Operation & Maintenance Management for Roads & Traffic In The Middle Area Governorate (Using GIS/DSS)

Mahmoud A. Al-Rahman A. Tabasha

Supervised By
Prof. Zaher Kuhail

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بـناء على موافقة عمادة الدراسات العليا بالجامعة الإسلامية بغزة على تشكيل لجنة الحكمة على أطروحة الباحث محمود عبدالرحمن عنقل طباشة المقدمة لكلية الهندسة لدبلجة الماجستير في إدارة المشاريع الهندسية

وموضوعها:

Operation & Maintenance Management for Roads & Traffic in the Middle Area Governorate
(Using GIS/DSS)

وبعد المناقشة العلنية التي تمت اليوم الأحد 25 صفر 1424 هـ الموافق 27/4/2003م الساعة 9 صباحاً،

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[signatures]

ان.د. زاهر كحيل

و.د. علي شهاب

و.د. عدنان انصاري

وبعد المداولات أوصت اللجنة بمنح الباحث درجة الماجستير في كلية الهندسة قسم إدارة المشاريع الهندسية

واللجنة إذ تمنح هذه الدرجة فإنها توصيتها بتجلى لله وترحم طاعته وأن يسخر علمه في خدمة دينه ووطنه

والله ولي التوفيق ،،،

[signature]

عميد الدراسات العليا

د. صالح حسن الرقب

نتيجة الحكم 132
قال تعالى:

الذي جعل لكم الأرض مهداً وجعل لكم فيها سبلاً لعلكم تهتدون.

صدق الله العظيم

(الخروج: 10)
Dedication

I would like to dedicate this work to my family

and to all of Palestine’s martyrs especially to my nephew

Ossama A. Al-Najjar,

and those who have supported me during
the course of this work

Mahmoud A. Al-Rahman Tabasha
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• I hope this work will be a present to the souls of my parents.

• Finally, more thanks to my family, especially my brothers, sister, nephews and especial thanks to my wife and my kids for giving me their support and encouragement.
Abstract

The municipalities in the middle governorate of Gaza Strip have its own roads policy, which includes managing, operating and maintaining system. This service sector should be managed carefully to secure protection to this service in safety conditions.

The operation and maintenance of roads and traffics (O & M) of (R&T) can't be managed successfully without a suitable modern systems.

This study aims to identify, evaluate and propose (O&M) system of roads and traffic in the middle area to enhance and protect this service to be always in a proper situation.

This study shows that, there is no independent departments deal with (O&M) of (R&T), and most of (O&M) are implemented in random manner, without planned policy or strategy.

There is no experience and training of the municipal engineers or technical staff. This is consider an obstacle to monitor the maintenance needs. Also, small and random budget are used to cover (O&M) expediters.

Through this study and by using Geographic Information System and Decision Support System (GIS/DSS) software, all roads in the middle area selected municipalities (Nusairate, Buraij, & Maghazi) were classified into four types & taken as a pilot area. And all inventory database, which are related to this roads, were gathered by visual inspection. Al-Buraij roads were taken as an example area to make more details about their roads like: (assignment and inspection of the different types of roads distresses and other details).

This study provided the proposed (O&M) system, which consist of:

- Roads management system (RMS), was divided into two models of (PMS & RFMS), and this models consist of five modules.

- After gathering all inventory data requested and through integration between (Geomedia, Access, Excel, & AutoCAD), GIS/DSS software model was constructed. And provided appropriate image and different queries about (O&M) of these roads through period of nine years from (2002 to 2010) according to special assumption criteria.
Twenty proposed decisions were designed and divided into three groups (Planning, Operation & Maintenance), and represented by objectives, algorithm charts, data flow ones & special forms, that can be used to serve facilitate the decision making for (O&M) of (R&T) issues.

- Proposed institutional setup provided with detailed chart, related to develop the “Joint Service Council”.

Twenty interviews included in filling questionnaires were administered with persons, who were dealing or having contact with roads sector.

The questionnaire’s answers were gathered and analyzed.

Three additional decisions were added to this study to cover some important points like:

- Structural remaining life of road.
- Bridge & culverts structural damage.
- Seasonal factors.

Moreover, the study shows and discusses many issues related to using GIS/DSS in (O&M) of (R&T) management.

Also, this study indicates the methods of recording and inspecting the roads distresses, and show how to assign and measure the severity level of the roads distresses.

Furthermore, the study provides several recommendations that may help in producing a suitable (O&M) system, which deal with all (R&T) in the middle area in the Gaza Strip.
المتخصّص

إدارة صيانة وتشغيل الطرق والمرور بالمنطقة الوسطى مع استخدام (نظم المعلومات الجغرافية ونظم دعم القرار)

إن جميع بلديات المحافظة الوسطى بقطاع غزة لها نشاطاً خاصاً بالطرق وتشتمل أنظمة الإدارة والصيانة وكأنها وتثبت هذه الكتات من الخدمات يجب أن يلحق ببعضه بقسمين حماية هذه الخدمة وقباءها ووضع أمن، وإن صيانة وتشغيل الطرق لا تستطيع إدارتها بشكل ناجح دون استخدام أنظمة وتنبيات حديثة.

إن الهدف الرئيسي من هذه الدراسة هو تعريف وتقديم نظرة الصيانة وتشغيل الخاص بالطرق والمرور بالمنطقة الوسطى ثم تقديم نظام مفتوح جديد يقوم بتحسين وحماية هذه الخدمة لتبقى دائماً بوضع مثالي، حيث أن الدراسة أيضاً وضعت أنه لا يوجد إكسام مستقلة خاصة بصيانة وتشغيل الطرق والمرور بالمنطقة الوسطى ومعظم أعمال الصيانة والتشغيلة يتم بطرق ذهنية بدون وجود سياسات تخطيط مرحلة أو استراتيجية.

وقد أشارت الدراسة أيضاً إلى أن مهندسي بلديات المنطقة الوسطى وكذلك الفتيين ليس لديهم الخبرة والتدريب الكافي. وهذا يشكل عقبة في إيجاد تصورات وحداثة الصيانة المطلوبة. وكذلك وضعت الدراسة أن معظم الميزانية الخاصة بتغطية نفقات أعمال الصيانة والتشغيلة هي ميزانيات صغيرة وعشوائية.

ومن خلال هذه الدراسة باستخدام برنامج (نظم المعلومات الجغرافية ونظم دعم القرار) تبين أن جميع الطرق بلديات (النصيرات - البريج - المغازي) والتي أخذت كعينة من المنطقة الوسطى صنفت إلى أربعة أنواع، وتجمع جميع المعلومات الخاصة بهذه الطرق بطريقة نظرية. وكذلك تم أخذ منطقة البريج كمثال وعمل تفصيل أكثر من خلال حصر وقياس جميع أنواع الخراوات على الطرق الرئيسية بالبريج، كذلك قمت هذه الدراسة نظام مفتوح خاص بعملية صيانة وتشغيل الطرق بالمنطقة الوسطى وهو يتكون من:

- نظام إدارة الطرق وينقسم إلى نموذجين (نظام إدارة جسم الطريق - ونظام إدارة عناصر المرور)، ويعمل هذان النموذجان من خلال عمل خمسة نماذج صغيرة.

- بعد أن تم جميع المعلومات الخاصة بالطرق المذكورة من خلال عدة ملفات تم ربطها باستخدام مجموعة من برامج كمبيوتر (الأوتوكاد - الإكسيل - الأكسسس - الجيودلية) وتتم تكوين قائدة بيانات، والخروج النموذج الرئيسي والذي يعمل من خلال استخدام برنامج نظم المعلومات الجغرافية، ويمكنه هذا النموذج تزيدهنا بالإجابة على...

تقديم رسم تفصيلي خاص بإعداد الهيكلية التنظيمية المفتوحة الخاصة بتطوير وتفعيل دور مجلس الخدمات المشترك، والذي تم تشكيله بالمنطقة الوسطى قبل سنتين. كذلك تم عمل استبيانات وتم تعبئة عشرين عنية وذلك من خلال انتخابات مباشرة مع بعض الأشخاص مثل المدراء والذين لديهم الخبرة والاتصال المباشر في مجال الطريق. ثم قام جميع إجابات الاستبيانات وتحليلها. حيث ظهرت ثلاث نقاط هامة تم على أثرها عمل وتقييم ثلاث قرارات إضافية جديدة لتغطية النقاط المذكورة وهي:

- العمر الافتراضي للطريق.
- الأضرار الخاصة بالجسور والعوارض الخرسانية.
- تأثير الفصول المناخية.

كذلك ناقشت الدراسة العديد من القضايا التي لها علاقة باستخدام (نظام المعلومات الجغرافية - ونظام دعم القرار) في عملية إدارة صيانة وتشغيل الطريق والمرور، أيضاً وضحت هذه الدراسة أن الطريق التي يتم من خلالها قياس وتسجيل أنواع الخراب على الطريق وكيفية تحديد وقياس شدتها، علامة على ذلك فقد قدمت الدراسة العديد من التوصيات والتي من الممكن أن تساعد في إيجاد نظام صيانة وتشغيل مناسب يتعامل مع الطرق والمسور بالمنطقة الوسطى في قطاع غزة.
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<td>O&amp;M</td>
<td>Operation and Maintenance</td>
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<td>R&amp;T</td>
<td>Road and Traffic</td>
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<tr>
<td>GIS/DSS</td>
<td>Geographic Information System/Decision Support System</td>
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<td>PCBS</td>
<td>Palestinian Central Bureau of Statistics</td>
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<td>PNA</td>
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<td>SMDM</td>
<td>Support to Municipal Development and Management in the Gaza Middle Area</td>
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<td>FIFO</td>
<td>First – In – First – Out</td>
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<td>PMS</td>
<td>Pavement Management System</td>
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<td>Traffic Management System</td>
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<td>TMC</td>
<td>Transportation Management Center</td>
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<td>MBMS</td>
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Chapter No. (1)

Introduction
Chapter (1)
Introduction

This chapter includes the following:

- Some data about Gaza strip.
- Problems against operation and maintenance of roads and traffic.
- How to deal with the different inventory large data.
- What is the practical problems facing the municipalities in the Gaza Strip
- Problem definition.
- Objectives and the importance of the study.

