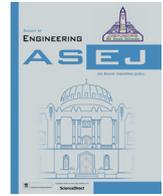




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# Assessment of compliance to planned cost and time for implemented municipal roads projects in Palestine



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## ABSTRACT

The adherence to planned budget and time schedule of engineering construction projects is an important indicator for the successful project planning and implementation. Most of the Palestinian governmental and municipal organizations face technical and financial challenges during the planning, bidding, and execution phases of their projects. The paper investigates and assesses the cost changes and delays for a sample of forty-six municipal road projects that were executed as part of the Municipal Development Program, financed through a multi-donor fund, administered by the Municipal Development and Lending Fund, and followed up by local consultants. It supports small- to medium-sized municipal projects, mainly roads, and has restrictions on budget and time changes. The findings indicate that there are limited cost deviations with an average of about 5% and that about 8% of the projects suffered from unjustified delays. The paper analyzes the reasons behind the noticed cost and/or time deviations, which include the underestimation of the project budget, delay by the contractors, lack of deterrent measures, and addition of new items or making changes in the scope of the project that result in variation orders. Recommended actions are identified, which are expected to contribute to reducing the consequences of the indicated challenges.

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## 1. Introduction

The governmental and municipal construction industry is large, volatile, and requires considerable financing. For developing economies, road construction on the national or municipal level constitutes a major component of the construction industry. A considerable share of the national budgets or international donors support in such economies is spent on infrastructure development and road rehabilitation and construction projects.

The municipal road projects in Palestine can be characterized as small- to medium-sized projects, which are mainly funded by donors, with limited governmental budgets. Since the establishment of the Palestinian National Authority as a result of Oslo

Accords signed in 1993, the economy has been dependent on international support, especially as related to financing the infrastructure, including road projects. For these projects, the delay or cost overrun is too risky, as the continuation of donors support is dependent on the timely and strict adherence to budgets of the executed projects.

The Municipal Development Program (MDP) is multi-phase national program that is designed to contribute to the larger Palestinian National Development Plan goal of strengthening the local governments and making public services more easily accessible by citizens. The main source for funding of the program is through external donors, mainly the World Bank and European countries, while the Palestinian government contribution to the program is about 7% of the total allocated program cost. The program targets all the 134 municipalities and provides them with a combination of technical assistance and annual performance-based grants for priority municipal projects. The MDP is implemented by the Palestinian Municipal Development and Lending Fund (MDLF) [1].

In order to assist the MDLF in the execution of the program, Local Technical Consultants (LTCs) were selected to support the MDLF and assist the municipalities in each of the northern, middle, and southern regions of the West Bank, as well as in Gaza Strip,

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Fig. 1. The distribution of the municipalities in the various governorates.

towards the successful execution of the program. The LTCs were requested to provide technical assistance to the MDLF and the municipalities for implementing, monitoring and reporting on the supported municipalities' projects. In addition, the LTCs responsibilities included providing support for building the capacities of the municipalities' staff on proper procedures to follow up projects both technically and financially [1].

All the road projects supported by the program in the northern region of the West Bank during its second cycle of the second phase, which spanned over the two-year period from 2016 to 2017, are selected for analysis in this study. The scope during this funding cycle of the MDP covered a total number of 35 participating municipalities that had road projects in this region. These municipalities include 16 in Jenin Governorate, 12 in Nablus Governorate, 8 in Tulkarm Governorate, 8 in Qalqilya Governorate, and 2 in Tubas Governorate. Fig. 1 illustrates the distribution of these municipalities on the various Governorates [1].

In this paper, the authors studied and analyzed all the 46 road projects out of the total of 58 projects funded by the program during the stated period in the targeted region. These projects include the rehabilitation and reconstruction of paved roads as well as the construction of new municipal roads. There were two procurement methods used in this program depending on the size of the project expressed by its contract value; National Competitive Bidding (NCB), where the value of the contract is  $\geq$  \$200,000, and shopping

method, where the contract is  $<$  \$200,000. The number of road projects per governorate and according to the method of procurement is illustrated in Table 1.

The contribution of the paper is highlighted in the study of the cost and time overrun of the municipal road projects that are characterized as small- and medium-sized projects with relatively limited budgets. It is important for the municipalities in a developing country like Palestine to ensure that the allocated money for a project is compatible with the cost estimate of the project as well as its designated implementation duration. The timely completion of projects with no extra cost will encourage the donor community to continue supporting the developmental programs.

Previous studies on project cost and/or time overrun in Palestine did not target municipal roads funded projects that are char-

Table 1  
Number of road projects according to governorate and procurement method [1].

Governorate	Shopping	NCB	Total
Jenin	6	10	16
Nablus	6	6	12
Tulkarm	6	2	8
Qalqilia	6	2	8
Tubas	0	2	2
<b>All Governorates</b>	<b>24</b>	<b>22</b>	<b>46</b>

acterized as small- and medium-sized projects with relatively limited budgets. Therefore, the paper adds to the knowledge in the targeted subject in this important sector.

The paper also analyzes the reasons behind the noticed cost and/or time deviations, which were observed in some of the implemented projects, and therefore, recommends actions that could reduce the consequences associated with the challenges of such deviations.

The paper presents first a review of literature, focused on the cost overrun and delay of projects, followed by research objectives. The research methodology is then presented, followed by the data collection process. Next, the collected data are analyzed to determine the extent of cost overrun and the delay in the projects. Finally, conclusions and recommendations are presented.

