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Evaluation of Implementation of Municipal Roads Maintenance Plans in Palestine:**A Pilot Case Study**

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Abstract

The recent preparation of the Operation and Maintenance (O&M) Manual for Palestinian municipalities is an important step to guide them towards preparing and implementing their O&M priority-based plans, considering scarce resources. During the course of preparation of the Manual, the proposed procedures were applied at ten pilot municipalities. This study aims to explore the outcome of the implementation of the 2014 O&M road maintenance plans at these municipalities. To achieve this, analysis of the outcome of a questionnaire designed to collect relevant information from these municipalities was conducted. The results show that seven of the targeted municipalities used the prioritization criteria proposed in the O&M Manual. Despite that the remaining municipalities had the liberty to slightly change the relative weight of the indicators, sensitivity analysis was conducted and indicated robustness of the indicators. The average percentage of roads lengths of the actually maintained to the planned was 35%, suggesting that the plans were ambitious and need to be more rational. Most of the allocated funds for road maintenance came from the municipalities own budgets, indicating need to have more financing by the government to ensure the integrity of the municipal road infrastructure assets. The results also indicated that 95% of the maintenance works were executed through external contracts, and that the municipalities need to be supported and equipped to conduct the basic road maintenance works.

Keywords: road maintenance plans; maintenance prioritization; municipal roads maintenance; maintenance plans evaluation; Palestine

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1. Introduction

The Palestinian National Authority gradually gained control over major cities in the Palestinian territories since 1994 after the establishment of Palestinian National Authority (PNA). The urban transportation sector was one of the major fields which were given priority in the developmental efforts to remedy the deteriorating urban infrastructure in the Palestinian cities after years of negligence [1].

The current road maintenance practices in Palestine are not based on scientific systematic methods. Most of the municipalities use one criterion to define the maintenance priorities, which is the “worst-first” criterion. Therefore, the current practices in defining roads maintenance plans are not dealing with the known phases that are generally followed, including those in establishing road inventories, road pavement condition survey, overall evaluation of pavement conditions, identification of the proper maintenance and rehabilitation measures, and setting priorities.

The amount and classification of traffic volumes, which directly affect the pavement conditions, are seldom considered in prioritization of maintenance works. Moreover, the social aspects (such as users' satisfaction and the importance of road to community) are not taken into consideration in the current practices.

The responsibilities of road maintenance activities in Palestine are divided between the Ministry of Public Works and Housing (MoPWH), in charge of all the roads outside the municipal boundaries, and the municipalities in charge of all the roads inside their boundaries. The municipalities operate under the guidance and support of the Ministry of Local Government (MoLG).

Based on the above, there has been a need to develop and adopt appropriate methods to assist in the decision-making process related to maintaining and upgrading the pavement structures of the

roadway network in Palestine. The MoLG, and through the Municipal Development and Lending Fund (MDLF), had hired a local consulting engineering firm for the development of Operation and Maintenance Manual for Municipal Roads and Buildings, that could be utilized by all municipalities in the West Bank and Gaza Strip of Palestine. The Manual is considered as the first step in the country in proposing a systematic approach for road maintenance and in identifying a decision-making tool to help the municipalities in creating their operational and maintenance plans, and in prioritizing their annual maintenance activities based on the available budgets. As part of the consultancy, the manual procedures to prepare O&M Plans were applied to ten pilot municipalities, and their comments and feedback on the draft Manual were taken into account.

As Palestine is considered as an emerging country, the success of applying the new O&M Manual required selection of pilot sample composed from ten municipalities in order to check their capabilities in applying the manual before generalizing the new maintenance procedures on all the municipalities. In selecting these municipalities, the MDLF takes into consideration different aspects that cover all municipalities in Palestine such as the location, area, population, extent of existing roads network, and the classification of the municipality, the number of technical staff, etc. It is worth to mention that the ten municipalities form about 7% of the total of 132 municipalities.

The O&M Manual is considered as the reference that guides the municipalities towards the preparation of their O&M Plans in the fields of municipal roads and buildings. The Manual has specified the policies, procedures, scope, responsibilities, legal and mandatory requirements, and included flowcharts, tools, and relevant forms and a damage catalogue [2].

The procedures identified and outlined in the Manual were proposed after a thorough investigation of the regional and international experience in preparing such manuals, and in developing and implementing road maintenance management practices. Examples of investigated experiences and

practices included those in countries such as Jordan [3], Saudi Arabia [4], United Kingdom [5], South Africa [6], the Organization for Economic Co-operation and Development and the World Bank [7], and USA [8]

In the developed O&M Manual for the Palestinian municipalities, regional and an international experience and practice had been considered as indicated before. The criteria adopted for roads maintenance prioritization was composed of five indicators: pavement condition, functional classification of road, average daily traffic, importance of road to community, and citizens' complaints [9]. The weight of each indicator was identified considering the regional and international practices, and the feedback of the MDLF and municipalities' representatives.