1.1 Background:\cite{1.1.4,16}

According to current administrative divisions, the Palestinian territory was divided into two geographic regions. The West Bank and Gaza Strip. The West Bank was divided into nine governorates and two districts (Jenin, Tulkarm, Qalqiliya, Nablus, Ramallah & Al-Bereh, Jerusalem, Jericho, Bethlehem, Hebron, Tubas, Salfit Districts), while Gaza Strip was divided into 5 Governorates (North Gaza, Gaza, Middle area, Khan Yunis, Rafah).

The Gaza Strip is bounded by the Mediterranean Sea from the northwest, by Al-Naqab Desert from east and south and by Egypt from the southwest. The Gaza Strip has an area of only 365 km². The population in 1998 was 1.1 million capita (Palestinian Central Bureau of Statistics - PCBS, 1998). From 1948 to 1991, the total population tripled from 260,000 to 785,000 capita, which makes this area one of the most densely populated areas in the world (2,150 persons/km² in 1991). During this time the population of refugees also tripled from 170,000 to 510,000 capita. It is estimated that 280,000 capita (55 percent) are living in the more densely populated refugee camps. Considering 1995 population as 886,000 in the Gaza Strip (365 km²), the population density is then 2,427 persons/km². The Gaza Strip is composed of five governorates as shown in the map in Figure 1.1.

The distance from north to south is about 45km, and from east to west is varying from 5 to 12km. The area includes several Israeli settlements covering approximately 1/5 of the total area (Sogreah and Team engineering group, 1998).
Figure No. 1.1, The Governorates of Gaza Strip

The topography of the area is flat, and in some regions, it is rising to a maximum height of 65 m above sea level. The climate is typical of that of the eastern Mediterranean with mild wet winters and hot dry summers. Monthly average temperature reaches 35 °C at maximum, and 4 °C at minimum. Sand dunes are the main feature along the coastal line; sandy soil, loessial sand soil, which prevail in the eastern part of the strip. In contrast the soil in east of Gaza town consists of dark brown clay loams. There are no permanent surface water sources. Annual rainfall is between 150 and 350 mm. Groundwater is the only significant source of water in the
Gaza Strip. This is directly replenished by rainwater infiltration and underground flow from the east.

Institutional arrangements in the Gaza Strip are weak, which resulted from lack of investment, from the exigencies of the occupation and from lack of support by the local population.

This study concentrates on the Gaza Strip, particularly the middle area governorate in Gaza Strip.

It lies in the middle of Gaza Strip, and contains five municipalities and two village councils as follows:

- Deir El-Balah Municipality.
- Al-Nusairate Municipality.
- Al-Buraj Municipality.
- Al-Maghazi Municipality.
- Al-Zawayda Municipality.
- Al-Mussadar village Council.
- Wadi Al-Salqa village Council.

The total population of this governorate is about (192655) people according to expected date (June, 2003), and it includes:

**Dier El-Balah Area**: It is located in the southern part of the middle area, it is over looks the Mediterranean Sea. It is surrounded by Al-Zuwaida and Al-Musaddar Area from the north, the Truce Line (1948 borders) from east, and Wadi Al Salqa from the east. Its area is (9.5) square Kms, and it has a population of (57000).

**Nusairate Area**: It is located in the center of the Gaza Strip. Its western part over looks the Mediterranean Sea. Al Nusairate lies about 10 Kms from the south of Gaza city, 2.5 Kms from the north of Dair Al-Balah. It is surrounded by Salah Al-Din Main Road from the east, Gaza Wadi from the north, and Al-Zawaïda Village from the south.

The total area of Al-Nuseirat is about (9.8) square Kms, and its population amounts to (59469) people, most of whom are refugees driven out of their homelands during the Nakbah (Calamity) of 1948.

**Bureij Area**: It is located 9 Kms from the south of the city of Gaza, and it is bounded by the Gaza Wadi from the north, Al Nuseirat from the west, Al-Maghazai from the south and the Truce Line (1948 borders) from the east.
Like other Gaza Strip towns, villages and camps, Al-Burajj is characterized by its location on a relatively hilly and coastal area – as it is located only 4 Kms away from the sea. Its population is amount to (33481) capita, and the total of its area is about (5.57) square Kms.

**Al-Maghazi Area:** It is located in the flank of Gaza Strip in the governorate of the Middle Area. It is one of the eight camps of Gaza with a population of (22415) capita, most of which are refugees migrated from northern Gaza villages during the 1948 (Nakba) Calamity, and its area is about (3.5) square Kms. The camp is located 14 Kms from south of Gaza. It is surrounded by Bureij camp in the north, Mussadar village in the south, Dair Al-Balah in east and Salah Al-Deen Street in the west.

**Al-Zuwaida Area:** It’s located in heart of the middle area, it covers an area of (8000) donums. It is bounded by Salah El-Deen St. from the west, by El Nussairat from the north & by Deir Al Balah from the south. The population is (14291) capita.

**Al-Musaddar Area:** It is located between Al Maghazi and Dier Al Balah Area, it is surrounded by Salah El-Deen St. from the west, the Truce Line (1984 borders) from the east, its area is (4 ) square Kms and is has population of (1698) habitant.

**Wadi Al Salqa Area:** It is located in the western part of Deir Al-Balah, its area is (5.0 ) square kms and has a population of (4301) habitant.

### 1.2 Problem Definition: [14]

In Middle area Governorate, there are five municipalities and two village councils. Every municipality has different departments, where engineering department is considered the most important one, which is responsible for many duties, especially managing the operation and maintenance of roads and traffic. Middle area municipalities had many damaged, destroyed and old roads till 1996, when the Palestinian National Authority ( PNA) was formed and many infrastructure projects were executed.

Therefore, in the recent years, several new roads were constructed in the middle area, especially through (SMDM) fund, which includes all infrastructure elements. Hence, there is no special independent department concern with (O&M) of roads and traffic. Also, there is no clear job description for those involved in (O&M), where the existing organizational chart is depending the conflict in authorities and procedures.
The low level staff in every municipally, doing more than one job, has lead to unskilled workers with un-clear chain of command or reporting procedures.

The current situation in the middle area municipalities, fails to provide a clear and accurate definition of the responsibilities required to manage, plan and execute road maintenance in any uniform or coherent manner, as no precise definitions or criteria for the required levels of (O&M), such as reconstruction, rehabilitation, safety and preventive (routine maintenance).

"Joint Services Council", help the technical staff of the four municipalities by providing some tools, equipment & materials on hire basis (fuel is paid by the municipality requesting machineries)

The number and type of equipment (if at all exist) for every municipality do not reflect the work load and maintenance needs. Also, there is no defined criteria for selecting qualified technical staff at all levels of the maintenance team.

The experience and training of the municipal engineers or technical persons are not uniform, sufficient or appropriate to the required maintenance activities.

Different traffic signs, humps with painted lines and some of cat eyes and handrails were replaced a long the sidewalks. That helped to save and to improve the movement of traffic and people, especially beside the schools and the crowded areas.

Most of roads and traffic are operated and maintained by random manner, through using some small tools, some materials and unqualified staff, without using any modern software techniques like (GIS/DSS).

This random approach usually takes the form of making use of the available manpower in the maintenance department so that, on occasions, not every one is responding to emergency calls.

Thus, a random a broach means that occasionally some maintenance is pulled, but there is no precision in the process. The craftsman is not accounted for any work and there is usually no record of what was done. Therefore, most of roads need a proper O&M system, which helps the municipalities to protect their roads and save their lost budgets.

Finally, it is clear that the middle area is in need of a special independent departments, providing with qualified staff and an accurate managerial programs related to O&M system of roads & traffic.
This study may help decision makers to take a proper actions and decisions for continuity of improvement and development of roads and traffic condition, through using proposed planning, operation and maintenance decisions.

1.3 Research Aim:

The aim of this research is to identify, evaluate and propose (O&M) system of roads and traffic in the middle area. (to recommend how development and progress can be achieved).

1.3.1 Research Objectives: The specific research objectives are:

1- To identify the (O&M) management system for roads and traffic in middle area governorate.

2- To evaluate the efficiency of existing (O&M) system & its impact on existing roads.

3- To identify the technical and institutional dimensions needed to develop and improve (O&M) system.

4- To establish an efficient O&M system suitable for the middle area.

1.4 Importance of the Study:

The roads sector in Gaza Strip especially in the middle area is managed by municipalities and village councils, where each municipality or village council has its own roads policy, which includes managing (O&M) system.

In the middle area municipalities, there is no independent (O&M) department, which deals with (R&T). The “Joint Service Council” which was established before two years is helping the technical staff, in each municipality in (Nusairat, Buraj & Maghazi), in achieving the maintenance requirements, through using small equipment, tools and materials without using any modern techniques and trained labors.

Each municipality has a special area with limitation boundaries, also it has a new urban plan concerned with the land uses and indicates all main roads, widths and places, that consist the networks roads.

Also, it includes all existing roads and any suggested roads that is expected to be needed through the next 25 years. There are different problems that faced (O&M) system in Gaza Strip like:

a- Gathering and dealing with the large inventory data, where this task will need modern software program like: (GIS/DSS).

b- Surveying and measuring the conditions of roads, where this task will need modern techniques like automated equipment & tools.
In the recent years, several new roads were constructed in Gaza Strip, especially in the middle area, where (SMDM) fund, that includes all infrastructure elements. Therefore, several new roads were constructed in the middle area, and need special (O&M) system to deal & to protect these roads through operational stages.

There is a need to use modern software programs like (GIS/DSS) to deal with the large quantities of inventory data. By using this modern technique many decisions related to (O&M) of roads & traffic will be got, and suitable actions will be taken by decision makers.
1.5 Methodology

The adapted methodology, or framework needed to accomplish this study, depends on many approaches, and techniques, like: GIS/DSS, where, Database structure, data flow, field data acquisition, queries, constrains and conditions, Geomedia 4, AutoCAD map, digital photographs, scanner, Access, Excel, O&M decision trees & other management elements have been all integrated to form the management model needed for roads, which provides the requested output & acceptable achievement of the research objective.

1.5.1 The adapted methodology consist of:

1- The first part of this study was prepared as literature review of previous studies related to (O&M) in (R&T) in Gaza strip and other countries.

The study includes, the review of literature related to the concerned subject, through visits, libraries, internet web sites and... etc.