## 2. Literature review

In this section, a review of relevant literature on the compliance to planned cost and time for implemented road projects is presented. However, before doing that, it is important to state that the construction industry is one of the main driving sectors of the economy in Palestine, contributing to about 26% of the GDP [2]. It also plays a key role in providing public facilities and infrastructure, absorbing a considerable portion of the workforce, and improving the regional and local economy.

Successful completion of construction projects within the specified budget and duration is a challenging task. It is uncommon that a project is completed well within the estimated budget and time, and with desired quality. To overcome that, conditions of contract for construction the Palestinian cabinet has ratified (FIDIC 99) in October 2006 to represent the Palestinian unified conditions of contract for construction. FIDIC (Federation Internationale Des Ingenieurs-Conseils) is the French acronym for International Federation of Consulting Engineers. The General Conditions of Contract (GCC), which are the core of the standard form, consist of twenty chapters that deal with the obligations, rights, responsibilities, and risk allocations of the parties concerning contract price/payment, quality, schedule, and the procedures for claim and dispute resolutions. Construction contract general condition clauses have a major influence on the likelihood and degree of project success.

A number of studies have been conducted to investigate the compliance of the building construction and road projects to planned costs and durations, including assessment of cost overrun and/or delay in time in developed as well as developing countries [3,4]. Before reviewing literature on cost overrun and/or delay related to road projects in a number of developed and developing countries, including Palestine, a brief on worldwide overview is presented first.

Aljohani et al. [5], for example, declared that about 90% of road construction projects around the world experience cost overruns. The authors identified 173 causes of cost overrun with the main potential causes were payment delay for completed work, contractors' financing, frequent design change, poor material management, lack of contractor experience, poor tendering documentation, and poor cost estimations. Flyvbjerg et al. [6] studied cost overrun for 258 transport infrastructure projects in 20 countries. These projects include 167 roads, 33 fixed links (bridges and tunnels), and 58 railways. The projects were distributed in different countries and continents, considering developing and developed countries. The main findings include that 90% of transport projects had cost deviations while the average cost deviation for roads was 20%.

As for road construction projects delay, Karunakaran et al. [7] had investigated this issue worldwide and found that delay was a common global phenomenon in the road construction industry.

The authors reviewed the factors that cause delay in the delivery of road projects. The study involved 92 factors consisting of various construction phases. Based on this review, the top most common and frequently occurred factor that cause delay is poor project planning and scheduling, and that the related percentage calculated based on the frequency analysis was 2.5%.

Although concentration in this paper is on a developing country, Palestine, a review of representative literature in developed countries is presented first. As for cost overrun, Creedy et al. [8] identified the owner risk variables that contributed to significant cost overrun in highway projects in Queensland, Australia. The authors used stepwise multivariate regression analysis to investigate the correlation of the percentage of cost overrun. The authors studied different indicators such as indexed cost, highway project type, project delivery method, and geographic location. The results indicated a correlation between the percentage cost overrun and reciprocal of project budget size.

Catalão et al. [9] analyzed cost overrun by using a dataset of 4,305 public infrastructure projects, of which 3,338 are local projects, carried out in Portugal between 1980 and 2012. The authors studied the exogenous determinants such as political, institutional and governance, and economic-related). An average cost overrun of 19% (nine billion Euros in volume, with about one billion Euros overrun) was identified. They found that central governments incur an average cost overrun of 23% and local governments on 6%. The analysis confirmed that projects developed by local governments tend to perform better regarding cost deviations and overruns and that exogenous determinants have a strong impact on cost deviations and overruns. The authors stated that dealing properly with these factors can improve the decision-making process when launching new infrastructure.

Other studies that investigated cost overrun in road construction projects in developed countries include that of Odeck [10] who studied the Norwegian road construction during 1992–1995. The author investigated the statistical relationship between the estimated and actual costs. The deviation value between estimated and actual costs presented by 7.9% as the mean cost overrun ranging from –59% to +183%.

Shane et al. [11] indicated that approximately 50% of the large transport projects in the USA have overrun their initial budgets. They investigated through an in-depth analysis the factors affecting cost increase factors. The authors revealed 18 primary effects on the cost of most types of construction projects. They investigated that through conducting interviews with more than 20 state transport agencies. These factors behind cost escalation problems included internal factors that are cost escalation factors that can be directly controlled by the project's sponsoring agency/owner, such as underestimation of project costs, delivery/procurement approach, and project schedule changes. External factors behind cost escalation problems defined as those over which the agency/owner has little or no direct control over their impact, were found to include local concerns and requirements typically for mitigation of project impacts on the surrounding community, effects of inflation, and scope changes not controllable by the owner.

Regarding time delay for road projects in developed countries, Ellis and Thomas [12], for example, observed in their study on root causes of delays in highway projects in USA that time overrun in 150 projects averaged 272 days or 25% of contract duration. Hashem et al. [13] identified a set of project factors that might affect the rate of claim occurrence in different projects and used data from Colorado Department of Transportation projects to test the potential causes of claims to assess which project management attributes are most likely to lead to claims. A total of 780 projects were selected from a data set of 1,060 projects completed in a time window from 1997 to 2012. These showed 213 claims within a subset of 62 claim-contained projects. Results showed that delays

are the main cause of claims in the projects studied and are more important than the effects of added items and change orders. The study also showed that projects with fixed completion date schedules are more susceptible to claims than projects with more flexible schedules.