In identifying prioritization of maintenance works for a municipal road network, the O&M Manual defined a Priority Index (PI) composed from the five stated indicators with different weights. The dominant indicator in terms of weight is the pavement condition, set to 0.45. Through the literature, the pavement condition ranks also the first in terms of weight among other indicators with range between 0.2 and 0.7. For example, in [10], [11], [12], and [13], the weight of the pavement conditions was 0.2, 0.33, 0.45, and 0.7, respectively. The adopted weight value in Palestine is 0.45 due to the backlog related to road maintenance, which is considered as a vital asset in Palestine. All the targeted municipalities had adopted the stated weight, except one municipality. Each of the remaining indicators has less weight as indicated in the PI equation presented below.

The PI is calculated using the following equation, as defined in the O&M Manual [2]:

$$PI = 0.13 \times F1 + 0.45 \times F2 + 0.12 \times F3 + 0.20 \times F4 + 0.10 \times F5$$

where

F1, F2, F3, F4, and F5 are functional classification of roads, pavement condition, average daily traffic, users' satisfaction, and citizen's complaints.

The consultant's duties had included as well coaching each of the targeted ten municipalities engineering staff on the use of O&M Manual towards the systematic preparation of their annual O&M Plans related to municipal roads and buildings. The consultant team had provided the municipalities' relevant staff with hands-on on-the-job training. The consultant team then conducted frequent field visits to all the pilot municipalities and verified their prepared roads inventories databases, and examined samples of the road condition surveys outputs. In addition, the consultant team discussed with the relevant municipalities' representatives the steps and practical preparations for the development of the O&M Plans, through step-by-step implementation of the procedures of the O&M Manual. Moreover, the municipalities were assisted in the formulation and the final preparations towards the production of their 2014 O&M Plan with all relevant documentation [2].

2. Study objectives

The aim of this paper is to evaluate the application of the recently prepared O&M Manual in the ten pilot Palestinian municipalities in the preparation of the maintenance of roads part of their O&M Plans.

The objectives included assessing the adherence to the adopted criteria for prioritizing maintenance works related to the pavement assets, as well as the level of implementation of the annual plans after one year of their preparation, and the reasons behind lack of adherence, if any. Objectives also included examining the degree of satisfaction of the Municipal Engineers in the procedures followed.

The evaluation of the application of the Manual and preparation of the O&M Plans was conducted after about one year of implementation the pilot project. The prepared 2014 O&M Plan was the target of assessment.

3. Study location

As mentioned before, the MDLF selected ten pilot municipalities for the development and application of the O&M Manual. The ten municipalities are distributed between West Bank (seven municipalities) and three in Gaza Strip (three municipalities), where the locations of these municipalities are illustrated in Figure 1. Table 1 presents basic information on the pilot municipalities, including the population, area, and the lengths of paved roads categorized based on the functional classification of roads. The presented data illustrate that, on the aggregate level, local roads form the majority of the municipal roads (57%), followed by collector roads (27%) and then arterial roads (16%).

Figure 1. Location of targeted pilot municipalities

Table 1. Key indicators of the targeted pilot municipalities in the West Bank and Gaza Strip

4. Methodology

In order to achieve the objective of the paper, a detailed questionnaire was developed to investigate the implementation of the O&M Manual utilized towards the preparation of the municipalities' O&M Plans in the roads sector. The study sample included all the ten pilot municipalities.

The questionnaire was designed to be composed of several parts covering issues related to the preparation and implementation aspects of the O&M Plans for roads. These include the criteria used in the prioritization of roads maintenance works compared with that proposed in the O&M Manual, details on the actual implementation of road maintenance works compared with those included in the O&M Plans, and the financial sources utilized in roads maintenance works. Moreover, other investigated aspects include the capacity of the municipal staff in performing the required roads maintenance tasks, the level of benefit from the training activities and workshops, as well as from the O&M Manual, the parties which conducted road maintenance works, the major obstacles faced in the implementation of road maintenance plans, and proposed suggestions to overcome these obstacles.

The questionnaire was sent to the Municipal Engineer of each of the considered municipalities. This was followed by a telephone call with each Municipal Engineer to ensure clarification of questions and to encourage timely response.

The results of the questionnaires were then analyzed to assess achievements, examine the degree of satisfaction of the Municipal Engineers in the procedures followed, assess the implementation aspects of the prepared O&M Plans related to maintenance of roads, and draw proper conclusions and recommendations.

5. Analysis of results

The following sub-sections highlight the major findings, based on analysis of the responses of the Municipal Engineers in the ten pilot municipalities.

5.1 Criteria of prioritization roads maintenance works

The results of the questionnaire on the criteria for prioritization of roads maintenance works is shown in Table 2. Seven of the ten targeted municipalities agreed with the prioritization indicators and relevant weights listed in the O&M Manual. However, the three municipalities of Qalqilia, Hebron, and Al Maghazi had changed slightly the criteria, where change ranges from 10% to 20%.