2- This study includes, important information about the international (O&M) of (R&T) systems, through GIS/DSS usages in roads.

3- Through this study, a comprehensive assessment of the existing situation of (O&M) of (R&T) in the middle area of Gaza strip were applied by the following:
   • Surveying and collecting fixed data of existing roads in (Nusairate, Buraij & Maghazi).
   • Meetings and interviews were set with municipalities and village councils concerned staff.
   • Assigning and measuring the existing different distresses in Al-Buraij roads. This was administrated by the assistant group, which consists of three trained persons.
   • Through using special assumption criteria, an accurate image was got about the expected values of the different distresses that will be expected to happen through the coming nine years from (2002 to 2010).

4- The (O&M) institutional arrangement of the municipalities and village councils in the middle area were identified, and Buraij area was taken as an example area through:
   • Studying & analyzing the existing (O&M) institutional arrangement, where flow charts, related to the existing institutional arrangement of the middle
area in Gaza Strip, were prepared with more concentration on Al-Buraij area, as an example area.

- The study included a comparison between Gaza strip middle area and Kuwait area, (O&M) system of (T&R). This cameraperson will encourage the concerned people in the middle area municipalities, especially in the highest administration level to start to apply the (GIS/DSS) software, as a tool of management, and to build a proper database inventory system. This will lead to more cooperation between different municipalities and ministries.

5- This study has produced an accurate (O&M) proposed system for middle area, which included:

- (RMS) which apply through using two models [(PMS) & (RFMS)] that apply through using five modules.

- Twenty three specific decision were designed the classified to three groups (planning, operation & maintenance), where every decision consists of (objectives, algorithm chart, data flow chart and special form).

- Proposed institutional setup related to develop the "joint service council" which constructed two years ago.

6- A questionnaire was prepared for managerial & technical staff, this questionnaire was designed to investigate and measure some important issues related to the study subject such as:

- Efficiency of the existing (O&M) system of roads & traffic.
- Efficiency of the proposed decisions needed to cover (O&M) activities.
- The importance of suggested decisions through rearrangement.
- Frequent use of suggested decisions through rearrangement.
- The causes of (O&M) system of (R&T) problems and how to solve them.
- Willingness to improve and develop (O&M) system and concerned persons skills.

1.5.2 Preparing The Questionnaire:

- The Interview and Questionnaire Design:

1.5.2A Types of Questions:

- A questionnaire with an interview was administered to stand on the opinions of the experts who deal or have contact with the study subject. The questionnaire was developed with specific questions and it was designed in a manner that allow every respondent to express about his thoughts and opinions in a free manner.
- The questionnaire consisted of three types of questions. The first type was related to the background of the respondent and it included some areas of questions such as type of firm/institution, experience year, position and qualification level. This section consisted of four questions from No. (1 to 4).

- The second type included three questions from No. (5 to 7) about investigating the efficiency of the proposed decisions through knowing if it is adequate to cover (O&M) activities and to arrange their suggested decisions according to their importance and frequent use.

- The third type included eight questions from No. (8 to 15) about investigating the efficiency of the existing (O&M) system of roads and traffic and how to solve the (O&M) problems, and investigating the willingness for improving and developing (O&M) system and concerned persons skills.

1.5.2.B The Interview and Questionnaire Sample Size:

- The interview and questionnaire sample consists of experts or directors who had contact or dealt with (O&M) of (R&T) sector in the Gaza Strip. To identify about the credibility of the proposed decisions level. Therefore, all of the concerned people were managerial, practical and academic persons, who will understand the concept of the questionnaire tasks. Twenty persons were interviewed. Eight of them represented the municipalities, other four persons represented the universities, another four of them represented the ministries and the last four areas represented other institutions.

1.5.2.C Collecting & Analyzing the Questionnaire's Data:

- Most of questionnaire data was collected quantitatively. Collection of data from the concerned people in different organizations included interviews that took place about three weeks ago.

- Two data tables were prepared:
  - Table (1): sample distribution.
  - Table (2): results table.

- Excel program was used to analyze the collected data and some related graphs to display the different results.

- Three additional decisions charts provided with three data flow charts were added to this study to cover some important points that were get through analyzing the collected questionnaire data.
7- (GIS/DSS) software model was followed the proposed system which shown in the above item No. (5). It was applied through this study to illustrate the efficiency of the (O&M) proposed system.

Database structure, data flow, field data acquisition, queries, constrains and conditions, Geo-media 4, AutoCAD map, Digital Photographs, scanner, Access, Excel, O&M decision trees & other management elements, have been all integrated to form the management model needed for roads, which provided the aimed outputs.

That is summarized to:

- Thematic map about:
  - Road condition.
  - Queries.
- Road condition reports.
- Decisions were related to choose the type of maintenance and materials that should be used, and other decisions were related to planned and operated issues.

8- The last point of the methodology was the conclusion and recommendations that may help in producing a suitable (O&M) in (R&T) system, using GIS/DSS which will be used in the middle area of Gaza Strip to cover the needed (O&M) of roads and traffic.
Methodology Charts:
The methodology of the research can be presented simply by the chart indicated in Figure No. 1.2

**Topic Selection**

- Identify the problem and establish objectives
  - Literature review for previous studies related to O&M in R&T
  - Studying an important international (O&M) of (R&T) systems.

**Studying & evaluating the current situation of (O&M) in (R&T) system in the middle area of Gaza Strip**

- Meeting & interviews with municipalities & village councils concerned staff in the middle area governorate
- Surveying & collecting fixed data of existing roads in (Nusairat, Burjai & Mghazai) as a pilot area
- Surveying & collection data of existing (O&M) system of (R&T) in sample of one municipality "Burjai" and measuring the existing distresses in Al-Burjai roads

**Analysis of the (O&M) institutional arrangement of the municipalities through preparing flow charts related to the existing institutional arrangement, also provided with comparison studies about middle area & Kuwait (O&M) system.**

**Proposed (O&M) system in the middle area included with specific decisions (planning, operation & maintenance decisions) provided with data flow charts**

**Identification of the (O&M) institutional arrangement of the municipalities & village councils, where considered Burjai area as an example area**

**Preparing questionnaire for technical and managerial concerned staff**

**Collecting and analyzing of questionnaire by using excel program**

**To: Investigate and measure**

**Efficiency of the existing (O&M) system of (R&T)**

**Efficiency of the proposed decisions to (O&M) activities**

**The importance of the suggested decisions through rearrangement**

**The use (usage) frequency of suggested decisions through rearrangement**

**The causes of (O&M) system of (R&T) problems and how to solve**

**Willingness to improve and develop (O&M) system and concerned persons skills.**

**Conclusion & Recommendations**

Results including two tables, charts and graphs were got. Also, three additional decisions charts provided with three data flow charts were got to cover some important points that were get through the questionnaire answers.

Getting software model related to (O&M) new system using GIS/DSS through the integration process by using (Geo-media, Access, Excel & AutoCAD map).
Chapter No. (2)

Literature Review
Operation and Maintenance
Management of Roads & Traffic
2.1 Planning: [10]

Planning involves making decisions on what we are going to do, also, it helps us to act rather than react, to transfer our ideas to upper management and to assure that our maintenance activities are cost-effective over the long run.

Without planning, we will never get an effective organizing, staffing, controlling or directing our operation and maintenance works.

Through a good planning, we should select a set of objectives and determine the policies, programs and procedures needed to be used for achievement of the selected objectives. Planning is decision making, because it involves selection among alternatives.

Through management procedure, planning is a way that permits workers in the department of operation & maintenance to be more active through a clear future seeing.

When planning is given proper attention, it facilitate the maximum utilization of available resources like labor, money and materials that are requested. Without clear goals, policies, programs and procedures, execution of planning, organizing, staffing, controlling and directing functions will be suboptimal.

Effective plans need to determine what type of planning should be done, who should do it and when and how it is needed to be done.

A good planning requires the operation and maintenance of the department of organization to achieve its duties. The organizational structure should be continually appraised through revisions of department objectives.

Staffing involves manning, which is the positions required in the organizational structure. This function includes defining manpower requirements, selecting and hiring the suitable persons, developing and training employees to accomplish their tasks. Staffing can not be effectively if you do not plan how you are going to get it done.
Directing involves supervising and guiding, that is orienting and motivating people, towards improved performance and clarifying their duties.

Through planning the execution, we can not measure our performance & correct negative deviations without first determining what techniques we are going to use and how they can be applied. In theory, planning comes first and organizing staffing, directing & controlling follow in sequence. Hence, (O&M) departments carries out, all master plan components. However, a maintenance manager may find himself performing all his functions at the same time.

Planning related to operation and maintenance will save one over fifth of the cost.

- **Period of plans:**
  - A- Long-term plans (Projects three to ten years into the future).
  - B- Short-term plans (Cover a time span of one to three years)
  - C- Near-term plans (cover monthly and quarterly time period)

**A-** Some maintenance managers claim that long range plans are impossible to develop, because they cannot correlate meaningful information. The requirements of long-term plans should be communicated to other departments involved in the process of their implementation. Without strongly support from other departments, the maintenance department can not be expected to get its long-term plans implemented.

**B-** Short-term plans are more easier to develop than long-range plans. Normally short-term plans should contain more details for the first covered year than for succeeding ones. The last two years of the plan are more generalized, showing categories of effort and major programs needed to be completed. The first year should interface directly with the established budget for the year. The time frame is shorter, and the planning process is facilitated.

**C-** Near-term plans contain more details and represent the operating plan for each month or week in the covered period. These plans include the milestone dates for each task job being performed and the number of man-power allocated to breakdown maintenance, repair, rehabilitation effort, preventive maintenance, and so on.
- Thus, the plan should constitute the completion of all work to be performed by the maintenance department.

- Detailed estimates have been prepared for work, the hours estimated for each craft skill providing the data for developing the near-term plan for the period during which the work is to be performed.

- **Planning information systems in O&M:**

  "Planning is the area of data management, which is suitable for concept of decision support system (DSS). The reason is the need in planning to ask questions of "What if". It makes no sense, however, for planning to be separate from operations with databases; the two ways are needed to be connected.

  Databases will be necessary for effective planning, which include data for the supply system, the demographics, and the demand parameters. Unless these databases are organized by the planning staff, they may ignored.

