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Assessment of life cycle cost of municipal roads projects: A case study from Palestine

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ABSTRACT

The development of urban areas in Palestine is usually linked with the implementation of municipal road projects. The assessment of life cycle costs for municipal roads is presented in this research. This paper aims to highlight the main factors and their impact on the cost overrun during the different life cycle phases of road projects and therefore proposes recommendations that aim at reducing the differences between the estimated and actual costs. A study was conducted across twenty-six municipalities in the various regions of the West Bank. Over the study period of 2016 to 2018, there were 123 implemented road projects within these municipalities, where sixty-three of these projects surpassed their initial cost estimates and encountered cost overrun by an average of 26.9%. Among these, forty-seven projects were deemed suitable for research based on the assessment of the filled questionnaires by these municipalities. The main factors leading to cost overruns include challenging terrain, lack of specialized engineering offices for design and tender preparation, the timing of the tender release, awarding projects solely based on the lowest bids, changes during implementation, and financial constraints. Project cost measures that rely on professional management practices need to be considered in the planning designing, tendering, and implementing phases.

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1. Introduction

The construction industry is a major driver of the national economy in countries around the world. Roads projects are considered of the most important projects within the construction sector in developing countries, including Palestine. Municipal road projects contribute well to this regard and have tangible impacts on the provision of proper infrastructure in urban areas, resulting in considerable economic and social benefits as well as in the improvement of the quality of life. The share of the roads projects funded through the Municipal Development and Lending Fund (MDLF), the major semi-governmental body supporting municipal development in Palestine, reached about 63% of all the funded projects valued about 200 million USD of the third phase of the internationally supported Municipal Development Program, covering the four-year period 2019-2022 [1]. Evaluation of the Life Cycle Cost (LCC) of the road projects and comparing the estimated costs with the actual costs for such projects is crucial for the identification of the factors behind the difference between these costs for such projects. The LCC assessment of projects is a key component of the infrastructure management process and is used extensively to support network- and project-level decisions [2].

The final cost of the project is usually affected by many factors throughout its life cycle. This can be observed from the first phase, which is presented

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by planning and concept development, until reaching construction completion (the final phase). One of the common phenomena in roads projects that can be observed generally in developed, as well as developing countries, including Palestine, is the cost overrun. The expected results of cost overruns usually include delay in project delivery, as well as social, financial, and environmental impacts. Molenaar [3] and Creedy et al. [4] showed that roads infrastructure projects usually suffer from cost overrun. The authors insisted that the cost overrun is an international phenomenon, which affects the relationship between the project stakeholders (owner, contractor, and project manager). A dramatic increasing trend in the cost of roads projects in terms of maintenance, rehabilitation, and construction is noticed [5]. This in turn would make the municipalities and road agencies aware to take proper decisions through practicing good management and adopting correct cost estimation policies. The careful study and investigation of municipal roads projects cost overrun causes will indeed contribute to minimizing the difference between the actual and estimated costs. This could better allocate the required funds and financial resources to the planned projects, and consequently consider more projects for implementation.

Shane et al. [6] stated that it is very crucial to understand the expected factors, which might impact the final cost overrun of the project during its life cycle (planning and design, tendering, and completion). The authors identified two sets of influencing factors, including internal and external factors.A wide range of causes could result in cost and schedule overrun as indicated by Kaliba et al. [7]. For example, the mismatching between the available funds and budget requirements could result in further delays. Accordingly, the resulting impacts are expected to be detrimental to the construction industry, especially in the case of developing countries. Altaf et al. [8] illustrated that an effective way to evaluate the economic sustainability of construction projects is to apply Life Cycle Cost Analysis (LCCA). This method was examined in Malaysia construction projects in terms of implementation, awareness, and promotion factors. The authors proposed several factors that can enhance the implementation of LCCA in the developing countries including Malaysia. On the other hand, Khodeir and El Ghandour [9] suggested a methodology to mitigate and control cost overrun in Egyptian construction residential projects using Value Management (VM). The authors declared that VM method could save about 15-40% of the total project cost.

In this paper, the authors present the outcome of the study of LCC and cost overrun analysis for a sample of municipal roads projects in Palestine that were implemented during 2016-2018 by the municipalities, whether funded from their own sources, the MDLF, governmental funds, or from direct external sources. This is the first research that investigates the extent of the presence of cost overrun and the factors behind that in each of the phases of the LCC for the municipal roads projects in Palestine. Assessment was conducted based a sample of 63 roads projects implemented in 26 municipalities. This was done through detailed inspection of each of the projects during their LCC phases, and proper analysis of the outcome of the research questionnaire. This assisted in drawing proper recommendations that could reduce the cost overrun in municipal roads projects and lessen the associated impacts. The research gap intended to be addressed in this study is highlighted as being the first study in Palestine that targets municipal roads projects, at specific, investigating in depth the factors which cause cost overrun during the projects life cycle phases (planning and design, tendering, and implementation). Previous research conducted on cost overrun in Palestine, as illustrated in the next section, dealt with construction projects or roads projects in general terms.

In the next section of this paper, relevant recent literature on cost overrun for roads projects, especially municipal roads, are reviewed, whether related to developed or developing countries, including Palestine. Section 3 presents research objectives, while Section 4 illustrates the followed research methodology. Data collection is presented in Section 5. This is followed by the analysis and discussion of results in Section 6. Finally, Section 7 presents conclusions and recommendations.