Research on construction projects in developing countries either tackled both cost overrun and time delay together, or each separately. Studies on both issues in a number of countries are reviewed. In Jordan, for example, Al-Hazim et al. [14] investigated the most relevant 20 factors that caused cost and time overrun in about 40 public infrastructure projects in Jordan during the period from 2000 to 2008. Based on the study results, the terrain and weather conditions were the top factors. Johnson and Babu [15] used a mixed-methods approach utilizing interviews and a questionnaire targeting UAE construction professionals to investigate the main causes of poor cost and time performance. The top five causes of cost overrun were summarized as inappropriate procurement method, financial constraints of client, delay in client's decision-making process, poor cost estimation, poor cost estimation, and design variation. Whereas, the top five causes for time overrun were concluded as inaccurate time estimation by the consultants and change orders from clients, delay in obtaining government permits and approvals, unrealistic schedules and completion dates projected by clients, and design variation from client and consultant.

On the other hand, Heravi and Mohammadian [16] conducted a study on cost overruns and delay in municipal construction projects in Iran considering 72 urban road and building projects. This study showed that large municipal construction projects are faced with higher cost overruns and delay. Kassa [17] investigated the causes of cost escalation and time overrun in infrastructure projects in the federal roads in Ethiopia. The author collected the data from clients, contractors, and consultants. Interviews were made with 18 senior engineers, and 73 questionnaires were collected for 25 roads. The results revealed that 88% of the road projects suffered from time overrun and 80% from cost overruns compared with the initially planned. Finally, the author identified the major causes of time and cost overrun for the investigated road construction projects.

Lende and Rathod [18] studied the cost and time overrun of road construction projects in Amravati region in India. The authors used a questionnaire survey in order to find the causes of the cost and time overruns. The main causes for cost overrun included change in cost of services, delay in payment, design changes during construction, change in quantity due to actual site conditions, delay in design and approval of design, delays in shifting existing utilities, and poor communication between government bodies.

Concerning cost overrun in road projects in developing countries, Alhomidan [19] identified the main causes of cost overrun in road projects in Saudi Arabia. The most common severe causes among 41 factors considered in road projects were payment delay, poor delay in decision making, and internal administrative problems. Al-Zarooni and Abdou [20] conducted a study to check variations in the public projects' cost estimates in UAE. The variations between feasibility and contract cost values were ranging between -28.5% and +36%. Such variations might be attributed to that the feasibility studies are normally done before any details are settled.

Sohu et al. [21] identified the main causes of cost overrun and determined the possible mitigation measures considering contractors of highway/road projects in Pakistan. The authors used a mixed mode (quantitative and qualitative) approach. They identified 30 causes of cost overrun from literature. They used SPSS for analyzing the collected data using the average index method. The most relevant causes for cost overrun were found to be inadequate planning, owner's interference, and fluctuation of material prices.

Other studies have been conducted to investigate the factors and causes of delay in developing countries, Aziz and Abdel-Hakam [22] stated that construction delays is a common phenomenon in civil engineering projects in Egypt including roads projects. The authors studied 293 delay causes identified from literature considering different countries, different delay causes, and different periods. The results of the analysis of the questionnaire they distributed to investigate projects delays revealed high correlation of causes and groups between contractors and site/design engineers and between consultants and site design engineers, while a somewhat low correlation between contractors and consultants.

Al-Momani [23] investigated the causes of delays on 130 public projects in Jordan to aid construction managers in establishing adequate evaluation prior to the contract award using quantitative data. The results of this study indicated that the main causes of delay in construction of the projects relate to designers, user changes, weather, site conditions, late deliveries, economic conditions and increase in quantity. On the other hand, Battaineh [24] assessed the progress reports of 28 highway projects and 164 building projects constructed between 1996 and 1999 in Jordan. The author stated that delays were extensive, as the average overrun of actual completion time to the planned contract duration reached 160%.

There are limited studies that have been conducted investigating cost and/or time overruns in Palestine. Enshassi et al. [25] discussed and assessed the factors and causes leading to cost and time overruns in construction projects in Gaza Strip, Palestine. The investigated sample of respondents was composed from 31 owners, 66 contractors, and 27 consultants. The survey included 110 delay and 42 cost overrun causes grouped into 12 major groups. The main four causes of time overrun included material-related factors, strikes and border closures, lack of materials in markets, and delays in materials delivery to the site. In addition, the main three causes for cost overruns included price contractor delays in material and equipment delivery, fluctuations of construction materials, and inflation.

Al Hallaq [26] 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 authors 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.

Mahamid and Bruland [2] in their investigation on cost deviation in road 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 deviation between estimated and actual cost had an average of 14.6%, ranging from 39.3% to 98%. The results showed that cost under-estimates were more common than cost over-estimates in road construction projects implemented in the West Bank regardless of the project category.

Dmaidi et al. [27] performed studies to check the time overrun in road construction projects in the West Bank, Palestine. The main results illustrate that all projects suffered from time overrun. Among them about 70% of the projects suffered from delays that ranged between 10% and 30% of the project duration. The study presented the statistical relationship between the estimated and actual cost of 100 road projects awarded in the region. The main results indicate that the average cost deviation in the checked items was 18.5% for asphalt works, 12.9% for base course works, 36.4% for furniture works, and -15.7% for earthworks.

Mahamid et al. [28] studied the delay overrun causes in road projects in Palestine based on the results of a field survey. The

authors studied the extent of such causes from the consultants' and contractors' perspectives. They identified 52 causes and classified them into eight groups. Interviews were conducted with 30 consultants and 34 contractors. The main five causes of time overruns were found to be segmentation of the West Bank regions, limitations on the movement between areas, awarding projects to bids with lowest prices, shortage of equipment, and progress payments delayed by the owner.