  These databases should offer to management the opportunity to gain a perspective operation, and give attention for the planning staff to make proper organization. Particular interest in the future will be given to the complication of planning databases that allow the combination of hydrologic & financial studies of the same time.

  Decisions can be scripted by support of planning. This allows the examination of alternative scenarios, &it’s approach which is necessary for very complex situation.

  Planning is a general concept meaning preparing to manage (R&M) effectively. Planning constitutes the first task of (R&M) management. Nevertheless, it is needed everywhere in the organization at the same time. Every aspect of management must be planned, including construction, development of facilities and operation and maintenance. classifies plans into five categories:

  - A master linking or integrated plan (sometimes called the "comprehensive general plan").
  - Master plans for the development of each service or type of facility.
  - Needs assessment tied to the budgeting process.
  - Plans to develop the (R&T) organization.
  - Plans to improve operations and maintenance."
2.1.1 Policy Analysis in (O&M) of (R&T):[12]

Policy analysis is one of the most important, of all types of planning, in today's complex world. Policy analysis is concerned with finding the right policies; in effect, it is the part of planning concerned with steering big decisions correctly. All kinds of organizations, but especially public organizations, need good policy analysis. Policy planning is well embedded in the literature of public administration, but has not found its way into engineering planning literature very much. The reason is that it is mostly a concern of managers. However, infrastructure managers are quite often engineers by background training, and need exposure to this planning technique. The concept of analysis, however, is a part of the engineering toolbox. When we recognize the importance of analysis to engineering problem solving, then the concept of policy analysis is easier to appreciate.

The term “analysis” means to divide something into its component parts; it is the opposite of “synthesis,” which means to combine the parts into one. Thus we find many used to the term “analysis”: mathematical analysis, chemical analysis, engineering analysis, and, now, policy analysis. The process of synthesis is also necessary in (R&M) management due to many divergent considerations and opinions that must be synthesized to reach decisions.

Basically, policy analysis is the application of the problem-solving process to finding the best policies to implement. To do this requires breaking the problem addressed and the possible policies into their separate elements. Policies are basically courses of action in relation to particular issues. In a legal sense they have a position in the hierarchy of rules and regulations. A company “policy” is a rule lacking the force of law but still an important guideline. The field of social science has a large subdivision called the “policy sciences,” generally being those concerned with government and public matters.

The essence of policy analysis, when all of the background materials is stripped away, is to find the best policies. Following this line, the steps in the planning process should be used to explore alternatives. The problem should be identified, the goals set, the alternative policies identified and evaluated, and the best courses of action selected and recommended.
The outline of steps in policy analysis represents a good also for a policy analysis report:

- Statement of the problem
- Diagnosis of the problem including its components.
- Purposes, goals, missions, and objectives to be achieved.
- Alternative policies to achieve the goals.
- Evaluation using all the appropriate tools of analysis.
- Recommendation of policy to be adopted.

2.1.2 Decision Support System In Organization:[21]

The term “decision support system” is used to refer to the use of computers to develop and display information to improve decisions. “Decision support” implies, however, more than just the processing of data; it includes analysis, some using computer models which actually add value to the raw data. In other words, the DSS is the system that organizes the processing, analysis, and delivery of information that is necessary for decision making.

There are two main activities in the DSS, managing data and studying alternatives, and these are the activities that convert data or “information” into “knowledge” that is useful in the decision-making process. The role of the DSS is thus, to bring the data together with the studies, judgement, and analysis results.

How is the DSS different from the traditional staff activity to make recommendations to the boss? It isn’t different; it is just a way to organize the concepts better and arrange to handle information more effectively through the use of computers.

In organizations both the management of data and decision-making cluster around the organizational form. Before the computer, when data bases could be less formal, every department would have its own files, and both information management and decision making were very customized, and more expensive than necessary.

2.1.3 Decision Making in Organization:[21]

Decision making is distributed throughout all levels and parts of organizations, many with dissimilar functions but with needs for the same information.

There are several ways to classify decisions according to the stage of management or the level of detail. One model that seems especially useful considers
the level of management (executive, management, worker), the stage of management (planning, organizing, controlling), and the function/sub-function (R&T).

Some refer to decisions as political, management, or operating, but this classification is another variation of the processing scheme. The political level is subsumed in the policy level of decision making which oversees the executive manager.

The linkage between decision making and problem solving is that decisions are made to solve problems. If the problem is not clear, we study it to make it clear, or to give it structure. If the problem is complex, we decompose it into sub-problems to arrive at a problem structure we can deal with. There appears to be no really "unstructured problem"; the essence is the complexity. It seems that any problem can be made structured with enough analysis and decomposition”.

2.2 Scheduling: \([10]\)

Scheduling is a method of planning with specific objectives to be accomplished in a certain period of time.

It can be applied to a large number of activities in the department of maintenance. Planning of rehabilitation jobs assigned to workers of the maintenance department for execution should be scheduled. Near-term operating plans should be reduced to specific schedules with certain weeks or months.

If annual budget has been received, scheduling on major construction projects is best done for estimated time periods expressed in days or weeks. After receiving the annual budget, the estimated time schedule should be converted to specific calendar days. If the budget is received after the scheduled start date, authorization to proceed is received.

Rescheduling is not necessary, if calendar dates are not assigned to the schedule till an annual budget is approved. The use of schedules as a planning tool is not restricted to internal operations. It may also be used as a communication device in dealing with other departments.

A scheduling system is a planning tool, and its purpose is to assign resources to accomplish work. Kind of scheduling system needed to used by a given maintenance department depends upon the scope and nature of the department’s duties.
2.2.1 Using First-In–First-Out (FIFO):
- The first-in-first-out scheduling method has all work orders sequentially as they are received. This means that all requests for work are treated on the basis of equal priority.
- The (FIFO) approach cannot be applied to all maintenance operations because all work should not have equal priority.
- Thus, FIFO can seldom be completely practiced because this method lacks realism. All maintenance work can not be assigned on the basis of equal priority if operations are to be performed efficiently.

2.2.2 Applying convenience Assignment schedules:
- The purpose of the convenience assignment method of scheduling work is to reduce operation costs connected with travel as:
  ♦ Grouping work requests to be performed in the same geographical area.
- When work orders are grouped by geographical area, the travel time of repetitive trips to the same area is eliminated, since all the work related to the same orders is accomplished on one trip. Hence using this technique we can save more money.

2.2.3 Using A fixed priority by work classification:
- This scheduling method involves establishing an order of precedence for the accomplishment of work based on a work classification system like:
  ♦ First priority – Emergency / Breakdown work.
  ♦ Second priority – Modification work.
  ♦ Third Priority – Preventative maintenance.

- Emergency / Breakdown work is defined as work that must be immediately accomplished to prevent damage to facilities or personnel. This type of work would take precedence over all other works.

- The next classification would be modifications. After first priority – Emergency service being handled, available manpower would then be assigned to modification work.

- Finally, any additional manpower available would be assigned to preventative maintenance.
- Through this classification method of scheduling, we can find that all men in the maintenance department possess an approximately equal capability of performing all work assigned.

2.2.4 Establishing Priority Systems for Major Jobs:
- A priority system for major jobs is used to define the order of precedence in assigning the accomplishment of specific work orders involving construction, modification or rehabilitation such as:

A Top Priority:
Work requires immediate action, for safety or security requirements.

B Secondary Priority:
Assigned work to assure complication for a specific data is needed to support operations.

C Routine Priority:
Assigned work orders that may be accomplished on a first-in-first-out (FIFO) work schedule cycle, where there is no specific need for data, has been established. Any priority system for major jobs will involve a certain amount of rescheduling effort.

2.3 Maintenance Classification: [14]
- A pavement management system (PMS) is a set of methods that help decision makers in finding optimum solution for maintaining pavement in a good condition through a limited period of time. Therefore, roads require more frequent reconstruction.
- Maintenance of high way pavement have been classified in several ways.
- Main definitions according to the standardization related to maintenance classification are as follow:

A. Routine/ Preventative/ Periodic Maintenance:
Maintaining components of the service or part of it to keep its integrity and efficiency.
B. Emergency / Breakdown Maintenance:
   Repairing the breakdown of the service to continue its running function, without major improvement in its quality.

C. Corrective Maintenance:
   Comprehensive maintenance to a frequently broken-down service component.

D. Major Rehabilitation:
   Complete maintenance to service component(s), with full routine maintenance.

E. Reconstruction:
   Replacing a whole component of the system where no other maintenance is optimum.

2.4 Road Pavement & Road Service Failure:- [24]

   (This summary is related to most of the decision maintenance charts)

2.4.1 Highway Failure:
   There are many types of road failure, & there are many reasons for each type of failure. In these situations, it is difficult to replace an experienced engineer/technical with a guide, but an attempt is made to give guidance & to supply some information.

2.4.2 Failure of the road pavement Deflectograph:
   - The (Deflectograph Machine) is used to carry out a (Deflectograph survey). It measures the amount that a road pavement will deflect when it is subjected to a standard load.
   - Surveying is carried out to determine weak areas of highway prior to actual failure & to determine road strengthening measures to prevent failure.

2.4.3 Pavement structure failure:
   - The layers that make up the pavement may fail for various reasons e.g.:• Through age, inadequate design, or an altering in requirements of the strength of the (Pavement) by increased traffic flow/weight, impeded drainage decreasing subgrade strength, etc..
- When we have (structural failure) the solution is always a form of (reconstruction).
- If total (reconstruction) is needed, but we really need the experts in here to advice, with a few years of real experience, however much data they can provide. (seek good Advice!)

2.4.4 Determining cause of road pavement failure (Trial Hole) site investigation:
- A few don't know what is the existing road pavement. We should dig a hole & have a look. Trial hole are not expensive.
- The hole will give an indication of the strength of the materials of construction.
- Some things can be known by common sense through digging a trial hole without need for much experience like:
  - How thick is the construction, how thick are the various layers.
  - What type of material is used? bituminous, concrete, granular, what condition is found.
  - What is the high of the water table.
  - What is the type of subgrade, what is the CBR of the subgrade.
  - Is the road pavement material excavated in sound condition or it is stripping & losing.
- All these questions need answering to get at the new road design.