2. Literature Review

This section presents a sample of relevant research concerning the assessment of LCC of roads in terms of cost overrun in roads projects in both developed and developing countries, including Palestine.

2.1. Relevant studies from developed countries

Numerous papers had studies the roads projects LCC and cost overrun phenomena. Many of these had investigated the main factors that led to cost overrun in developed countries. A sample of research findings in these countries is presented hereafter. Williams [10] analyzed cost overrun in transportation projects considering the United States and the United Kingdom. The author declared that the contract size and cost overrun could be correlated by a log linear relationship. Contract elements and size of projects were the main attributes of the inconsistency appearance.

Odeck [11] found that smaller construction projects had more frequent cost overruns occurrence compared with large projects in Norway. The author indicated that cost overrun could be avoided by more management efforts. However, Shane et al. [6] found that the final costs of many projects were larger than the assigned budget in many studies conducted on a wide range of projects. Chan [12] investigated the economic and environmental aspects for Michigan Department of Transportation (MDOT) projects by utilizing the LCCA. Ten highway sections were studied by comparing the actual and estimated costs. The author developed LC assessment model for thirteen MDOT projects to compare environmental impacts of asphalt and concrete pavements. The adopted procedure by MDOT had correctly predicted the pavement type with lower initial costs while comparing actual with estimated costs.

The challenges presented by political and socio-economic influenced and played a major role in the engineering projects cost and complexity. The prediction of the scope of such challenges is usually failed by many owners and municipalities [6]. For example, in the USA, a considerable number of owners faced a real problem concerning the control of project budget and the final project cost along its life span. Shane et al. [6] identified eleven internal and seven external cost overrun causes after conducting interviews with representatives of twenty transportation agencies. Project schedule changes, delivery/procurement approaches, engineering and construction complexities caused by the location or purpose of the project, scope changes, poor estimation, and faulty executions by an owner in managing a project are examples of internal factors that could lead to cost overrun. On the other hand, external factors were identified to include local government concerns and requirements to mitigate the project effects on the local community, effects of inflation, scope creep, market conditions, and unforeseen events and conditions.Creedy et al. [4] declared that there is a poor correlation between projects geographic location and cost overrun by applying regression analysis. Siemiatycki [13] studied large-scale infrastructure projects in Canada through comparing cost overrun and delay. He illustrated that the scale of the projects is directly proportional

with the probability of facing cost overrun and delay. Finally, the author proposed strategic misrepresentations, over-optimism, and technical challenges as the three main causes of cost overrun and delay.

The outcome of the study of Abou Rizk et al. [14] found that the inherent uncertainty that is associated with the municipal projects cost estimate was underestimated, and consequently, serious deviations in terms of overruns or underruns were noticed. To have an acceptable level of budget performance, the overruns and underruns tend to cancel each other. The authors indicated also that inspection on project-by-project basis is expected to help decision makers to accurately estimate budgets during the concept development and preliminary phases. However, the final expected outcome in terms of estimate accuracy should reflect what is achievable.

2.2. Relevant studies from the developing countries

Relevant research from five developing countries is reviewed in this section. The presented studies are extracted from research conducted on projects in Zambia, Ghana, Jordan, South Africa, and Sri Lanka. Kaliba et al. [7] studied Zambia's road construction projects with respect to the cost overrun. They found that the scope of the project could be changed due the the weather conditions (heavy rain and flooding), which was the main cause of cost overrun. Furthermore, technical challenges, local government pressures and the cost of protecting the environment also attributed to cost overrun. Chileshe and Berko [15] presented the reasons for cost overrun in Ghana. They identified several relevant causes, such as social and financial conditions, poor management, and technical difficulties. In addition, the authors identified the most relevant factors causing cost overrun, which include schedule slippage, falling to professionally and completely understand project design plans, delay in payment to contractors, inflation, underestimating project activities cost, and tender documents and design errors.

Mbaabu [16] focused on the elements that affect the construction and implementation of roads projects in Kenya. The author assessed project resource mobilization approaches, project leadership and management, contract documentation, and local politics influence. The results showed that the main factor that affect the construction and implementation of roads projects was the contract documentation. The second and the third factors were resource mobilization approaches and local politics. Finally, the project leadership and management got the last rank. Al-Hazim and Salem [17] studied a sample of projects implemented in Jordan during 2000 to 2008. The authors studied nineteen factors that might cause cost overrun during the construction of roads projects. These identified factors included delay in relocating utilities, difficulties in the work type, difficulties in reaching the work site, land acquisition issues, and the lack of civil services near the work site. Mulenga and Bekker [18] studied cost overrun causes concerning funds allocated for municipal infrastructure projects in South Africa. The authors collected the data using a questionnaire and project documentation. The questionnaire was distributed to 65 experts who represent service providers in the municipal sector. About 69 factors were studied and 21 among them were considered as the most affected. The main causes of cost overrun included inadequate funding, inadequate planning, and discrepancies in the procurement processes and policies. The study recommended practical actions to reduce the cost overrun such as modifications in the construction process and policy, and refinements in project planning. Santoso and Gallage [19] analyzed the factors which affect large construction projects performance in Sri Lanka. The authors explored and discussed the causes, impacts and mitigations of the critical factors. The main significant causes and critical factors were human capacity, lack of technical and management skills, lack of knowledge and understanding of the local context, changes in government policies and political interference.