From the above, it can be concluded that the research that investigated the extent and reasons of cost and time overruns of road projects showed that overruns are common phenomena in developed and developing countries alike. Researchers have used various methodologies to examine the existence and magnitude of deviations of the actual cost and time of implemented road projects compared with planned cost and time, as well as in investigating the factors behind such deviations. However, there has been a gap in the research oriented to examine such deviations and the related factors concerning limited-budget small- and medium-sized municipal road projects, which are implemented under strict time and cost control measures set by the client and financiers, especially for developing countries, including Palestine.

### 3. Research objectives

The paper aims to investigate the issues of cost overrun and delay of small- and medium-sized limited budget municipal road projects. The main objectives of the paper are:

- To study and assess the extent of the adherence to planned budgets and timelines of funded municipal road projects at specific.
- To find the significant factors that contribute to cost overrun and cause delay in the construction of municipal road projects.
- To assist the municipalities and the official institutions to better manage the municipal road projects through considering the necessary means to adhere to the projects planned cost and duration.

### 4. Research methodology

The research paradigm considered in this article followed the positivism approach, as it well suits research in construction man-

agement. The research is well associated with the derivation of scientific knowledge from the accumulation of data obtained from observations through a verification a process. On the other hand, a 'mixed method' approach that combines both quantitative and qualitative methods is followed in this research in order to provide a rich understanding of the research problem.

The followed methodology in this research is presented in Fig. 2. The authors performed extensive literature review considering the cost and time overruns for road and infrastructure projects. To investigate the extent of cost and time overruns in municipal road projects, data were collected through contacting the LTC and the MDLF. The collected data were then analyzed by comparing the project's cost estimate with awarded value and calculating the cost deviation, as well as its planned time with actual execution time and calculating the delay. Moreover, the authors reviewed the variation orders (VOs) and assessed their relation with cost and time deviations, if any.

A mixed approach has been adopted by many researchers in construction management. For example, Kassa [17] used this approach focusing on primary data survey conducted through questionnaires and interviews presented physically in the respondents' offices and construction sites. The researcher considered quantitative approaches using a structured questionnaire that was distributed to the project managers and engineers to identify the variables that play an important role in cost and time overrun.

In this research, the authors interviewed technical staff at the MDLF as well as the LTC on implemented municipal road projects in the northern West Bank during 2016–2017, funded by the MDLF. The questions concentrated on the role of the local counterparts, the reasons that led to cost and time overruns in the targeted roads projects, as well as the VOs. Specific information were also gathered and analyzed regarding the actual projects cost and time compared with the estimated values.

As for the method used in quantitative analysis, a number of researchers, such as Heravi and Mohammadian [16], had conducted statistical analysis of collected data. They used regression analysis to estimate the relationship between predicted cost/time and actual cost/time of projects. Moreover, the authors performed class range analysis of cost overruns/delay versus predicted cost/time of projects. Mahamid and Bruland [2] investigated the statistical relationship between actual and estimated cost of road

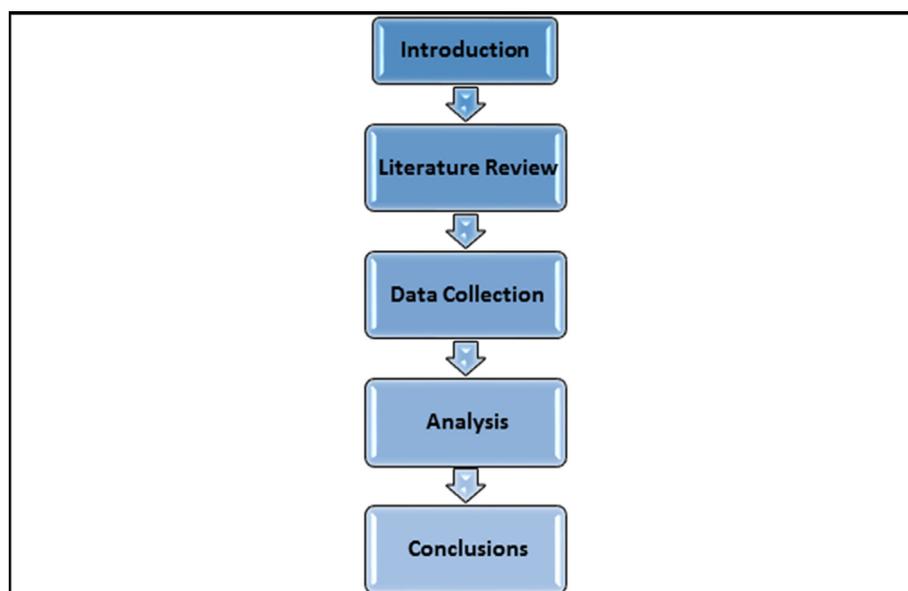


Fig. 2. Research methodology.

construction projects in Palestine, where several linear regression models were developed considering a sample of 169 road construction projects.

In this research, regression analysis was used to investigate the correlation between the actual cost and respective cost estimates as well as the actual and planned project duration. This involved the formulation of mathematical models that depict the relationships among variables, and the use of these modeled relationships for the purpose of statistical inferences. The method of least squares is the efficient method for estimating the regression parameters to minimize the overall discrepancy.