Table 2. Roads maintenance prioritization criteria in the targeted municipalities

In Qalqilia Municipality, the weight of pavement condition and importance of road to community were increased to 0.50 instead of 0.45, and to 0.25 instead of 0.20, respectively, while the weight of the citizens' complaints indicator was scored zero instead of 0.10. In Hebron Municipality, the weight of the importance of road to the community was scored as 0.10 instead of 0.20, and a new indicator was proposed concerning the maintenance cost with a weight of 0.10. Finally, in Al Maghazi Municipality, the weight of the functional classification of roads indicator was given 0.23 instead of 0.13, the importance of road to community was omitted, while a new indicator concerning the maintenance cost was proposed and given a weight of 0.10.

The results of investigation regarding such changes show that in Qalqiliya Municipality, the Municipal Engineer omitted the citizens' complaints indicator due to lack of citizens' complaints records and mechanisms at the Municipality, and distributed the respective weight on two other indicators. In Hebron and Al Maghazi Municipalities, the Municipal Engineers believe that the maintenance cost is one of the important indicators that should be added in the prioritization criteria. Accordingly, both municipalities gave a weight of 10% for this new indicator. It can be concluded that such new item of maintenance cost need to be investigated for possible inclusion in the prioritization criteria in the revised version of the O&M Manual.

5.2 Extent of implemented compared with planned road maintenance

The lengths of planned and actually maintained roads in 2014 by class for each of the ten Municipalities are presented in Table 3, while the overall percentages of implementation are illustrated graphically in Figure 2.

Hebron and Al Maghazi Municipalities had achieved the highest percentage of implementation of the planned road maintenance works included in the O&M Plans, forming 69% and 67%, respectively. Al Bireh, Deir Al Balah and Nablus Municipalities achieved intermediate levels of implementation of about 50% of the planned maintenance. Three other municipalities (Qalqilia, Dura, and Salfit) exhibited limited levels of implementation (15%-25%), while the least achievements were recorded in Al Samou and Rafah Municipalities, with 3% and 4%, respectively.

Table 3. Planned and actual implementation of maintenance roads lengths based on the O&M Plan

Figure 2. Percentage of actual maintenance implementation of the planned roads lengths per Municipality

The results show very low rates of implementation of maintenance and operation plans in both Al Samou and Rafah Municipalities. The main reason that caused such low level at Rafah Municipality was the inclusion of all the roads, which have various degrees of deterioration, in the plan. Moreover, another reason behind the very low rates of implementation for both Al Samou and Rafah Municipalities was the critical financial situation which both municipalities had faced. This is mainly attributed to low collection rates of arrears, the lack of enough budgets allocated by the municipal councils for maintenance of roads, and the very limited financial support, whether governmental or external, that was received by the municipalities.

5.3 The Sources of Funding

The Municipal Engineers at the pilot municipalities were asked about the sources of funding for the implementation of the roads maintenance works specified in the O&M Plans. Among the sources of funding, the local municipal source had the highest overall percentage of 80%, followed by funds from the Municipal Development and Lending Fund (MDLF), with about 17%. Other sources, whether governmental or directly from external foreign sources, formed only minor contributions of 1% and 2%, respectively. Table 4 illustrates the contribution of the four sources in the allocated budgets specified for maintenance of roads for each municipality. Figure 3 illustrates graphically the percentages of the distribution of funds per source.

Table 4. The distribution the contribution of sources of funding for road maintenance per municipality

Figure 3. The percentage of road maintenance funds per source for all the pilot municipalities

The results show that the government and the external sources (whether local or foreign) provided only 20% of the funding needed for maintenance activities. The local communities were responsible for securing the majority of the funds needed for maintaining municipal roads.

Based on these results, and due to the generally intermediate to low level of the extent of implementation of the planned road maintenance works, and the difficult financial situations that all municipalities face, it is recommended to increase the share of the MDLF contribution, and to significantly boost the government financial contribution and to urge it to intensify efforts to attract additional external foreign funds to be allocated for roads maintenance. This will assist in keeping the road asset in acceptable conditions, in order to avoid future escalation of pavement deterioration, which would then require increasing funding, based on the well-known pavement life cycle cost.

5.4 Capacity of the local municipal staff in maintenance activities

The aim here was to investigate the qualification and the capabilities of the local municipal staff responsible for following up the maintenance processes, starting from establishing road inventories and conducting visual inspection phase till the implementation and completion of the maintenance works. Five categories were used in the questionnaire to assess such capabilities based on Likert five-point scale; very high (4.2-5.0), high (3.4-4.2), moderate (2.6-3.4), low (1.8-2.6), and very low (1.0-1.8). The responses illustrate that the qualifications of the technical staff in the implementation of the four phases ranked between high and very high.