2.4.5 Failure of a road pavement design - Drainage - CBR :
- Drainage is (very important). We must keep the water table low to prevent the moisture content of the (subgrade) from increasing, and hence decreasing the (CBR) value on which the (Road pavement) was designed.
- If this is not done by the use of (French Drains), or even open ditches the road will weaken & fail.
- The water-table will rise & fall from winter to summer, so we should take into condition through the design stages.
- Water below the (Road Pavement) must be kept low & not be allowed to rise up into the construction layers.
- Water that enters the (road pavement) from the surface must have a drainage path.
2.4.6 Road Pavement failure – (Wheel Track Rutting):-
- It is a cumulated plastic deformation as a result of loading cycles.
- During hot weather & the weight of traffic the various bituminous layers will compact causing a depression in the wearing course, it referred to as (Densification).

2.4.7 Road pavement failure - water damage - poor drainage:
- If water entered a road pavement, damage is initially caused by hydraulic pressure, i.e. vehicles that pass over the road pavement cause sudden pressure on water. This pressure forces the water to the road up.
- If water entered the road pavement, and then freeze and thaw during the winter, it will cause failure for the road pavement
- If water arrived to the sub-grade layer, it would make the CBR & the subgrade decrease. Asphalt failure of the road will begin.

2.4.8 Road surface failure:
- The (Road Pavement) is still sound, the (Wearing Course) is still structurally entire, but the surface is beginning to oxidize, this means, the (Skid resistance) is no longer adequate.
- A suitable (Surface dressing) can provide good skid resistance when the traffic loading is not very severe.
- The life of (A surface Dressing) on a very heavily trafficked road can be short.
- Fatted or poor surfaces need to be replaced with thin bitumen macadam wearing courses, e.g. 10 mm CGM.

2.4.9 Wearing Course Failure:
- If the wearing course material has failed altogether, the material will need replacing.
- If there is relatively sound condition an (Overlay) could be used, when surrounding surface "levels" permit the addition of another road pavement layer. This will increase the strength of the road pavement.
- If the (Running surface) is no longer satisfactory but the material itself is still good.
- The (Anti Skid Properties) of the surface may be restored with a suitable (Surface Dressing, or even Retexturing).
- Problems such as (Wheel Track Rutting) also have to be considered. Both the material & (Running Surface) may be adequate but there may be ruts of such depth as to be dangerous to vehicles passing through them on overtaking movements.

- This will mean replacement or (overlay) with (Wearing course) even base course as well

2.4.10 Iron Work Failure & How to Avoid It:-

- The (Ironwork) used in highways maintenance & construction means gulleys (drains), manholes, stop-tap covers, inspection chamber covers, etc.

- All these products will be manufactured according to (British standard) with regards.

- To achieve maximum effectiveness & strength, (Iron work) must be installed in a correct way. Any poor workmanship in installation is the main cause of failure.

- Any (iron work) that has been lifted poorly will "move & settle" making the road unsafe, and cause failure of the pavement construction / surfacing / overlay, & failure of the manhole cover, gully. Etc...

- Chambers/gulley pots are pre-made in concrete, or performed in plastic which is completely surrounded with fresh concrete to get strength.

- The (Iron Work) shall be bedded on an approved mortar, & a strength of 10n. mm. Squared at 2 hours.

- (Ironwork) can be lifted before or after laying the wearing course, but it is preferred to be lift before final surfacing if possible. This allows more inspection of the (Ironwork lifting), and it avoids extra joints in the surfacing & allows better compaction of material.

2.4.11 Why Did It Fail? (Workmanship):

- First, we must determine weather the quality of (Workmanship) available is suitable for the nature of the work to be done according to the workmanship standard.

- In Contrary, some opinion in management who believe that road maintenance & construction can be performed by any type of workman, & can achieve quality of work.

- This is not right. We need qualify men & quality of work.
- This is not right. We need qualified men & good quality plant for quality work & to get the job in hand.

2.4.12 Why Did It Fail? - Bituminous Materials:

- The following are a few main points:

1. Did we order the correct material, & did we receive the material we specified, did we check the delivery ticket.

2. Was the material too hot/cold, did we check the temperature.

3. Did the material (visually) appear to be of the correct (composition), did it look dry/rich, uncoated, coarse/fine, segregated. Make site notes & take sample of testing.

4. Was the suitable material lorry body.

5. Was there segregation with the material, a problem with larger aggregate.

6. With incomplete dried material, we get bituminous material with poor stability.

- This can be a problem in hot rolled asphalt after periods of heavy rain, and when sand stockpiles at quarries have become saturated.

- If you have doubts about a material, record these doubts even if there is no failure at that time. It may still happen!!.

2.4.13 Why did it Fail? Surface Dressing Failure:

- The failure can be obvious, when we have:

1. Wrongly assessed road hardness.

2. Wrong used size chipping.

3. Chosen binder.

4. Different rate of spread of (Binder) e.g.
   a. Incorrect speedometer of sprayer.
   b. Incorrect rate of spread speed chart for a particular sprayer.
   c. Incorrect Tank pressure.
   d. (Binder viscosity) that is not specified.

5. Wrong specified Binder viscosity specified for temperature.

6. Poor traffic control.

7. Site that is not suitable for surface dressing, e.g. areas of "screwing" traffic.

8. Too cold temperature.


10. Badly formulated binder, e.g. unsuitable base binder.
2.5 Maintenance Methods:[25]

2.5.1 Patching with Bituminous Materials
(This summary is related to decision maintenance chart No. 8)

2.5.2 The problem with patching:
- The main problem with patching is that, it is a patch, a small area, probably a lot of small areas to be completed during the day. It is difficult to keep the workability of materials in a full compaction level & without full compaction the life of the patching area will be reduced.
- The first patched areas in the day may be satisfactory but late patched areas in the day may be poor because the temperature of the material is too low to achieve full compaction.
- The list of points that need to be considered as advice & guidance on how to achieve good patching work is as follow:
  - According to the type of maintenance treatment (normal maintenance or emergency patch of a temporary nature needed to make the road / footway safe. (Bituminous material will be chosen appropriate to the work).
  - Where ever possible excavate the patch till you reach sound material both at the edges & beneath.
  - Remove all loose material.
  - Tack coat the base & fully paint all vertical joints with bitumen.
  - Choose an appropriate material for the patch
    - Consider the stiffness and the aggregate size.
  - In patching work it is often needed to choose a material of smaller stone size. That is usually recommended because we will obtain better workability, less segregation & better compaction.
  - Lay, compact the material while it is still hot.
    - This means having enough operative compaction on site.
    - This point can be ignored if we are using a bituminous mixture with a heavily cutback bitumen binder, but only use this material in temporary patches.
2.5.3 Suitability of Bituminous Mixtures for Footway Patching:
- There are only three specified bituminous materials that can be used for footway surfacing & patching, because we usually want to put down only a thin layer of material, so we can avoid constructed work (Kerbs & iron work).
- Three materials are:
  • Macadam, 6MM. Size Medium Graded Wearing Course.
  • Macadam, 6MM. Dense Wearing Course.
  • Macadam, 3MM. Fine Graded Wearing Course (this was known as Fine Cold Asphalt)

2.6 Road Marking with white thermoplastic: [26]

(This summary is related to decision maintenance chart No. 11)

2.6.1 Thermoplastic road marking material:
- This material is supplied in melt able "Poly" bags, e.g., we put the whole bag into the heating unit.
- This material consists of a light colored aggregate, white pigment (titanium dioxide), glass beads, and it is all held together with a thermoplastic resin.
- In the UK recently the thermoplastics was made to a specification that laid down "a recipe", and they will still by many terms (maintenance contracts) where BS 3262.

2.6.2 Producing Quality Road Marking:
- Skilled operator can produce excellent road marking that will comply with most contract documents.
- The thermoplastic material has been used at correct temperature, and the correct amount of good quality glass beads
- A good reflect will be achieved during life of the line. The traffic slowly abrades the line surface. It is not difficult to produce good quality road markings.
- The factor, which is outside the control of everybody is the weather.

2.6.3 Operating Skills:
- The skill of the operator pushing the "trolley" at the correct speed, according to the heat and viscosity of the thermoplastic, will achieve the road marking of the required width and thickness.
2.6.4 Basic "Trolley" Description:

- The hopper at the back contains the glass beads.
- The glass beads are discharged from the hopper on to a flat plate that spreads the beads to the width of the line.
- The flow of the beads must achieve the reflective requirement stated in the contract document.
- It is not difficult to test the reflectivity.
- The difficulty of traffic management cost can be the main factor which conduct performance tests on laid road markings.

2.7 Methods of assign the road type condition:[3]

2.7.1 Standard Test Method for Pavement Condition Index (PCI) Surveys:

- Pavement condition index (PCI) – a numerical rating of the pavement condition that ranges from 0 to 100 with 0 being the worst possible condition and 100 being the best condition.
- Pavement condition rating – a verbal description of pavement condition as a function of the (PCI) value that varies from “Failed” to “Excellent” as shown in figure (2.1)
- Pavement distress – external indicators of pavement deterioration caused by loading, environmental factors, or construction deficiencies, or combination typical distress are cracks, rutting, and weathering of the pavement surface. Distress types and severity levels must be used to obtain an accurate (PCI) value.
- In this study (PCI) was considered as a main numerical rating of pavement condition.

2.7.2 Present Serviceability Index (PSI): [3]

It is considered as alternative numerical rating of the pavement condition that ranges according to:

Table No. 2.1, Classifying of road condition and maintenance type according to (PSI) value

<table>
<thead>
<tr>
<th>(PSI Value)</th>
<th>(Road Condition)</th>
<th>(procedure Maintenance Type)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0&lt; PSI&lt;1</td>
<td>Very poor</td>
<td>(CR) reconstruction.</td>
</tr>
<tr>
<td>1&lt; PSI&lt;2</td>
<td>Poor</td>
<td>(AO2) Thick Asphalt Layer</td>
</tr>
<tr>
<td>2&lt; PSI&lt;3</td>
<td>Fair</td>
<td>(AO1) Thin Asphalt Layer</td>
</tr>
<tr>
<td>3&lt; PSI&lt;4</td>
<td>Good</td>
<td>(RM) Asphalt Spreading &amp; Aggregate</td>
</tr>
</tbody>
</table>
Through using this ranges we will know the road flexible pavement condition maintenance type and materials that should be used.