The discrepancies between actual and estimated costs were studied and used to derive the magnitude and direction of the ratio  $\lambda$  of divergence defined as in Equation (1):

$$\lambda = \left( \frac{\kappa - \varepsilon}{\varepsilon} \right) i, i = 1 \dots n \tag{1}$$

where  $\kappa$  is the actual cost and  $\varepsilon$  is the estimated cost.

The same procedure was used to calculate the deviation between the actual and planned project durations.

Finally, proper conclusions and recommendations were addressed in order to be considered in the future by the relevant stakeholders.

### 5. Data collection

The needed data in the selected 46 projects were collected by visiting the LTC office, and conducting interviews with the consultant's engineers who followed up the projects and reviewed all relevant documents. Moreover, the authors interviewed the client's

technical supervisors at the Technical Department at the MDLF in order to obtain the complementary needed data and understand their perspective of projects cost overrun and delay, when happen.

A semi-structured interview style was adopted in this research where questions of interest were shared with the personnel prior to the interview keeping the session open to discuss any questions related to the research problem. The interviewees were fully cooperated interview provided descriptive critical analysis for the research objective. The file for each project was reviewed looking for cost estimates and awarded contracts values, the variation orders, and the delay considering justified and unjustified days exceeding the contract period. The final payment for each road project was also reviewed to check the discount amount in terms of delay and/or incompliance to quality requirements.

Based on the gathered information on the MDP [1], the distribution of the road projects by the allocated money and governorate compared with the remaining other projects is illustrated in Table 2. It shows that road projects form the majority of the projects reaching 81% of total.

### 6. Analysis and discussion

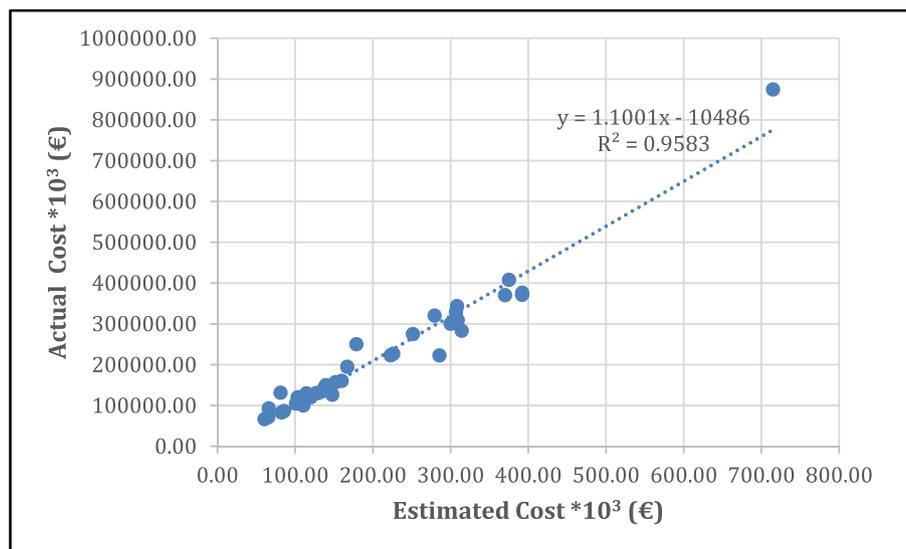
#### 6.1. Comparison of cost estimates and actual costs

In this paper, statistical analysis of cost deviation ( $\lambda$ ) for the collected data for the studied 46 road projects shows that:

- There are 37 out of the 46 projects, forming 80%, which suffer from cost deviation (i.e., actual and estimated costs are not equal). The cost deviation ranges from -22.1% to +61.6%.

**Table 2**  
The distribution of road projects by governorate according to allocated money.

Governorate	Number of road projects	Road projects allocated money (€)	All projects allocated money (€)
Jenin	16	2,794,930	3,198,902
Nablus	12	2,703,547	3,688,140
Tulkarm	8	1,640,487	2,115,453
Qalqilia	8	1,087,746	1,087,746
Tubas	2	537,202	710,970
<b>All Governorates (%)</b>	<b>46</b>	<b>8,763,912</b> <b>81%</b>	<b>10,801,211</b> <b>100%</b>



**Fig. 3.** The actual cost vs. estimated cost in road construction projects.

**Table 3**  
Road projects average cost estimate and actual cost per governorate.

Governorate	Number of road projects	Average estimated cost (€)	Average actual cost (€)	$\lambda$
Jenin	16	174,683	182,483	4.47%
Nablus	12	225,295	231,864	2.92%
Tulkarm	8	205,060	227,727	11.05%
Qalqilya	8	125,913	131,311	4.29%
Tubas	2	268,601	252,994	-5.81%
<b>All Governorates</b>	<b>46</b>	<b>188,910</b>	<b>197,400</b>	<b>4.57%</b>

- There are 26 out of the 37 projects that suffer from cost deviations, forming 70%, have cost underestimation.
- There are 11 out of the 37 projects that suffer from cost deviations, forming 30%, have cost overestimation.
- The average cost deviation in all projects = 4.6% by taking the arithmetic average of cost deviation percentages for all projects.

The deviation between estimated and actual cost had an average of 4.57%. The results showed that cost underestimates were more common than cost overestimates in road construction projects implemented in the West Bank regardless of the project category.

