the selection of optimal methods.

Understanding the significance and prioritizing the affecting factors in each stage of construction and selecting the appropriate construction method based on these priorities plays a significant role in achieving the project objectives and enhancing productivity and successful project delivery.

The detailed analysis and results of prioritizing of affecting factors from this research will be used as a platform and benchmark for future studies. Also, this platform will be utilized for evaluating the level of efficiency of buildings and a guideline to increase the effectiveness of the building project by selecting optimum construction methods based on agreed project objectives and targets.

9. Acknowledgement

The financial assistance of the National Research Foundation (NRF) towards this research is hereby acknowledged.

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