The evaluation of the capabilities of the municipal technical staff in establishing road inventories and conducting visual inspection phase were ranked as high with 4.17 average score out of 5.00. The identification of maintenance priorities capabilities were ranked as very high with 4.20 average score. The capabilities of the local municipal staff in the preparation of the maintenance plans were ranked as high with 4.12 average score. Finally, the capabilities in following up the implementation of the maintenance plans phase were ranked as high with 3.96 average score.

The above results show that overall evaluation of the capabilities of the Municipal technical staff in implementing the four phases (from the first phase inventory and visual inspection to the last phase related to following up the implementation of the maintenance plan) was ranked between high and very high.

The results demonstrated that the local technical staff in the Palestinian Municipalities has well comprehended the O&M Manual and procedures, and has gained the knowledge and expertise needed to execute all required maintenance phases during a relatively short period.

5.5 Level of benefit from training

In order to make sure that the pilot municipalities had the required capabilities to use the O&M Manual and to prepare the annual maintenance plans, training and coaching workshops were conducted to all participating municipalities' relevant staff. The coaching was conducted by the local consultant who prepared the O&M Manual. The responses illustrate that three out of the ten municipalities' representatives rated the level of benefit from the coaching workshops as very high, while the representatives of the other seven municipalities rated the level of benefit as high. The overall rank was high as the average score was of 4.04.

The resulting evaluation score emphasizes the high level of satisfaction related to the implemented capacity building and training program, which was designed and offered by the consultant team. The municipal staff assessed the training workshops to be of considerable benefit in building their capacity in preparing and implementing their road maintenance plans.

5.6 Level of benefit from the O&M Manual

The questionnaire included a question that was illustrated to investigate the level of benefit from the O&M Manual, which had guided the municipalities' technical staff towards following the defined procedures in identifying the roads maintenance priorities. The responses rated the benefit between high and very high equally. The results of overall evaluation ranked as very high with an average score of 4.20.

The resulting high score illustrates that the level of benefit from the O&M Manual was distinctive. On one hand, the consultant illustrated the O&M Manual contents in a detailed and practical way, and on the other, the municipalities' representatives demonstrated their high level of benefit from the Manual and the real desire towards the application of the stated approaches, which are consistent

with the regional and global trends in this regard, taking into account the realities on the ground in the Palestinian territories. It is worth stating that the MDLF has recently decided to computerize all the procedures included in the O&M Manual.

5.7 The parties dealing with conducting road maintenance works

The questionnaire proposed three parties that usually execute road maintenance works: the municipality itself through local municipal staff, or external contractors whether with annual-based or project-based contracts.

The results show that the majority of road maintenance works, in terms of the amount of spent money, were executed by project-based external contractors, forming 93.2% of total. The local staff ranked second with 5.1% of total, and finally the contractors with annual-based contracts ranked last with a share of only 1.7% of total. Table 5 presents the length of maintained roads and the corresponding maintenance expenditure for each of the three parties, while Figure 4 shows the percentage of roads maintenance expenditure per executing party.

Table 5. The distribution of maintained roads expenditure on the executing parties

Figure 4. The percentage of roads maintenance expenditure per executing party for all the pilot municipalities

The results show that there is a lack in the capabilities of the targeted municipalities in performing roads maintenance works, which could be attributed to the shortage in the required staff, equipment, and materials.

5.8 Obstacles facing the implementation of road maintenance plans

Analysis of the responses of the pilot municipalities Municipal Engineers as the challenges facing implementation of their road maintenance plans illustrate that the major obstacles were:

- The current difficult financial situation of the municipalities; where the main problem is the insufficient governmental and external funding.
- The limited allocated budgets specified by the municipalities' councils for road maintenance works.
- Changing the priorities during the abnormal winter season; and
- The lack of qualified implementation workers and dedicated road maintenance equipment.

In addition to the above mentioned obstacles, and for Gaza Strip municipalities at specific, the consequences of the last war on the strip by the Israeli army during the summer of 2014, which had resulted great destruction for considerable part of the roads and other infrastructure assets, had caused changes in the priorities and formed the major challenge to implement the prepared O&M Plans in Gaza Strip three municipalities of Al Maghazi, Deir Al Balah, and Rafah.

5.9 Overcoming the obstacles in implementing the maintenance plans

The results of the part of the questionnaire aiming at identifying the proposed suggestions by the pilot ten municipalities to overcome the obstacles related to the implementation of the maintenance plans are presented here. The following were the main suggestions proposed by the Municipal Engineers in this regard:

- Establishment of road maintenance unit in the municipalities in order to follow up the maintenance of assets.
- Conducting training sessions for the local municipal staff on regular basis to make sure the capability of following the required phases in a better way.
- Providing the municipalities with the required equipment necessary for basic road maintenance works.
- Ensuring the commitment of the municipalities' councils towards spending the allocated budget for the maintenance works specified in the municipalities annual maintenance plans.
- Allocating the needed annual budget through the MDLF or maintenance works of roads assets.
- Increasing the budgets allocated by the government as well as external foreign sources for the purpose of roads maintenance works.
- Modifying the road maintenance plans every six months to account for emergencies and urgent maintenance issues.