After conducting regression analysis between actual and estimated costs of the studied 46 road construction projects, a linear relation between these two costs can be shown from the graph plotted in Fig. 3, which illustrates the relation between the actual cost (Y) and the estimated cost (X) for the considered road projects. Equation (2) describes the relationship between actual and estimated costs.

$$\text{Actual cost (€)} = 1.10 * \text{Estimated cost (€)} - 10,486 \quad (2)$$

The coefficient of determination  $r^2$  for the equation is 0.96, which means a strong relationship between both costs exists, and, accordingly, the deviation between both costs is minimal. It is worth mentioning here that the cost estimates of projects were prepared depending on market prices and previous awarded contracts, which were later reviewed and amended as needed by the LTC, in coordination with the client (MDLF).

Table 3 shows the projects average estimated cost and awarded price, as well as the cost deviation ( $\lambda$ ), per governorate.

In this research, it was noticed during this cycle that there were some differences between the prepared estimated costs and actual

costs. The reasons behind the gap (plus or minus) were investigated and can be summarized to be related to the following:

- Willingness of many contractors to participate in bids originated by MDLF, as the allocated moneys by the donors are credited to the MDLF accounts and can be requested for payments and usually paid within a short period in contrary to other clients, thus noticing that some of actual costs of a number of projects were lower than the respective estimated costs.
- High competition among contractors, which resulted in having sometimes the actual cost of a project less than its estimated cost.
- Fluctuation of material prices which led to uncertainty in the pricing process.
- The existence of one or several VOs in a number of projects due to problems in design and drawings plans, and in bidding documents, or because the municipality requests new requirements, which in general caused increase in the actual cost compared with the estimated one for these projects.
- Low number of overall bids announced for public projects during the project period, which contributes to the lower awarded prices, compared with the estimated ones.

### 6.2. Comparison of delayed with on-time projects

Unjustified delays were noticed in four projects out of 46. The average delay deviation ( $\lambda$ ) was about 1%. Moreover, the time delay was justified by the municipalities for 14 delayed projects out of the total 46 road projects. Delay penalties were applied only to four projects that are found to have unjustified delays. These results indicate that most of the projects were finished as planned as illustrated in the procurement plans.

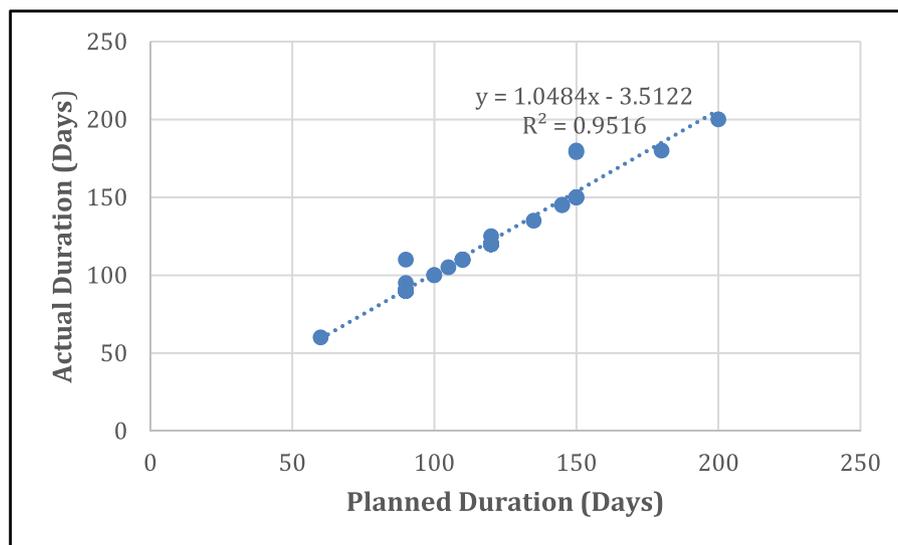


Fig. 4. The actual and the planned duration for all road projects.

Fig. 4 illustrates the relation between the actual duration and the planned duration for the 46 road projects. A linear relation between actual duration (Y) and estimated duration (X) of road construction projects can be noticed. Equation (3) that describes the relationship between actual and planned time is:

$$\text{Actual duration (days)} = 1.048 * \text{Planned Duration (days)} - 3.512 \tag{3}$$

The coefficient of determination  $r^2$  for the equation is 0.95, which indicates the presence of a strong relationship between the actual and planned duration.

Among the justified delay projects, about 70% of the projects suffered from delays that ranged between 10% and 30% of the project duration. However, the percentage of time delay in the unjustified projects ranged from 6% to 22%. Table 4 shows the project average planned and actual durations as well as the time deviation ( $\lambda$ ) per governorate.

The percentages of unjustified delayed projects compared with completed on-time projects were 8% and 92%, respectively, as presented in Fig. 5. However, the reasons behind justified delays were investigated through interviews with the MDLF as well as the LTC, which were found to be as follows:

- In some of the larger projects, the municipalities have infrastructure works within road(s) included in the project. The delay in conducting these works by the municipalities caused delay in the contractor's works as in Qalqilya, Tulkarm, Jenin, Nablus, Qabatia, and Tubas roads projects.