- **Definition:**
  - PSI = Present Serviceability Index.
  - SV = mean slop variance in both wheel paths i.e. an assessment of surface irregularity.
  - C = Lineal feet of major cracking per 1000 ft² area.
  - P = Bituminous patching in ft² per 1000 ft² area.
  - RD = mean rut depth in inches (both wheel tracks) measured with a 4 ft straightedge (i.e. an assessment of permanent deformation).

- In flexible pavement (PSI) should be calculated through using this equation:
  \[
  \text{PSI} = 5.03 - 1.91 \log (1+SV) - 0.01 (C+P)^{0.5} 1.38 \text{RD}^{0.5}
  \]

- In Concrete Pavement (PSI) should be calculated through using this equation:
  \[
  \text{PSI} = 5.41 - 1.8 \log (1+SV) - 0.09 (C+P)^{0.5}
  \]

- In this study (PSI) was considered as alternative measurement.

2.7.3 **Surveying and Measuring Equipment and Automated Equipment of Roads Distresses:** \[31,32\]

- Equipment for evaluation of skid resistance of pavement (SCRM).
- Falling weight deflectometer.
- Lacroix-type deflectograph.
- High capacity laser profilograph.
- Surface roughness analyzer (ARS)
- Ground penetrating Radar for roads
- Other surveying equipment.
  - Benkelman Beam.
  - Viagraph.
  - Pivoting profilometer.
  - Dynamic penetrometer.
- Dynamic penetrometer.
- Automation and Control (Road Crack Pavement Inspection System)
- Vertek's Accelerated Pavement Test Machine (APTM).

*Note:* Most of these equipment were not available in Palestine. Therefore, different road distresses were measured through visual inspection.
Chapter No. (3)

International (O&M) of (R&T) System Using GIS/DSS in Road
Chapter (3)

International (O&M) of (R&T) Systems using GIS/DSS in Road

3.1 Pavement Management System [PMS] [17]

- Pavement represent the largest capital investment in any modern highway system.
- Maintaining & operating pavements involves complex decisions about how & when to resurface or apply other treatments to keep the highway performing and to keep operating costs at a reasonable level.
- Traditional methods, used since Roman time, left these decisions up to a road supervisor who would select treatments based on his extensive knowledge and experience. This system is still widely practiced and works well in low traffic areas or where repair/restoration funds are not limited.
- However, this is not the situation. First, seldom are there enough funds to complete all identified road repairs. Second, high traffic levels are severely restricted when roads can be closed for maintenance.
- A pavement management system consists of three major components:
- In most agencies, these components are combined with planning needs and political considerations to develop annual highway repair/preservation programs.
- The (PMS) divided the activities required to support pavement management into four main elements. The following is a brief description of each activity:
  1. Construct a database of data elements needed to conduct pavement management analysis (data integration).
  2. Collect history of pavement and data of conditions to populate the pavement management database.
  3. Prepare the available decision supporting tools to conduct pavement management at each level of government (local, regional, or statewide).
  4. Make pavement condition, history and inventory data and pavement management system parameters available to individual jurisdictions (data delivery)

- Through development of the (PMP), the planning, design, and development process had to be considered as institutional issues.
3.1.1 The Roads Maintenance Problem:
- The roads maintenance occupies the pre-eminent position in the hierarchy of highway engineering problems. The large amounts of money needed to be spent on belated highway maintenance programs demand that the maintenance problem be cast.

- Defining the Problem:
- The nature of the problem:
- The problems of road maintenance can be divided into our general categories as follow:
  - Physical
  - Equipment
  - Materials, and
  - Management
- Attached table No. 3.1 shows a breakdown of the physical problems into surface, drainage, shoulder, roadside problem and traffic control each.

Table No. 3.1, Physical problem associated with road maintenance

<table>
<thead>
<tr>
<th>No.</th>
<th>Category Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Surface:</strong></td>
</tr>
<tr>
<td>1.</td>
<td>Paved roads, cracking, breaking, pot-holing, rutting, distortion,</td>
</tr>
<tr>
<td></td>
<td>depression, corrugation, aggregate loss, bleeding &amp; sealing.</td>
</tr>
<tr>
<td></td>
<td><strong>Drainage:</strong></td>
</tr>
<tr>
<td>2</td>
<td>Blocked drains, culverts, malfunctioning under drains, bulking</td>
</tr>
<tr>
<td></td>
<td>shoulders, depressed surfaces, road surface bonding.</td>
</tr>
<tr>
<td>3</td>
<td><strong>Shoulders:</strong></td>
</tr>
<tr>
<td></td>
<td>Bulking, earth/ground loss, depression, erosion.</td>
</tr>
<tr>
<td>4</td>
<td><strong>Roadside:</strong></td>
</tr>
<tr>
<td></td>
<td>Erosion, landslides.</td>
</tr>
</tbody>
</table>

3.2 Traffic Management System [TMS]^{[19]}
- Traffic management is simply the modification of a roadway to discourage usage by a large number of vehicles which travel at higher speeds than residential area ones.
- In recent years, efforts have been made to integrate the geographic information system (GIS) technology with transportation planning modeling. GIS assisted in building the transportation network and Traffic Analysis Zones (TAZs). GIS made it easier to perform sub-area analysis and to modify the (TAZ) structure.

- A number of transportation agencies have used GIS for network coding, socioeconomic data manipulation, and display data from travel forecasting models.

- The Traffic Management System (TMS) reduces incidents and minimizes the impact of incidents by free managing. It may give access by quickly clearing the road way after an incident has occurred. The three major elements of the Traffic Management System consist of:

A - Preparing input data for traffic demand modeling:

- Input data for traffic demand modeling that include a transportation network, TAZs, TAZ centroids, and centroid connectors. GIS can help in building a transportation network from different data sources, such as networks maintained by state or local transportation agencies.

- TAZs usually follow available census data boundaries, such as census tracts, block groups, or blocks, so that data collected in the census can be used with minimal manipulation.

- GIS can help in creating a TAZ map automatically by overlaying the necessary boundary files and by performing query and analysis of socioeconomic and land use data. To connect the transportation network with TAZs, it needs centroids and centroid connectors.

B - Establishing an integrated database:

- A GIS can be used to maintain and manage all map layers and their attributed data related to transportation planning as long as the map layers are geo-referenced.

- The database may include the transportation network and related traffic data, zonal boundary files such as census tracts, blocks, associated socioeconomic data and other layers on land use like hydrography, soil and elevation. Increasingly, image data, such as digital orthophotos and satellite images, are used in transportation planning.

- A GIS allows integration of data from different sources and different scales. It can also aggregate forecasted traffic data and produce cross reference files between different levels of geography.
C- Displaying Modeling Output:
- GIS is an excellent tool for displaying transportation data and model results.
- The graphic presentation is important for effectively communicated results of a transportation model on the public and elected officials.
- GIS's query capabilities make it possible to quickly respond to questions that arise during meetings, and to focus attention on affected area.

3.3 Traffic Team Management System [TTMS] \(^2\)
- When a major incident occurs, a traffic management team is dispatched by the Transportation Management Center (TMC) to provide equipment and personnel to aid in the management of traffic near the incident site. When a truck pass message sign (CMS) and portable a Highway Advisory Radio, the Team can provide early warning and alternate route or detour signing to motorists. This warns drivers so that they may be alerted to the unusual conditions and they may adjust their speed to provide a larger margin of safety or consider using alternate routes to bypass the problem.
- (TTMS) are dispatched to major incidents. They do not duplicate normal activities or maintenance function. They supplement these functions with emphasis on improving traffic flow through or around the incident.

3.4 Decision Support System in Operation & Maintenance of Roads & Traffic [DSS in (O&M) of (R&T)] \(^{15}\)
- Through implementation of any kind of project or research concerning roads, planning and management involves different types and levels of decisions.
- There have been many attempts to classify these decisions. One of the classifications that show hierarchical descriptions of information and decision flows among each type of decisions is the following:

A - Strategic planning decisions:
- Decisions related to choose the highest-level policies and objectives were made.

B - Management control decisions:
- Decisions were made for the purpose of assuring effectiveness in the acquisition and use of resources.

C - Operational control decisions:
- Decisions were made for the purpose of assuring effectiveness in the performance of operations.
D - Operational performance decisions:
- Day-to-Day decisions were made while performing operations
- Strategic decisions are associated with the most important used levels.
- Operational performance decisions are related to daily ones that are concerned with specific tasks.
- A key point in this classification is that high-consequence decisions are made in a less frequent way than low-consequence decisions.
- Highway management is a process that accompanies several highway-related activities involving planning, design, construction, operation, maintenance, and research developments. Each of these activities require frequent decision making in order to approach various problems that are ambiguous in terms of their scientific aspects. Hence, in order to carry out the management process effectively, some types of decision support system is essential.
- In general, a decision support system (DSS) can be defined as a system that supports technological, managerial decision making by assisting in the organization of knowledge about illustrated, semi-structured or unstructured issues.
- A DSS is an interactive, computer-based system that helps decision makers in utilizing data and models to solve ambiguous problems.
- A DSS caters satisfy the needs of all levels of management decisions. However, it is oriented toward the needs of strategic and tactical level management. The decision levels of particular interest involve strategic planning and management control decisions.
- A DSS emphasize the significance of interactive activity and the direct involvement of the user. This implies feedback between the different elements of the system based on this feedback mechanism inherent in a DSS.
- The user of a DSS can improve the quality of decision making and can move management toward achieving better use of limited highway resources.
- The role of the DSS is to answer “What is, what would, and what if” questions.
- The major components of a DSS include a model-base management system (MBMS), a database management system (DBMS), and a display generation and management system (DGMS). The architectural aspects of the DSS are shown in Fig. (3.1). The key word is “knowledge”. To approach it, a model is driven
knowledge is information. Understanding is a strategic approach to knowledge; information is a tactical approach gained piece by piece from data.

- Referring to figure (3.1), the knowledge base should be obtained from both information and understanding. Both database and Model Base are needed. As indicated in Figure (3.1), a DSS requires wisdom, which is knowledge applied within value base or value system so as to be able to trade between highway mobility and highway safety.

- The following describe the major features and roles of each management system.