2.3. Relevant studies from Palestine

In Palestine, the analysis of cost overrun in the road construction industry was investigated in a number of limited studies. Enshassi et al. [20] revealed through his study on the cost overruns in Gaza Strip, Palestine, that this issue was not given the required attention by the three main parties of the project (owners, consultants, and contractors). The authors identified the two main causes of cost and time overruns. They indicated that the first cause was due to the absence of professional monitoring during the construction activities, whereas the second cause reflected the political conditions, considering contractors point of view.

In another study conducted by Enshassi et al. [21], the authors evaluated and studied the causes and factors that could lead to cost overrun in Gaza Strip construction projects, through inspecting a sample composed from thirty-one owners, sixty-six contractors, and twenty-seven consultants. The authors surveyed one hundred and ten and forty-two causes for delay and cost overrun, respectively, and grouped them into twelve main groups. Finally, they indicated that the main causes for cost overruns were contractors' prices, fluctuation of construction materials, inflation, and delays in materials and equipment delivery. Mahamid and Bruland [22] and Mahamid [23] in their investigation on cost deviation in roads projects, which were awarded over the years 2004 to 2008 in Palestine, found that all projects suffered from cost deviation; 76% had cost under-estimates and 24% had cost over-estimates. The authors found that there was an average divergence of 14.6% between estimated and actual cost, with a range from 39.3% to 98%. Moreover, the results of studying road construction projects in the West Bank presented that the under-estimate costs were more popular than over estimate costs nevertheless of the project classification. Dmaidi et al. [24] examined the cost overrun for road construction projects in the West Bank, Palestine. They studied 100 roads projects and developed the statistical relationship between estimated and actual costs. The results showed that the cost deviation was 15.7%, 18.5%, 36.4%, and 12.9% for earth works, asphalt works, furniture works, and base course works, respectively.

Al Hallaq [25] explored the significant factors that cause contractors business failure considering contractors viewpoint in Gaza Strip. The author illustrated five critical groups: economical, organizational, managerial, contractual, as well as financial and political. The author stated that the most critical factors were dealing with suppliers and traders, Israeli attacks, changing funding sources, monopoly, delay in collecting dibs from clients, and lack of resources.Issa et al. [26] stated that during projects planning, bidding, and construction phases, financial and technical challenges were observed in most of the Palestinian municipal and governmental organizations. The authors investigated and assessed the extent of cost changes and delay for a sample of 46 municipal roads projects. The findings indicated that there were limited cost deviations with an average of about 5%. Lack of deterrent measures, contractors delay, and budget underestimation were found to be the main causes for cost deviation.

3. Research Objectives

The paper seeks to explore the reasons and factors associated with the cost

overrun in municipal roads projects. The primary objectives of the paper include:

- To examine and evaluate the prevalence of cost overrun issues in municipal roads projects in the West Bank, Palestine.
- To determine the degree of influence exerted by factors associated with the project life cycle on the occurrence of cost overrun in municipal roads projects.
- To assess the degree of influence of economic, environmental, and social factors on cost overrun in municipal roads projects.
- To investigate the relationship between the influence of factors associated with actions and decisions made throughout various project life cycle phases and factors such as project size, time overrun percentage, external influences, and economic, environmental, and social factors.
- To explore the correlation between the percentage of cost overrun and project life cycle and other potential influencing factors.
- To examine whether there are significant differences in cost overrun for municipal roads projects due to changes in project characteristics, the different project life cycle phases actions and decisions, project size, and municipality classification. More precisely, the following hypotheses are examined and assessed:

  - **HP1:** There is no notable distinction in the percentage of cost overrun based on key project characteristics, such as municipality region, project financier, municipality classification, and contractor classification.

  The alternative hypothesis proposes that there is a notable distinction in the percentage of cost overrun based on key project characteristics. It suggests that at least one of the project characteristics (municipality region, project financier, municipality classification, or contractor classification) significantly influences the percentage of cost overrun.

  - **HP2:** There is no substantial correlation between the influence of factors associated with actions and decisions made during various project life cycle phases and certain key project characteristics, including municipality region, project financier, municipality classification, and contractor classification.

  The alternative hypothesis suggests that there is a substantial correlation between the influence of factors associated with actions and decisions made during various project life cycle phases and certain key project characteristics. It proposes that at least one of the project characteristics (municipality region, project financier, municipality classification, or contractor classification) is significantly correlated with the influence of factors on project actions and decisions.
- To propose recommendations in the different LCC phases in order to reduce the potential of cost overrun in municipal roads projects.

4. Research Methodology

This section illustrates the procedural methodology followed by the authors in order to achieve the objectives of the research. The applied methodology involved gathering data on implemented roads projects from a sample of municipalities in the West Bank, and subsequently analyzing the collected data. The roads projects were studies to examine whether there were cost overruns, and in such case, the factors that could contribute to cost overruns from the perspective of the municipalities' representatives were further investigated.The research methodology flow chart is presented in Fig. 1. The diagram illustrates the successive stages of the research undertaken to fulfill its objectives. This research methodology consists of four primary stages, commencing with the literature review, followed by data collection and then data analysis, and concluding with the presentation of conclusions and recommendations.