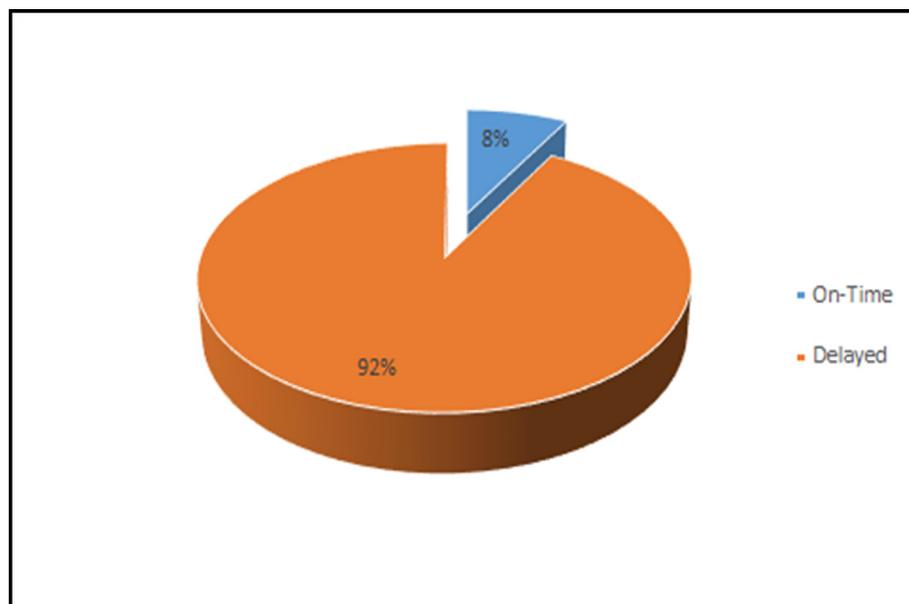
- Delay in identifying the right of way and in removing obstacles by the municipality as in Arraba and Qaffin municipalities.
- The existence of several variation orders in one project due to problems in design plans, drawings, and bidding documents, or because of municipality new requests
- The existence of severe uncommon weather conditions such as storms and heavy rains, etc.
- In general, sometimes the project's estimated original duration was not well-identified.

On the other hand, the reasons behind the unjustified delays were:

- The disability of some contractors in terms of financial and technical aspects.
- Some of the contractors were assessed to be weak and lacking proper managerial skills, thus contributing to unjustified delays.
- Lack of strict deterrent measures taken against the contractors, where a number of municipalities were even making excuses to contractors' delays.
- The delay in NCB projects is usually more than that for shopping ones. The reasons behind that are several qualification documents and requirements should be prepared by the contractor in the NCB case once the project is awarded. The lowest responsive bidder should prepare technical staff, equipment, bank facilitation certificates, turnover certified sheets, completion of similar projects certificates, filling all forms added to the bidding documents, etc.

**Table 4**  
Road projects average planned and actual duration per governorate.

Governorate	Number of road projects	Average planned duration (Days)	Average actual duration (Days)	$\lambda$
Jenin	16	110	113	3.13%
Nablus	12	115	115	0.00%
Tulkarm	8	121	121	0.00%
Qalqilya	8	105	109	4.05%
Tubas	2	120	120	0.00%
<b>All Governorates</b>	<b>46</b>	<b>114</b>	<b>116</b>	<b>1.01%</b>



**Fig. 5.** The percentage of delayed compared with on-time projects.

It is worth to mention here that in case of unjustified delay in performing a project, the followed procedures imply that the MDLF, through the beneficiary municipality, is entitled to terminate the contract and deduct 10% of the remaining non-accomplished works value. Moreover, the unjustified delayed workdays required the application of penalties with a value of 1/1000 of contract per each day of unjustified delayed workdays, with a ceiling of 10%.

### 6.3. Reviewing of variation orders

The VOs were reviewed by the LTC to verify the need for such VOs and the adequacy of these VOs. In addition, the LTC made sure that the municipality has the formal approval of the MDLF before starting implementing the VOs. During the project period, the LTC had reviewed 30 variation orders concerning road projects. The total variation orders value was €427,297, which represented 4.9% of the total allocations. The percentage of VOs usually varies from one project to another depending on contract items. However, the additional time period for the new variation order works was usually ranging from three to four weeks. Finally, it was noticed that the NCB projects usually have more VOs than those in the lower value shopping contracts.

### 6.4. Discussion of relevant issues

Based on interviews with MDLF technical officials and LTC representatives, and considering the results of the review of the files of the projects sample, the following can be stated:

- Care in preparing all bidding documents during planning, design, and tender phase minimizes problems such as cost and time overrun and improves accuracy to the required level.
- Lack of design quality and improper design in some bidding documents prepared by the municipalities, including in design drawings and bill of quantities, contributed to the appearance of such problems. Sometimes local consultants hired by the municipalities to prepare the design contributed to this. For example, the drawings were sometimes not comprehensive nor clear, or the bill of quantities were not precisely described.
- Lack of proper management skills of some of the contractors led to delay in execution.
- Some of the supervisor engineers appointed by the municipalities to follow up the road projects being implemented were not well qualified, as they were sometime incapable of solving site problems due to lack of the required relevant experience. This contributed to delays in some cases.
- In a number of cases, the municipal engineers do not have the required experience and time to follow their projects.
- Additional work requested by the municipalities from the contractors and the variation orders can be identified as the main cause of delay in most of the delayed projects. Additional work need to be bounded and limited to minimize potential delay.
- Finally, some practices of accepting the claims of the contractors to excuse the delays, and not assessing the liquidated damage caused by such delays, could give an impression to the contractors that they might escape from penalties, and thus can cause delays in the projects.

## 7. Conclusions and recommendations

### 7.1. Conclusions

There have been limited cost overruns and delays in the sample studied of funded municipal small- to medium-sized limited bud-

get road projects. The results show a strong relation between the estimated and actual costs as the estimated relevant model illustrates a coefficient of determination of 0.96. Similarly, the results show that there is also a strong relation between the planned and actual durations as the estimated relevant model illustrates a coefficient of determination of 0.95.