6. Sensitivity analysis

In order to examine the effects of variations in the weights of the indicators in the PI equation, as three of the ten municipalities had done, sensitivity analysis is conducted to examine whether such variations would have an impact on the ranking of roads with respect to maintenance priorities.

The robustness of the priority indicators and their relative important weights are usually checked through conducting sensitivity analysis by calculation sensitivity intervals and presenting the sensitivity graphs. The idea behind that is to show the effect of changing the weight of one of the indicators on the remaining indicators through the calculation of the PI [11]. The important point is

maintain the ranking of the indicators (Pavement Condition>Importance of Road to Community>Functional Classification>Average Daily Traffic>Citizens' Complaints). Table 6 illustrates the intervals of sensitivity for the five mentioned indicators, when these are changed by $\pm 5\%$. Sensitivity analysis was conducted for all the indicators; however, two of these are illustrated graphically here, which are pavement condition and importance of road to community, as illustrated in Figures 5 and 6. It is clear from the figures that the variation in trend (i.e., slope) is too small for all indicators, which means that the relative importance weight values are robust.

Table 6. Sensitivity intervals for the five indicators

Figure 5. Pavement condition sensitivity graph

Figure 6. Importance of road to community sensitivity graph

7. Conclusions and recommendations

It is evident from the survey results that the preparation and application of the O&M Manual had a positive impact on the ten pilot municipalities. The level of benefit from the Manual was rated as very high, and the level of benefit from the conducted capacity building and training workshops ranked as high, which was reflected on the capability of the municipal staff in all roads maintenance phases. Both results express the good satisfaction and high confidence of the Municipal Engineers in the prepared O&M Manual in terms of applicability and its guidance in the identification of their needs and formulation of their road maintenance priorities.

The criteria used by the municipalities for prioritization maintenance works were generally in line with the criteria specified in the O&M Manual. Seven municipalities out of ten applied the same indicators and weights as per the Manual. However, the remaining three municipalities either

slightly had changed the weights of indicators, or added a new item with limited weight, which is the maintenance cost indicator, with an overall variation up to 20% of the O&M Manual criteria. The developed O&M Manual has exhibited flexibility to allow tailoring the weights of the indicators according to the needs and realities.

Sensitivity analysis shows that the ranking of the five indicators in term of their weights remain the same for calculating the priority index, despite three of the ten municipalities had changed the weights of the indicators. This result indicates that the indicators are robust, and that there is some liberty in tailoring some of the indicators by the municipalities by $\pm 5\%$ to better reflect their specific requirements and conditions.

It is well understood that not all the proposed works in the maintenance plans were implemented. The main reason behind that was the lack of funds, whether allocated by the municipalities' councils (internally or externally) they obtained from other governmental and other sources. Other factors that contributed to this include the experience of local Municipal staff, and lack of equipment and materials used in maintenance works. Moreover, the war against Gaza Strip in the summer of 2014 contributed significantly to the destruction of considerable portions of the road network in Gaza Strip, and the municipalities there, consequently, had changed the priorities.

Due to the lack of funds, considered as the main constraint to implement the O&M Plans as stated before, the actual percentage of completion road maintenance works proposed in the O&M Plans varied from 3% to 69%. The results showed that the local contribution of the municipalities' local budgets formed the main source of funding for performing the maintenance works with 80%. The MDLF ranked the second source with 17%, and finally the remaining 3% were financed by the MoLG and other external foreign sources. Moreover, some municipalities did not comply with spending the money allocated in the annual budgets specified for maintenance works due to their

difficult financial situation and changes of priorities. It is observed that some O&M Plans are ambitious and do not correspond with the municipal budgets that can be reasonably allocated for road maintenance works.

The study showed also the real need for establishing new units in the municipalities concerned with maintenance works, taking into consideration assigning the required staff and allocating the demanded budgets, equipment and materials. This corresponds well with the proposed establishment of such units as recommended in the O&M Manual.

The results indicated that the majority of maintenance works in terms of expenditure were executed by project-based external contractors (93.2%), followed by local municipal staff (5.1%), and finally by external contractor through annual-based maintenance contracts (1.7%).

Based on the relative successful implementation of the O&M Manual in the ten pilot municipalities, it is recommended to extend and disseminate the experience to the rest of the Palestinian municipalities, and to include other infrastructure assets in the Manual such as water and wastewater networks, storm water drainage systems, electricity grids, etc. Moreover, it is recommended to apply similar maintenance prioritization procedures outside municipalities' boundaries by the MoPWH.

The MDLF is recommended to pursue its plans to develop a special software package, which implies the transformation of the O&M Manual into a computerized user-friendly O&M System as, and to be tested on the pilot municipalities.