The reviewed literature assisted in identifying the potential factors of cost overrun to be investigated for the various phases on the LCC of municipal roads projects. The study sample was identified as a first step towards collection of data. Accordingly, 26 municipalities of the 133 municipalities in West Bank (forming 22% of total) located in all its eleven regions, and representing the three municipal classes (A, B, or C), were identified. In the data collection stage, relevant documents were gathered pertaining to each of the roads projects implemented in the identified municipalities during its LCC. The questionnaire designed to investigate cost overrun and the potential factors pertaining to this phenomena during the projects' LCC phases was sent to these municipalities to gather information on the roads projects they implemented during the study period (2016-2018). The items investigated in the questionnaire are shown later in Tables 6, 7, and 8. The questionnaire was filled by the targeted municipalities' engineers who supervised or managed these projects.

Prior to further analysis of the data, validity and reliability tests were run. Assessing the questionnaire's validity, indicating its appropriateness for meeting the research objectives, involved examining correlation coefficients at a predetermined level of significance. To verify data reliability, Cronbach's Alpha tool was employed.The conducted data analysis incorporated descriptive statistical analysis and quantitative one-way analysis of variance (ANOVA). These methods were employed to scrutinize distinctions among the characteristic variables and questionnaire dimensions, as well as to evaluate the research hypotheses. The descriptive and quantitative analyses were conducted utilizing the Statistical Package for Social Sciences (SPSS) program. Based on the outcome of the analysis, proper recommendations were drawn, which aim to reduce the cost overrun and the associated impacts.

5. Data Collection

As a basic step, a representative sample was selected covering the municipalities in all the West Bank eleven regions (governorates) with different classifications as categorized by the Ministry of Local Government, considering size, financial, and administrative factors.

The sample of 26 municipalities included eight municipalities classified as A, eight as B, and ten as C municipalities. The municipalities' representatives reported that they implemented a total of 123 roads projects during the study period. Of these projects, 63 projects were found to have cost overruns, which therefore were targeted for further study and analysis [27].

For each of the projects that was found to have cost overrun, all relevant information were collected form the respective municipality, including project scope, financier, plans, cost, implementation time, variation orders, etc. Quantitative data were gathered by employing a questionnaire specifically crafted to meet the study's objectives. The researchers implemented a closed question structure in the questionnaire, enabling respondents to provide answers by selecting from a range of options. The respondents were the municipal engineers who followed up the implementation of the projects, whom the MDLF have trained over the years. Among the 63 filled questionnaires for the project that experienced cost overruns, only 47 of these were considered as valid, after assessing the completeness of the answers, which were then used for further statistical analysis.

A three-point Likert scale was utilized to evaluate the factors and circumstances contributing to cost overruns in municipal road projects. The respondent selects only one option that represents the case. The design of the questionnaire takes into account insights derived from a review of pertinent literature and other surveys relevant to the study's investigated topic [27]. The questionnaire, inclusive of general information, encompasses inquiries related to potential factors contributing to cost overrun. These factors are categorized based on the phase of the project life cycle, considering external influences and economic, environmental, and social factors associated with the project. The project LCC phases taken into account consist of the planning and design phase (comprising 10 items), the tendering phase (comprising 11 items), and the implementation phase (comprising 19 items) as presented later in Tables 6, 7, and 8, respectively. Furthermore, the external factors consist of six items, while the economic, environmental, and social factors encompass ten items. The data were then input into the SPSS software to be statistically analyzed to achieve the research objectives and verify the stated hypotheses.

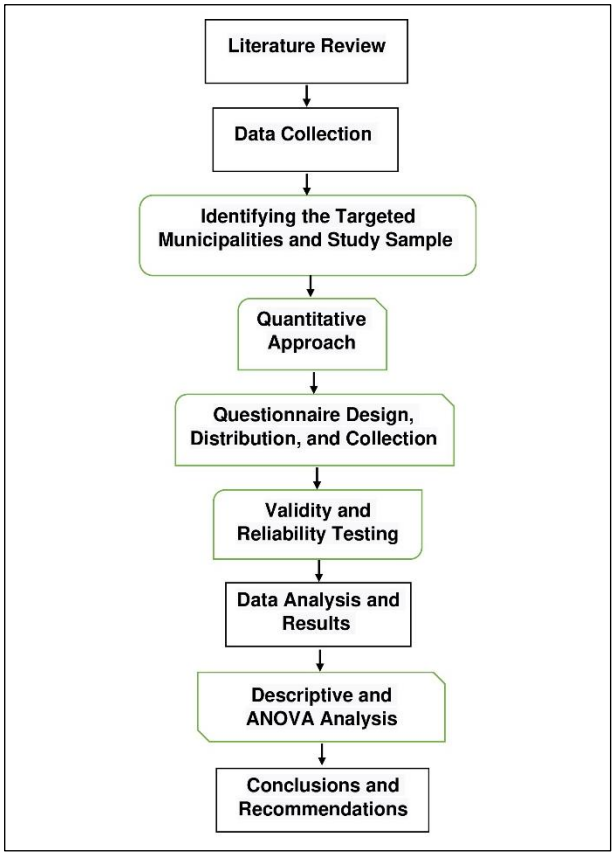


Figure 1. Research methodology flow chart

6. Data analysis and results

6.1. Testing validity and reliability

Before presenting the research data analysis, the outcome of tests concerning the validity of the questionnaire to ensure its suitability for achieving the research purposes and the reliability of the data is presented first.