It has to be indicated that although about 80% of the projects have different actual costs compared with the estimated costs, the average cost deviation of all projects is only about 5%. On the other hand, only about 8% of the projects suffered from unjustified delays, with an average time deviation in all projects of only about 1%.

The following points illustrate the main research findings that are related to some of the key causes concerning cost overruns and delays:

- During the planning phase, care should be taken by the municipalities in the selection of qualified consultants in order to produce sound design drawings, bills of quantities, and bidding documents.
- During the bidding phase, the criteria of selection of winning bidder should not only consider the financial offer, but also the technical qualifications.
- In some projects, the municipalities have infrastructure works within the roads included in the project. The delay in conducting these works by the municipalities caused delay in the contractor's works.
- It was clearly noted that the necessity for changes whether in the scope of work and/or in the quantities of the projects had a considerable impact on the progress of these projects, and in many occasions caused a significant delay in project implementation.
- It was noticed that some municipalities tolerate the contractors, and they do not emphasize on completion of the projects on time. They sometimes find excuses for the delay of the contractors.

### 7.2. Recommendations

The following points illustrate the main recommendations:

- To exhibit seriousness of the municipalities in dealing with project delays. It is recommended that they must apply delay penalties as legal and contractual tools to ensure that the contractors should bear their responsibilities in order to minimize unjustified delays.
- It is recommended to limit the maximum number of awarded projects per a contractor (for example to be three projects) during the same period by the same client, for example (MDLF in this study), so as they can perform better and could better manage their projects and have limited delays, if any.
- It is recommended that the municipality should hire a qualified engineer for a limited time to supervise its project, as in most cases, there were no dedicated municipality engineers for supervision. The funded agencies are recommended to assign 2–3% of the allocated budget for this purpose and oblige the municipalities to hire site engineers under its supervision, as a number of donors or implementing agencies do.
- To minimize the need for VOs and ensure better design and implementation of roads projects, it is highly recommended to ask the municipalities to conduct geotechnical testing for all the roads included in their projects to ensure better design, as to base design of pavement on the results of such tests. Even in case of what could be visually acceptable soil, a proper laboratory report describing the situation should be accompanying the design documents.

- The need for variation orders in the project may mainly be due to weakness in the original design drawings and corresponding bidding documents, as these are usually prepared by municipal engineers or not classified engineering design offices in road design or even sometimes by surveyors. To overcome this problem, it is recommended to assign a qualified consultant to be funded through the project allocated overall budget to prepare high quality design.
- During the execution phase, the municipalities should select the qualified and well-experienced supervision engineers.
- To ensure the presence of well-experienced technical staff by the contractor with specified proven minimum number of years of experience.
- The municipalities are recommended to implement the infrastructure works in the targeted roads, if needed, before starting the rehabilitation/construction works, and to choose to implement the roads projects away from the rainy season.
- To conduct regular seminars, workshops, and training courses, for all the involved parties (municipalities, contractors, and consultants) on all the factors affecting the three phases of road projects.
- The misunderstanding of all stakeholders of their rights and duties in the project as specified in the FIDIC contributed to the above cost and time overruns problems. Accordingly, it is recommended to train all relevant bodies on the FIDIC to ensure minimizing such problems in the future.

### 7.3. Research objectives summary

In this sub-section, conclusions on whether the research objectives have been achieved are illustrated. This is summarized as follows:

- For the first objective of assessing the extent of the adherence to planned budgets and durations of funded municipal road projects, it is concluded that there have been limited cost overruns and delays in the sample of studied small- to medium-sized municipal limited budget funded road projects. It has to be indicated that although about 80% of the projects have different actual costs compared with the estimated costs, the average cost deviation of all projects is about 5%. On the other hand, only about 8% of the projects suffered from unjustified delays, with the average time deviation of all projects is only about 1%.
- For the second objective of investigating the significant factors behind municipal road projects cost overruns and delays, the research successfully identified such factors. A major generic factor, where other factors can be related to it, is the poor management during the design, bidding or construction phases of the project, which is found to be one of the main causes of cost and time overruns.
- Finally, concerning the third objective of assisting the municipalities and the official institutions in better managing their municipal road projects, the outcome of the analysis of data and interviews resulted in recommendations that are directed to these parties to better manage their projects and eventually assist in reducing cost and time deviations, as illustrated in Section 7.2 above.

### 7.4. Limitations of the study and further research

Despite that the research targeted a gap in research on cost overruns and delays for small- to medium-sized limited budget funded municipal road projects, the following illustrate the limitations of the research:

- The studied projects were financed only by one source of funding, through the MDLF, although it is the major source for municipal projects in Palestine.
- All studied projects are classified as small- to medium-sized projects, where no large-scale projects were investigated.
- All projects were implemented in urban areas, where no projects were implemented in rural areas.
- The studied projects were only for one region of the West Bank, the northern region, where no projects were studied from the two other regions of the West Bank (middle and south), nor from Gaza Strip.

For future work and improvements, the authors recommend to investigate road projects that cover all the project sizes (i.e., to include the large-scale projects), all the areas (including the rural areas), as well as all regions of the West Bank and Gaza Strip in order to be representative of the national level.

It is also recommended to develop a predictable tool that can jointly (simultaneously) consider modeling both cost and time deviations.

### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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