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Table 1. Key indicators of the targeted pilot municipalities in the West Bank and Gaza Strip

No.	Municipality	Population ¹	Area ¹ (km ²)	Length of paved roads by class (km) ²			
				Total	Arterial	Collector	Local
West Bank							
1.	Nablus	146,493	29.0	403	51	65	287
2.	Qalqilia	49,441	27.9	91	13	28	50
3.	Salfit	10,215	4.0	50	8	32.5	9.5
4.	Al-Bireh	46,212	22.4	123	9	42	72
5.	Hebron	202,172	22.8	223.5	41.5	61	121
6.	Dura	35,030	17.6	48.5	17	26	5.5
7.	Al Samou	24,349	13.8	52.8	14.3	27.9	10.6
Gaza Strip							
8.	Al-Maghazi	28,000	3.0	30.5	3.5	11	16
9.	Deir Al-Balah	67,727	27.0	57	2	17	38
10.	Rafah	152,950	55.0	145	42	20	83

¹Palestinian Center Bureau of Statistics website: www.pcbs.gov.ps: 2014)

²The survey questionnaire

Table 2. Roads maintenance prioritization criteria in the targeted municipalities

All Municipalities		O&M Manual Criteria for Prioritization of Roads Maintenance Works (Weights)					
		Functional classification of Roads	Pavement condition	ADT ³	Importance of road to community	Citizens' complaints	
		0.13	0.45	0.12	0.20	0.10	
No.	Municipality	Used Criteria for Prioritization Roads Maintenance Works (Weights) ⁴					
		Functional classification of Roads	Pavement condition	ADT	Importance of road to community	Citizens' complaints	Maintenance Cost ⁵
1	Nablus	0.13	0.45	0.12	0.20	0.10	
2	Qalqilia	0.13	0.50	0.12	0.25	0.0	
3	Salfit	0.13	0.45	0.12	0.20	0.10	
4	Al Bireh	0.13	0.45	0.12	0.20	0.10	
5	Hebron	0.13	0.45	0.12	0.10	0.1	0.10
6	Dura	0.13	0.45	0.12	0.20	0.10	
7	Al Samou	0.13	0.45	0.12	0.20	0.10	
8	Al Maghazi	0.23	0.45	0.12	0.0	0.1	0.10
9	Deir Al Balah	0.13	0.45	0.12	0.20	0.10	
10	Rafah	0.13	0.45	0.12	0.20	0.10	

³ ADT: Average Daily Traffic

⁴ Bold figures indicate change.

⁵ New indicator proposed and applied by the Municipality.

Table 3. Planned and actual implementation of maintenance roads lengths based on the O&M Plan

No.	Municipality	Planned Roads Length (km)				Actual Executed Roads Length (km)			
		Arterial	Collector	Local	Total	Arterial	Collector	Local	Total
1	Nablus	8	4.5	8.5	21	2.5	3	3.7	9.2
2	Qalqilia	11.3	14.1	6.4	31.8	6.6	1.5	0	8.1
3	Salfit	8	32.5	9.5	50	1.6	5.0	0.80	7.4
4	Al Bireh	0.9	4.3	3.3	8.5	0	1.9	2.6	4.5
5	Hebron	9	12	5	26	4.5	9.5	4	18
6	Dura	17.3	26	5.3	48.6	4	6	2	12
7	Al Samou	3.6	1.3	0	4.9	0.17	0	0	0.17
8	Al Maghazi	3.5	11	16	30.5	3.5	11	6	20.5
9	Deir Al Balah	2	10.4	2.3	14.7	0.1	6	1	7.1
10	Rafah	42	20	82	145	3	1	2	6

Table 4. The distribution the contribution of sources of funding for road maintenance per municipality

No.	Municipality	Financial Sources (USD 1,000)				Total
		Local	MDLF	MoLG	Other External Sources	
1	Nablus	800.0	0	0	0	800.0
2	Qalqilia	253.0	0	0	0	253.0
3	Salfit	167.0	0	38.5	0	205.5
4	Al Bireh	892.0	0	0	0	892.0
5	Hebron	2,500.0	679.5	0	0	3,179.5
6	Dura	60.0	0	0	0	60.0
7	Al Samou	32.0	0	0	0	32.0
8	Al Maghazi	0	24.3	0	0	24.3
9	Deir Al Balah	14.5	121.8	0	40.0	176.3
10	Rafah	81.0	209.8	0	50.0	340.8
Total		4,799.5	1,035.4	38.5	90.0	5,963.4
Percentage		80%	17%	1%	2%	100%