To assess structural validity, correlation coefficients were determined and evaluated. Table 1 shows the correlation coefficient for each item expressing a potential factor affecting cost overrun with each of the three LCC phases. All coefficients were determined to be significant at a level of 0.05, signifying a strong correlation between each phase and its respective items. Consequently, each of these items can be regarded as representative of the corresponding phase. The sample was analyzed based on a confidence level of 95%, corresponding to a significance level of 0.05. To check the reliability of the data, the researchers utilized Cronbach's Alpha tool. The reliability tool serves as a measure of consistency, indicating that when measurements are repeated with the same respondents, the results would essentially remain consistent. Cronbach's Alpha values range between 0 and +1.0, with higher values indicating a greater degree of internal consistency. As depicted in Table 2, the Cronbach's Alpha values for all phases exceed 0.70. Furthermore, the overall Cronbach's Alpha for the entire study is 0.97, signifying a high level of consistency and, consequently, a high level of reliability for the entire questionnaire.

Table 1. Construct validity correlation coefficients for each phase

Planning & design phase		Tendering phase		Implementation phase			
Item	**Corr. Coff.**	**Item**	**Corr. Coff.**	**Item**	**Corr. Coff.**	**Item**	**Corr. Coff.**
D1	0.865	T1	0.655	I1	0.756	I12	0.808
D2	0.823	T2	0.680	I2	0.807	I13	0.739
D3	0.606	T3	0.863	I3	0.763	I14	0.797
D4	0.812	T4	0.825	I4	0.748	I15	0.716
D5	0.840	T5	0.841	I5	0.781	I16	0.783
D6	0.652	T6	0.840	I6	0.320	I17	0.796
D7	0.823	T7	0.829	I7	0.441	I18	0.671
D8	0.661	T8	0.719	I8	0.521	I19	0.730
D9	0.758	T9	0.812	I9	0.717		
D10	0.638	T1	0.665	I10	0.286		
		T1	0.383	I11	0.613		

Note: Details of each item are found in Tables 6, 7, and 8

Table 2. Reliability statistics

Phase	No. of Items	Cronbach's Alpha
Planning & design phase	10	0.914
Tendering phase	11	0.915
Implementation phase	19	0.933

6.2. Data analysis

Quantitative analysis was conducted on the obtained data. The results are presented in this section. The data were analyzed utilizing the following statistical tools:

1. Descriptive statistics, including mean, standard deviation, and frequencies.
2. Analysis of Variance (ANOVA), which was utilized to examine distinctions among characteristic variables and questionnaire dimensions.

It is important to highlight that a three-point Likert scale was employed in this study, categorizing responses into three main classes. Table 3 presents

the mean value distribution for each corresponding response class, whether categorized as high, moderate, or low. The authors utilized the three-point scale, in contrast to the five-point or seven-point scale, to facilitate interpretation by the respondents and reduce the margin of confusion when they fill the questionnaire.

Table 3. Distribution of mean value for each of the response classes

Mean Range	Response Class
Less than 1.66	Low
1.67- 2.33	Moderate
More than 2.33	High

6.2.1 Characteristics of the sample

The questionnaire revealed the characteristics of municipal road projects, as depicted in Table 4, presenting the frequency and percentage for each variable organized according to the survey categories [27]. The average project cost in the sample is 1,118,959 NIS (considering that, on average during the study period, one NIS currency equals 0.26 USD). The highest project cost within this sample is 18,480,000 NIS, whereas the lowest project cost is 78,000 NIS. The average project size in the sample, measured by road length, is 1,463 meters. The highest project size in this sample is 4,500 meters, and the minimum project size is 300 meters. The average percentage of cost overrun in the 63 projects that experienced cost overrun is 26.9%. The maximum cost overrun percentage within the sample is 139%, and the minimum cost overrun percentage is 1%. The average time overrun percentage is 87.8%. Table 5 summarizes the quantitative project characteristics.

Table 4. Results of analyzing quantitative project characteristics

Variable	Options	Frequency	Percentage %
Municipality region	North region, West Bank	24	51.1
	Central region, West Bank	14	29.8
	South region, West Bank	9	19.1
Project completion year	2016	11	23.4
	2017	18	38.3
	2018	18	38.3
Project financier	Self-funded	14	29.8
	Governmental	29	61.7
	External	4	8.5
Municipality classification	A	18	38.3
	B	14	29.8
	C	15	31.9
Contractor classification	First class	25	53.2
	Second class	21	44.7
	Third class	1	2.1

Table 5. Results of analyzing quantitative project characteristics

Variable	Mean	Std. Dev.	Minimum	Maximum
Project cost (NIS)	1,118,959	2670174	78,000	18,480,000
Project size (m)	1,463	1,051	300	4,500
The percentage of cost overruns (%)	26.9	.274	1	139
The percentage of time overruns (%)	.878	.525	17	185

6.2.2 Analysis results of the factors and impacts of cost overrun

The results of the analysis of the 47 valid filled questionnaires to investigate the factors and the impacts of cost overrun are presented hereafter for each of the three LCC phases.

- **Planning and design phase**

The findings indicate a moderate impact level of factors associated with the planning and design phase on cost overrun, with a mean of 1.88, as depicted in Table 6. The results reveal the prioritized factors in the planning and design phase that influence cost overrun as follows:

- The challenging topography of the project site.
- The organization is responsible for creating the design drawings and tender documents (if differ from a classified engineering office).
- Unreliable cost estimation.