3.4.1 Model Based Management System (MBMS)

- A model is an obstruction of reality that duplicates the functional essence of the system and sufficient details is to be used instead of the system for investigation and experimentation with less time, less money, and less risk. To the extent that a particular model is an appropriate representation of the system. It can be valuable aid to policy analysis, decision – making and problem solving.

- The important characteristic of an (MBMS) is that to enable the decision – maker to make decisions through using database with a model base of algorithmic procedures. The purpose of an (MBMS) is to generate information that is useful for decision making by utilizing data from (DBMS).

- The major objective of (MBMS) is to provide efficient models for use in specific applications, to centralize model-base management in the DSS framework, and to provide for model access and integration.

- The model is the backbone of the DSS, and three benefits occur:

  1. The model can be preserved over time without a loss of precision, which make it a good contribution to recorded knowledge.

  2. It can be executed on a computer where policy variables and measures of effectiveness can be outputted over future time in a form of scenario analysis.

  3. The model is a base for its own improvement using ensuring data or information. It is important to stress that model building comes before data collection. Indeed the model determines and prioritizes the data requirements.

- In performing highway management using a DSS, a model should satisfy the following requirements:

  - Major maintenance activities should be addressed.
- Inventories of physical assets to be maintained should be accompanied by data on their conditions.
- Distinct measures of levels of service should be defined and incorporated within the highway management system (HMS) planning and budgeting routines.

- The DSS highway management is adapted at an acceptable level of service in the form of a simulation and optimization model.

![DSS Process Diagram]

**Figure No. 3.1, DSS Process** [15]

- The DSS constructed in their research is linked with the GIS so as to facilitate the acquisition and preparation of highway related data, the graphical representation of basic data and analysis results.
- A pavement management model, as an analysis module in the (MBMS), is used to analyze pavement condition, and to predict future deterioration under different budgets and scenarios.
- The model also provides performance evaluation regarding the surface and service conditions of the highway system and changes in vehicle operating costs.

### 3.4.2 Database Management System (DBMS)

- A (DBMS) is one of three main components of a DSS. Through decision making process, wide data base system need to utilize for decision making.
- A (DBMS) is established to pursue three major objectives:
  - Data independence.
  - Data redundancy reduction.
  - Data resource control.

- Desirable characteristics of a (DBMS) include the following:
  - Ability to combine a variety of data sources through a data capture and extraction process.
  - Ability to add and delete data sources quickly and easily.
  - Ability to portray logical data structures in user terms.
  - Ability to handle personal and unofficial data at the user's request.

- In order to construct a (DBMS), a data model should first be identified. A data model is a collection of data structures and operations. There are four models that may be used to represent data:
  - The individual record model.
  - The relational model.
  - The hierarchical model.
  - The network model.

- The typical form of a (DBMS) consists of:
  - A spatial data base and
  - An attribute data base.

- The spatial database includes data describing the spatial distribution of geographic features in an area. The basic features primary include a highway network and a region's boundaries. The attribute data base includes the representative non-graphic information associated with each area and road section. This information includes, for example, pavement type, traffic volume, road capacity, etc.

3.4.3 Display Generation and Management System [DGMS] (Visualization)
- The result presentation system based on display base can be broadly categorized into (DGMS). The primary purpose of the DGMS) is to enhance the propensity and ability of the system user to utilize and benefit from the DSS.

- The (DGMS) is designed to satisfy knowledge representation, control and interface requirements of the DSS. The (DGMS) is responsible for presentation of the information outputs of the (DBMS) and (MBMS) to the decision-makers and for acquiring and transmitting their inputs to the (DBMS) & the (MBMS). It
should accommodate the languages or control mechanisms, which enable the user to manage the DSS outputs and inputs in the form of dialogues or processes.

- The types of languages or modes of communications can be broadly categorized into three types: words, mathematics, and graphics.

- There are five primary interaction styles for human computer interaction:
  1. Menu selection: in which the user prepares a list of items and selects the one, which is most appropriate for a particular task.
  2. Command language: in which the user interact with the system and should understand the DSS, and training is necessary.
  3. Forms: In which the data entry is required to fill in blanks in spaces of answers. Users should understand the logical structure of a DBMS to use this approach.
  4. Natural language: in which users are is able to input ordinary conversational dialogue
  5. Direct manipulation: in which the user is able to use graphical representation.

- The main function of the (DGMS) is to produce a screen of data display and information generated by the (MBMS). These output could be in a thematic map or in tabular formats or data files. These representations are usually facilitated utilizing GIS.

- Most GIS implementations consist of a data base and a display base. The display base using GIS presents the results of data queries and analysis in a geographic context.

3.5 Regional Case on (O&M) of (R&T) [Kuwait] [23]

- Maintenance Administration of the Kuwait Ministry of public works (MPW) has realized that using state of the art technologies & modern management techniques, including geographic information systems, is a must. Computers would be used for data storage & analysis. (GIS) must be a component of the overall system to provide integrated analysis & Maintenance planning on a nation wide basis. More cooperation between (MPW) maintenance programs & the programs of other ministries must be done to avoid any potential conflicts.

- Each of the individual (R&T) components are linked to Arc View which serve as the common (GIS) for the Kuwait (R&T. MMS)
Available (R&T) inventory & attribute data from existing map based such : the Kuwait Data Information Management System (KUDAMS) are being electronically ported to the (R&T. MMS) to serve as base attribute information.

- In addition to the existing utility spatial files, a street center line has been generated, linked for mapping access & displayed pavement & other information.
- Through the integration process, all the components may be viewed on one map so that integrated projects may be developed for maintenance & rehabilitation of the (R&T).

3.5.1 Kuwait (R&T. MMS) Components:
- The Kuwait (R&T. MMS) is made up of number of components integrated together in a common system, consisting of:

A. Pavement Management System [PMS]
- The (PMS) provides a comprehensive inventory & Conditioned Assessment of the road network of Kuwait.
- The model provides maintenance & rehabilitation analysis & development of priority programming.
- The (PMS) includes a comprehensive pavement database of:
  - Sectional information.
  - Section location & ID number.
  - Pavement length, width & no. of lanes.
  - Pavement layer thickness & type traffic volumes.
  - Drainage consideration.
  - Maintenance history data.
  - Shoulder information ad curb/ gutter.
  - Performance information, rehabilitation & maintenance work, cost & contract date.
  - Roughness, deflection, distress & skid resistance.
- The (PMS) also includes capabilities of network analysis based on the following:
  - Smoothness of ride provided to users.
  - Ability of the pavement structure to carry the current traffic loading.
  - Occurrence of pavement defects, deformation & cracking, the extent of each & the level of severity.

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- Safety aspects resulting from skid resistance evaluation.
  - The data is used to:
    - Develop pavement quality index to allow for objective comparison of one section versus another.
    - Or as the basis for current status summaries & future performance predictions.
    - Network - wide rehabilitation programming can be developed for up to 10 years in the future.
    - The system identifies the sections in need of rehabilitation & the most cost effective strategy to consider for each, based on the financial parameters provided by the user.
  - An optimum plan priority list is then determined for a specific budget.

B. Bridge Management System [BMS]

- The (BMS) is a management tool which help to organize implementation of all activities related to bridge maintenance, replacement & rehabilitation programs.
  - The (BMS) assists decision makers by using:
    - Maintaining all bridge inventory information.
    - Defining bridge conditions, identifying bridge needs & funding requirements for maintenance, replacement and rehabilitation (MR & R) Programs.
    - Identifying & prioritizing bridges for (MR & R) Programs.
    - Identifying bridges for assessment.
    - Finding cost-effective (MR & R) alternatives for each bridge.
    - Recommending & Accounting of (MR & R) strategies.
    - Scheduling minor maintenance & inspections through the work management system (WMS)
    - Monitoring bridges & Maintaining the appropriate database sof information.
  - The Comprehensive database of the (EMS), which stores information for every bridge includes:
    - Structure identification (number, location, type & name).
    - Rating (According to local loading conditions).
    - Strategic importance & engineering criteria.
    - Loading (type of construction & year).
    - Traffic volumes & year, speed limit, length/width, clearance, etc.
- Safety criteria, approach width, weight limit, sight distance, no. of accidents, etc.
- Secondary Information: -
- Historical significance & conditioning, road way approach.
- Estimated remaining life, Channel rating, super-structure, intermediate support & substructure.
- A Prioritized list bridge maintenance and rehabilitation programs can be developed on an annual basis for a ten year period. Budget or schedules can be modified.

C. Right- of- way features management system [ RFMS]
- The (RFMS) includes all features related to the street right of way like:
  - Traffic signs, pavement marking, traffic signals, guard - rails, curbs, gutters sidewalk & other roadway features.
- The (RFMS) outputs include:
  - Condition, priority list of work & complete details of location with costs that are provided through the work management system (WMS).
- The system will automatically establish inspection schedules.