Table 5. The distribution of maintained roads on the executing parties

No.	Municipality	Local Staff			External contractor with annual contract			External contractor based on the nature of project			Total (USD 1,000)
		Length of Roads (km)	Value (USD 1,000)	% of Executing	Length of Roads (km)	Value (USD 1,000)	% of Executing	Length of Roads (km)	Value (USD 1,000)	% of Executing	
1	Nablus	0	0	0%	1.5	100.0	12.5%	9.7	700.0	87.5%	800.0
2	Qalqilia	0	0	0%	0	0	0%	8.1	253.0	100%	253.0
3	Salfit	3.5	96.6	47%	0	0	0%	3.9	108.9	53%	205.5
4	Al Bireh	0	0	0%	0	0	0%	4.5	892.0	100%	892.0
5	Hebron	0	0	0%	0	0	0%	18	3,179.5	100%	3,179.5
6	Dura	12	60.0	100%	0	0	0%	0	0	0%	60.0
7	Al Samou	0	0	0%	0	0	0%	0.17	32.0	100%	32.0
8	Al Maghazi	1	0.6	2.3%	0	0	0%	15	23.7	97.7%	24.3
9	Deir Al Balah	1.5	14.5	8.2%	0	0	0%	5.6	161.8	91.8%	176.3
10	Rafah	2.3	130.7	38.4%	0	0	0%	3.7	210.1	61.6%	340.8
Total		20.3	302.4		1.5	100.0		68.67	5,560,1		5,963.4

Table 6. Sensitivity intervals for the five Indicators

No.	Indicator	Value in the PI Equation	Interval
1.	Pavement condition	0.45	[0.40 – 0.50]
2.	Functional classification	0.13	[0.13 – 0.18]
3.	Average daily traffic	0.12	[0.07 – 0.12]
4.	Importance of road to community	0.20	[0.15 – 0.25]
5.	Citizens' complaints	0.10	[0.05 – 0.11]

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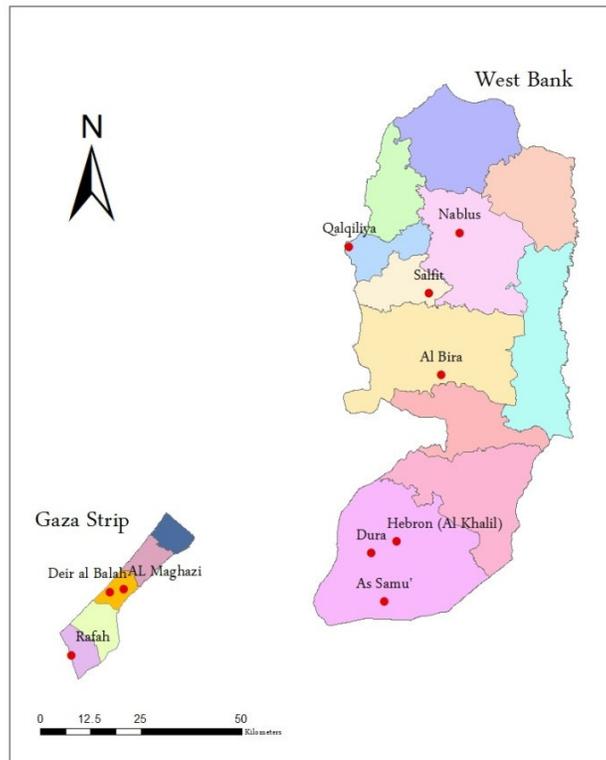


Figure 1. Location of targeted pilot municipalities

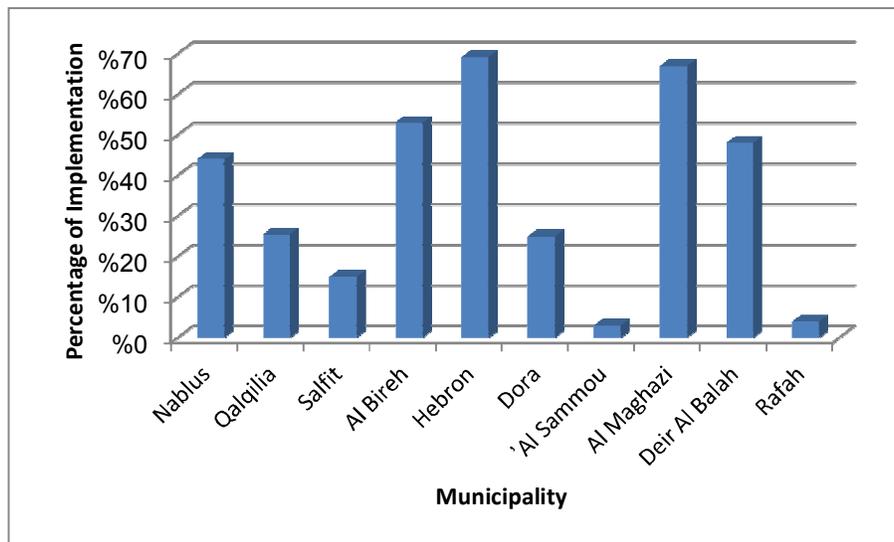


Figure 2. Percentage of actual maintenance implementation of the planned roads lengths per Municipality