Table 6. Mean and standard deviation measurements for the responses of the study sample regarding factors associated with the planning and design phase

Rank	Item No.	Item	Mean	Std. Dev.	Effect Level
01	D10	The project is situated in an area characterized by rugged terrain with steep slopes	2.00	0.692	M
02	D1	The entity that prepared the design drawings and tender documents (if different than a classified engineering office)	1.96	0.806	M
03	D8	Inaccurate cost estimation	1.96	0.721	M
04	D6	Inadequate soil testing during the soil investigation process for the design phase	1.91	0.747	M
05	D3	The project's level of complexity	1.91	0.747	M
06	D9	Making adjustments to the initial project design after the submission of financial statements by the contractors	1.89	0.814	M
07	D7	Mistakes in project design	1.85	0.780	M
08	D4	The detailed design drawings for the project were insufficiently prepared	1.81	0.798	M
09	D5	Utilizing aerial photos instead of surveying plans prepared by a certified surveying office for preparing design drawings	1.77	0.813	M
10	D2	The design engineer was unqualified	1.74	0.820	M
		All items	**1.88**	**0.58**	**M**

M: Moderate; **L**: Low

- **Tendering phase**

The findings reveal a moderate impact level of factors connected to the tendering phase on cost overrun, with an average of 1.69, as demonstrated in Table 7. The results illustrate that the most important tendering phase factors that affect cost overrun are ranked as follows:

- Lack of attention to the timing of tender release and project commencement, particularly at the onset of the winter season.
- Granting the project to the contractor offering the lowest price, solely relying on the financial proposals of the bidders.
- Impractical project timeline.

Table 7. Mean and standard deviation measurements for the responses of the study sample regarding factors associated with the tendering phase

Rank	Item No.	Item	Mean	Std. Dev.	Effect Level
01	T11	Failure to account for the timing of tender release and project commencement, particularly at the onset of the winter season	2.02	0.675	M
02	T1	Awarding the project to the contractor with the lowest price based solely on the bidders' financial offers	2.00	0.780	M
03	T2	Unreasonable project timeframe	1.85	0.751	M
04	T8	Disregarding the technical assessment of contractors during the selection phase	1.77	0.729	M
05	T10	The designated project timeframe by the donor is inadequate	1.72	0.615	M
06	T6	The contract terms are ambiguous and were not adequately clarified	1.60	0.681	L
07	T4	The client's delay in issuing the notice to proceed	1.60	0.712	L
08	T7	Conflict in the contract documents	1.55	0.746	L
09	T5	The scope of work unclear	1.55	0.686	L
10	T3	Postponement of project initiation by the client	1.51	0.655	L
11	T9	The contractor lacked classification from the National Contractors Classification Committee	1.40	0.648	L
All items			**1.69**	**0.51**	**M**

M: Moderate; **L**: Low

- **Implementation phase**

The results showed that the impact level of the factors related to the implementation phase on cost overrun is moderate with mean of 1.76 as presented in Table 8. The findings demonstrate the prioritized factors within the implementation phase that influence cost overrun as follows:

- Alterations in project activities during the implementation phase.
- Municipal construction of infrastructure works concurrently with project activities.
- Incorporation of infrastructure works in the contract, such as sewer and/or water utilities.

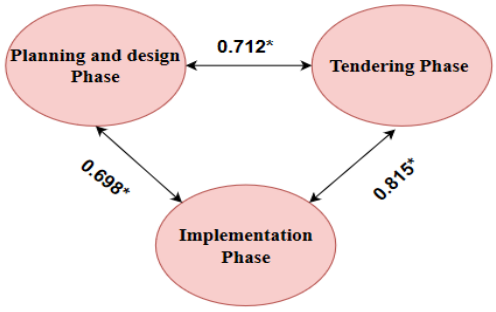
Table 8. Mean and standard deviation measurements for the responses of the study sample regarding factors associated with the implementation phase.

Rank	Item No.	Item	Mean	Std. Dev.	Effect Level
01	I10	Modifications in project activities during the implementation phase	2.23	0.666	M
02	I6	Municipality construction of infrastructure works in conjunction with project activities	2.21	0.657	M
03	I7	Incorporation of infrastructure elements in the contract, such as sewer and/or water utilities	2.00	0.752	M
04	I13	Inadequate qualification of technical staff and workers employed by contractors	1.87	0.741	M
05	I4	The estimated quantities in the Bill of Quantities (BOQ) were inconsistent with the design and tender documents	1.85	0.834	M
06	I18	Failure to adhere to shop drawings and plans by the contractor	1.85	0.751	M
07	I15	Inadequate management of human resources by the contractor	1.83	0.702	M
08	I8	Delayed payments to contractor due to insufficient resources of project owners	1.79	0.832	M
09	I12	The contractor failed to assign an engineer with the necessary years of experience as per the tender documents	1.79	0.778	M
10	I3	The contractor neglected to prepare shop drawings	1.77	0.813	M
11	I2	Absence of an initial survey plan for the existing conditions	1.72	0.772	M
12	I16	Poor coordination and communication on-site among the contractor, supervision, and owner	1.70	0.689	M
13	I19	Closure of borders and shortage of materials in local markets	1.62	0.768	L
14	I11	Alteration of material types during implementation	1.62	0.644	L
15	I14	Inadequate experience in supervision and follow-up	1.57	0.773	L
16	I5	Client's delayed response to contractor correspondences	1.55	0.619	L
17	I17	Strategy for project delivery and procurement system	1.55	0.619	L
18	I9	Delay in responding to test reports and samples submitted by the contractor	1.49	0.655	L
19	I1	Delayed handover of the site by the client.	1.43	0.617	L
All items			**1.76**	**0.49**	**M**

M: Moderate; **L**: Low

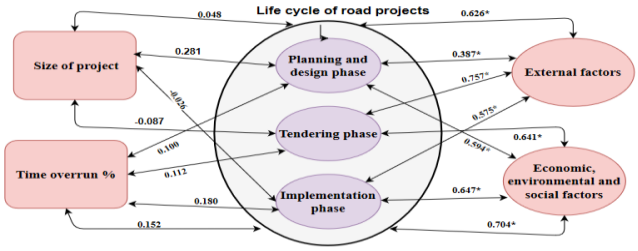
6.2.3 Correlation analysis to evaluate factors influencing the project life cycle and cost overrun

The results of the investigation of correlation factors, aimed at evaluating the relationships between the impact levels of factors associated with actions and decisions made throughout various project life cycle phases. (planning and design phase, tendering phase, and implementation phase), is presented here. Figure 2 depicts a robust association between the impact levels of factors leading to cost overrun in the tendering phase and the implementation phase, with a correlation coefficient of 0.815 at a significant level (α=0.05). This is succeeded by the relationship between the impact levels of factors causing cost overrun in the planning and design phase and the tendering phase, and ultimately the association between the impact levels of factors leading to cost overrun in the planning and design phase and the implementation phase. These results highlight role of the factors that caused cost overrun which are associated with the tendering phase, especially in relation to the implementation phase [27].



* Relation is significant at the level (0.05).

Figure 2. Relations between phases of life cycle



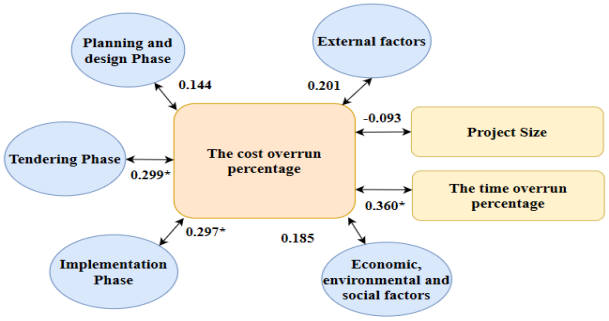
* Significant relation at the (0.05) level

Figure 3. Relation between the roads projects life cycle, economic, environmental, and social factors, external factors, project size, and time overrun percentage.

It is noteworthy to present the correlation between the life cycle of road projects (or its individual phases: planning and design, tendering, and implementation) and the impact levels of economic, environmental, and social factors, external factors, project size, and time overrun percentage, as depicted in Fig. 3. Robust correlations exist between the life cycle of projects and its phases with the impact levels of economic, environmental, and social factors, as well as with external factors, displaying correlation coefficients of 0.704 and 0.626, respectively, at a significant level (α=0.05).

The findings suggest, for instance, that there is a notable correlation between the impact level of external factors and the impact level of factors associated with the tendering phase. This is attributed to external factors, such as constant price fluctuations and unstable political conditions, which led to alterations in prices and specifications of agreed-upon materials, resulting in subsequent increases in project costs. This is similar to the outcome of the studies of Chan [12] and Enshassi et al. [20].

The outcomes of studying the correlation coefficients between the cost overrun percentage and various factors, including project life cycle phase, project size, time overrun percentage, external factors, as well as economic, environmental, and social factors, are presented herein. As shown in Figure 4, the results indicate that there is a significant relationship between cost overrun percentage and time overrun percentage at a significant level (α=0.05) with correlation coefficients of 0.360. Exceeding the planned schedule timeframe results in overhead costs, mistakes, and miscalculations that might happen during execution, which might lead to additional costs. This is similar to the outcome of the studies of Ondari [28] and Kehinde et al. [29]. It is worth mentioning that both studies and our study demonstrate some similarities, such as recognizing the significance of effective planning phases and the economic condition of the country in influencing cost overruns. However, there are also notable differences. For instance, in the study of Ondari, inadequate workmanship was identified as the primary cause of project cost overruns, whereas in our study, external and environmental conditions were found to be the leading contributors to project cost overruns.



* Significant relation at the (0.05) level

Figure 4. Correlation between the percentage of cost overrun and other independent variables.

6.2.4 Analysis results on hypotheses testing

- **Differences in cost overrun percentage due to project characteristics**

To test hypothesis HP1, an ANOVA test was performed to determine if there is a significant difference in the percentage of project cost overrun attributable to key project characteristics.

Regarding the municipality region (north, central, or south region of the West Bank), the findings indicate that there is no significant difference in the project cost overrun percentage based on the municipality region, as evidenced by a P-value of 0.532, which is less than the significance level α=0.05. Similarly, ANOVA test results concerning the municipality classification (A, B, or C), Demonstrating that there is no substantial distinction in the project cost overrun percentage attributed to municipality classification, show that the hypothesis is accepted with P-value 0.783>α=0.05. Hence, the results suggested that both municipality region

and classification do not exert an influence on the cost overrun percentage. This can be elucidated by the uniform adherence of all West Bank municipalities to identical guidelines and regulations, irrespective of their classifications. Moreover, the distinctions among regions, whether in terms of terrain or oversight mechanisms by the regional directorates of the Ministry of Local Government, are deemed negligible. These outcomes align with the findings presented in the study of Creedy's et al. [4].