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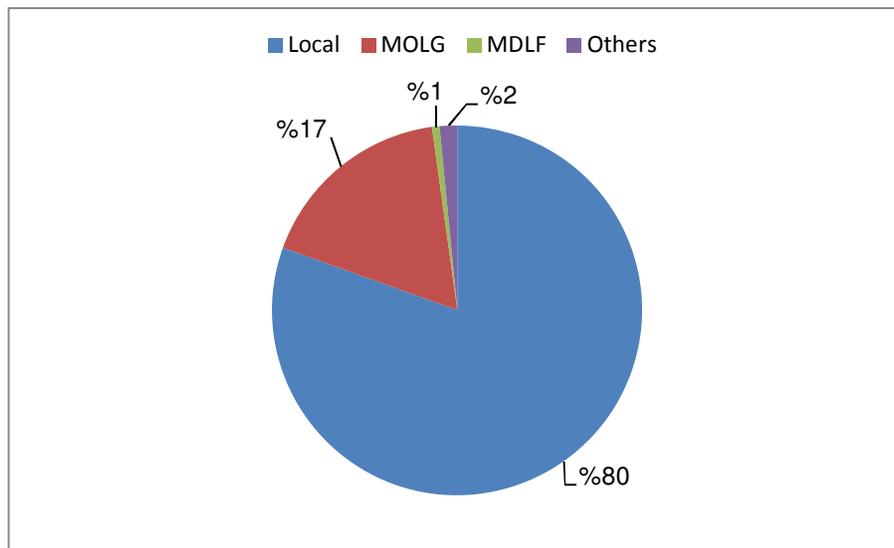


Figure 3. The percentage of road maintenance funds per source for all the pilot municipalities

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Figure 4. The percentage of roads maintenance expenditure per executing party for all the pilot municipalities

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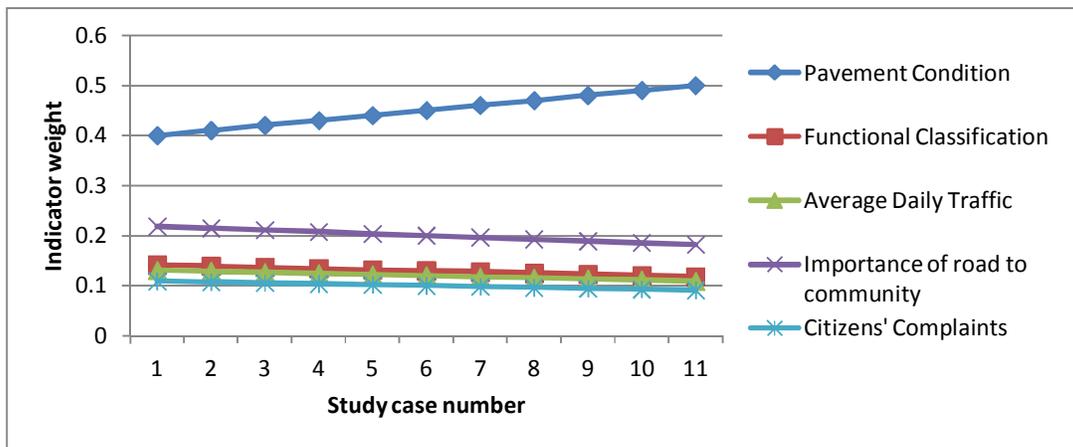


Figure 5. Pavement condition sensitivity graph

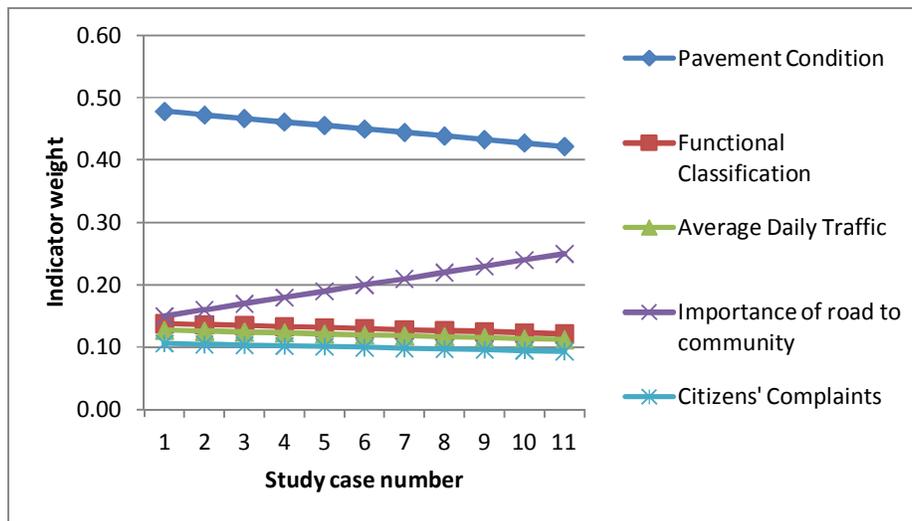


Figure 6. Importance of road to community sensitivity graph

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