The findings suggest that there is a significant difference in the project cost overrun percentage based on the project financier (self-funded, governmental, or external), as P-value was 0.000<α=0.05, and therefore, the hypothesis is rejected. The cost overrun percentage in self-financed projects is higher when compared with cost overrun percentage in projects financed by governmental or external sources. This could be explained by poor management, improper planning and design, inaccurate cost estimation, and weak monitoring of the implementation of project activities in self-financed projects. This result is consistent with the findings of Mulenga and Bekker [17] and Abou Rizk et al. [19].

Lastly, the hypothesis testing examines whether there is a significant difference in the project cost overrun percentage based on the contractor classification (first class, second class, or third class), show that the hypothesis is accepted, indicating significant difference as P-value 0.742>α=0.050. The findings are in line with the fact that there are similar regulations concerning the contractors, despite their classification, which is considered only as an administrative tool that identifies the size of projects they can bid for.

Table 9. Summary of hypotheses test results

No	Hypotheses	p-value	Result
HP1	There is no notable distinction in the percentage of cost overrun based on key project characteristics, such as:		
	- municipality region,	0.532	Supported
	- project financier,	0.000	Not supported
	- municipality classification, and	0.783	Supported
	- contractor classification	0.724	Supported
HP2	There is no substantial correlation between the influence of factors associated with actions and decisions made during various project life cycle phases and certain key project characteristics, including:		
	- municipality region,		
	- project financier,	0.156	Supported
	- municipality classification, and	0.038	Not supported
	contractor classification.	0.001	Not supported
		0.499	Supported

- **Differences in project life cycle phases decision impacts with project characteristics**

For hypothesis HP2, testing was performed to assess whether there is a significant difference in the project life cycle phases (planning and design, tendering, and implementation). decision impacts with key project characteristics (municipality region, project financier, municipality classification, and contractors' classification).

The ANOVA results indicate no significant relationship between the impact level of factors related to decisions made during the various project life cycle phases causing cost overrun, based on the municipality region, with P-value 0.156>α=0.05. Similarly, test results show no significant relationship between such impact level of factors made during the different project life cycle phases and the contractor classification, as the hypothesis is accepted (P-value 0.499>α=0.050).

Conversely, the findings reveal a significant relationship between the impact level of factors associated with decisions made during various project life cycle phases causing cost overrun based on the project financier and municipality classification, with P-values of 0.038 and 0.001, respectively, both exceeding α=0.05. The results show that the variations in both the project financier, especially if the project is financed externally, as well as the municipality internal decision-making process that is affected by the staffing and classification of the municipality, influence the impact of the decisions made during the different project life cycle phases that cause cost overrun. A summary of the hypothesis test results is illustrated in Table 9.

7. Conclusions and Recommendations

The study shows that the number of projects exhibiting cost overrun is 63 out of the 123 studied projects, forming 51% of the total, in the sample of 26 municipalities in the West Bank. This indicates that there is a considerable share of projects which suffer from cost overrun.

The study illustrates the relevance of successful management and planning through working with a qualified engineering team for the planning and design of professional projects, in order to obtain proper design as well as accurate cost estimates, thus contributing to the reduction of cost overrun potential. In the tendering phase, the most important factors causing cost overrun include the improper consideration of the time for tender release, especially if works began in the winter season, and whether the project is awarded to the bidder whose price is the lowest without due consideration of contactors capacity and experience. In the implementation phase, the most important factors causing cost overrun include changes in project activities during implementation, municipality construction of infrastructure work in conjunction with project activities, and inclusion of infrastructure activities (such as sewer or water works) on the contract besides road works.

The impact level of the external factors on cost overrun is found to be moderate and the factors are related to economic, environmental, and social aspects. Analysis of the results of hypotheses testing, regarding the differences in cost overrun percentage due to project characteristics, indicated that there is a significant difference in the project cost overrun percentage due to the project financier (self-funded, governmental, external). Analysis of ANOVA showed that there is a significant difference in the impact level of factors causing cost overrun that relate to the decisions made during the project life cycle phases considering the municipality classification. Thus, it can be concluded that the success of any project depends on following a clear and professional approach through all project phases, including proper planning and design resulting in clear and comprehensive tender documents for all work activities, and implementing the project through a financially and technically capable contractor, and well monitored by a qualified supervision team. It is recommended that the municipalities better manage the planning and design phase, either by having a qualified design department to prepare proper design plans and bidding documents or by soliciting design services from qualified professional engineering consulting offices. This is believed to facilitate

having the most feasible design suitable to the nature and size of the project, its level of complexity, as well as to better estimate the project's time and cost. Thus, reducing the potential of cost overrun of projects.

During the tendering phase, it is recommended to manage the timing of the process properly and to consider the technical and financial capacity of the contractors, without awarding the project to the lowest price bidder. Finally, during the implementation phase, it is recommended to avoid changes in orders as much as possible, as these could lead to considerable increases in the project's cost, causing cost overrun. Also, it is recommended to ensure coordination concerning the construction of infrastructure works and the road project and to monitor the project's implementation by a qualified supervision team.

Authors' contribution

All authors contributed equally to the preparation of this article.

Declaration of competing interest

The authors declare no conflicts of interest.

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Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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