![Diagram](image)

Figure No. 3.2, Kuwait (O&M) of (R&T) System
Chapter No. (4)

Middle Area Selected Municipalities
(Nusairate, Buraij & Maghazi)

(Existing Situation)
Chapter (4)

Middle Area Selected Municipalities (Nusairate, Buraj & Maghazi)

4.1 Roads & Traffic- Assets (Existing Situation)
4.1.1 Background:

- Middle area population till June of year (2003) is expected to be 192,655 habitants.
- (Dair Al Balah, Nusairat, Buraj, Maghzai, Zawaida, Al Musaddar and Wadi Al Salqa) are expected to be (57,000, 59,469, 33,481, 22,415, 14,291, 1,698 and 4301) habitants respectively.
- The total area of the middle governorate is (56.41 km²)
- The total area of (Nusairate, Buraj & Maghazi) are (18.87 km²) which is as: (9.8, 5.570, & 3.5) km² respectively
- The total length of the roads of the Governorate is (192.3 km). They are classified as follow:
  - Primary roads = 36 (18.7%)
  - Secondary roads = 62.5km (32.5%)
  - Tertiary roads = 40 km (20.8%)
  - Supplementary roads = (28%)

Table No. 4.1, The Roads distribution in middle area Governorate according to the type of road and vehicle flow/loading

<table>
<thead>
<tr>
<th>No.</th>
<th>Category</th>
<th>Length (Km)</th>
<th>Traffic Flow V.P. D</th>
<th>Typical 20 Years traffic Loading (m.s.a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Primary</td>
<td>36</td>
<td>&gt;14000</td>
<td>20</td>
</tr>
<tr>
<td>2.</td>
<td>Secondary</td>
<td>62.5</td>
<td>8000-14000</td>
<td>8</td>
</tr>
<tr>
<td>3.</td>
<td>Tertiary</td>
<td>40</td>
<td>40000-8000</td>
<td>2.5</td>
</tr>
<tr>
<td>4.</td>
<td>Supplementary</td>
<td>53.8</td>
<td>&lt;4000</td>
<td>1.6</td>
</tr>
<tr>
<td>Street No</td>
<td>Street Name</td>
<td>Zone</td>
<td>Length</td>
<td>Carriage way width</td>
</tr>
<tr>
<td>-----------</td>
<td>----------------</td>
<td>----------</td>
<td>--------</td>
<td>--------------------</td>
</tr>
<tr>
<td>N/01</td>
<td>Abu Baker (1)</td>
<td>Nusairat</td>
<td>1100</td>
<td>15</td>
</tr>
<tr>
<td>N/02</td>
<td>Abu Baker (2)</td>
<td>Nusairat</td>
<td>2800</td>
<td>6</td>
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<tr>
<td>N/03</td>
<td>Khaled Ben Alwaled</td>
<td>Nusairat</td>
<td>1470</td>
<td>7</td>
</tr>
<tr>
<td>N/04</td>
<td>Omar Ben Khabat</td>
<td>Nusairat</td>
<td>2400</td>
<td>7</td>
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<tr>
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<td>Nusairat</td>
<td>550</td>
<td>7</td>
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<td>Alkadesia (2)</td>
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<td>600</td>
<td>9</td>
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<tr>
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<td>7</td>
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<td>Al-Zohor</td>
<td>Nusairat</td>
<td>450</td>
<td>8</td>
</tr>
<tr>
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<td>250</td>
<td>8</td>
</tr>
<tr>
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<td>N/14</td>
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54
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<td>23075</td>
<td>20313</td>
<td>15213</td>
<td>58601</td>
</tr>
</tbody>
</table>

Table No. 4.6, Costs of roads according to their types in (Nusairat, Buraij and Maghazi areas)

<table>
<thead>
<tr>
<th>No</th>
<th>Cost according to roads type</th>
<th>Nus. ($)</th>
<th>Buraij ($)</th>
<th>Maghazi ($)</th>
<th>Total roads costs ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cost of main asph. Roads</td>
<td>2814790</td>
<td>2505604</td>
<td>1517595</td>
<td>6837989</td>
</tr>
<tr>
<td>2</td>
<td>Costs of main tiled roads</td>
<td>172900</td>
<td>-</td>
<td>-</td>
<td>172900</td>
</tr>
<tr>
<td>3</td>
<td>Cost of sec. Tiled. Roads</td>
<td>735500</td>
<td>295288</td>
<td>263343</td>
<td>1294131</td>
</tr>
<tr>
<td></td>
<td>Total Lengths</td>
<td>3723190</td>
<td>2800892</td>
<td>1780938</td>
<td>8305020</td>
</tr>
</tbody>
</table>

4.1.2 Road Cost Estimation:

- Through analyzing the detailed data and the bidder costs about the roads in Middle area, the value of roads are estimated according to the total length of each type, as follow:
  - The average width and length of each type of road is determined through reviewing as built & detailed drawing in each municipality.
  - The average cost per square meter for each type of road is determined by inquiry from contractors, reviewing and analyzing many tenders of road projects implemented in middle area municipalities.
  - The results were as follow:

Table No. 4.7, Cost of road ($/m^2$) according to its type

<table>
<thead>
<tr>
<th>No.</th>
<th>Type of Road</th>
<th>Cost of Road ($/m^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Asphalt road with curbstone &amp; sidewalks</td>
<td>20$</td>
</tr>
<tr>
<td>2</td>
<td>Asphalt road without curbstone &amp; sidewalks</td>
<td>18$</td>
</tr>
<tr>
<td>3</td>
<td>Tiles road with curbstone &amp; sidewalks</td>
<td>21$</td>
</tr>
<tr>
<td>4</td>
<td>Tiles road without curbstone &amp; sidewalks</td>
<td>19$</td>
</tr>
</tbody>
</table>
- The reduction value for depreciation per year = 5% from the road cost.
- The life time of road is 20 years.

Table No. 4.8, Equipment and tools used for maintenance through the joint service council [7]

<table>
<thead>
<tr>
<th>No.</th>
<th>Description of equipment &amp; tools</th>
<th>No.</th>
<th>Cost($)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A - Heavy equipment :</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Wheel Loader</td>
<td>1</td>
<td>130000</td>
</tr>
<tr>
<td>2</td>
<td>Excavator</td>
<td>1</td>
<td>56000</td>
</tr>
<tr>
<td>3</td>
<td>Jetter</td>
<td>1</td>
<td>108000</td>
</tr>
<tr>
<td>4</td>
<td>Track Provides with crane</td>
<td>1</td>
<td>112000</td>
</tr>
<tr>
<td><strong>B - Small maintenance equipment &amp; tools</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Asphalt Cutter ( Saw)</td>
<td>1</td>
<td>1700</td>
</tr>
<tr>
<td>2</td>
<td>Plate Compactor</td>
<td>1</td>
<td>1000</td>
</tr>
<tr>
<td>3</td>
<td>Roller Compactor (1.0 Ton)</td>
<td>1</td>
<td>9000</td>
</tr>
<tr>
<td><strong>C - tools- To maintain &amp; clean different equipment</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Air Compressor</td>
<td>1</td>
<td>500</td>
</tr>
<tr>
<td>2</td>
<td>Air Lubricator</td>
<td>1</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>Special pump (for cleaning equipment)</td>
<td>1</td>
<td>170</td>
</tr>
<tr>
<td></td>
<td><strong>Total Costs</strong></td>
<td></td>
<td><strong>418620 $</strong></td>
</tr>
</tbody>
</table>

4.1.3 Staff responsible for maintenance works of roads & traffic in (Nusairat, Buraij & Maghazi ) Municipalities [7]

Table No. 4.9, Distribution of maintenance staff in the three municipalities:

<table>
<thead>
<tr>
<th>No.</th>
<th>Staff</th>
<th>Nusairate</th>
<th>Buraij</th>
<th>Maghazi</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Civil Engineer</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Technical Person</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>Labor</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>Forman</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>1</td>
<td>7</td>
<td>6</td>
<td>20</td>
</tr>
</tbody>
</table>

- One mechanical engineer, who is responsible for " Joint services council ", Cooperate with the maintenance staff to provide them with required equipment & tools.
- Two drivers for heavy equipment.

Table No. 4.10, Number of traffic components through the different types of roads in the three municipalities:

<table>
<thead>
<tr>
<th>No.</th>
<th>Staff</th>
<th>Nusairae</th>
<th>Buraij</th>
<th>Maghazi</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Traffic Signs No.</td>
<td>66</td>
<td>131</td>
<td>38</td>
<td>235</td>
</tr>
<tr>
<td>2</td>
<td>Iron hand rails m.r</td>
<td>80</td>
<td>80</td>
<td>0</td>
<td>160</td>
</tr>
<tr>
<td>3</td>
<td>Humps No.</td>
<td>26</td>
<td>73</td>
<td>2</td>
<td>101</td>
</tr>
<tr>
<td></td>
<td><strong>General Total</strong></td>
<td>172</td>
<td>284</td>
<td>40</td>
<td>496</td>
</tr>
</tbody>
</table>
4.2 Technical & Institutional Dimensions Related to (O&M) of (R&T) in the Middle Area (Existing Situation) \textsuperscript{2,14}

4.2.1 Operation and Maintenance Status:

- The current situation fails to provide a clear and accurate definition of the responsibilities required to manage, plan and execute road maintenance in any uniform or coherent manner, due to the following reasons:
- There is no precise definitions or criteria for the levels of (O&M) required, such as reconstruction, rehabilitation, safety and preventive (routine maintenance).
- There is no proper emergency repair, minor or routine maintenance that overlays activities carried out by the municipalities.

A- Policy:

- There is no proper identification of (O&M) policies for maintenance activities that carried out by the municipalities for the roads projects.
- No a coherent and planned policy or strategy to balance needs of resources

B- Human Resources:

- It is divided into three categories as : (Training, Capability, & Qualifications)
- The experience and training of the municipal engineers is not uniform, sufficient or appropriate to the required maintenance activities.
- The technical staff, if at all exist, (foremen, operators, etc) are not appropriately trained or experienced for maintenance works.
- The lack of trained engineers in the municipalities/village councils seems to be an obstacle to effectively monitor the maintenance needs and activities in any municipalities.
- There is no defined and declared training policy and there is no separate entity for different ministries and other organizations that are responsible for conducting maintenance training courses for any level of staff.
- The number and function of the staff of the maintenance team is unbalanced and require improvement.
- There is no pool for equipment or personnel in any governorate to support the local maintenance teams during absence of staff.
- No professional maintenance team staff, are available & competent to evaluate a program & execute a maintenance activity in adequate way.
- There is no clear and defined criteria for selecting qualified technical staff at all level for the maintenance teams.

C- Budget:
- Most of the municipalities are recently formed and have very little budget.
- There is no proper and clear (O&M) budgeting for (R&T) including systems or procedures for (O&M) Expenditures.
- Regarding allocations of annual budget for maintenance in the municipalities, there is no allocation of funds within any department for carrying out road maintenance and asphalt overlays in the municipalities. Even if there is small fund, the allocation is not based on systematic and technical criteria which reflects the actual needs of the municipalities.
- Also, it failed to identify the levels of intervention below which maintenance become less economic and allows the roads to deteriorate on basis of unacceptable conditions.

D- Office- Work Places:
- There are no sufficient (O&M) teams employed by the municipalities, with no work stations (offices).

E- Equipment:
- There are no sufficient equipment or tools owned by the municipalities for carrying out road maintenance activities.
- There is no proper modern surveying and measuring equipment for the roads distresses, or automated equipment, that will help the maintenance staff to gather all the data requested.
- There is a big problem in dealing with different large data without using modern techniques like (GIS/DSS).
- The number and type of maintenance equipment for every municipality do not reflect the work load and maintenance needs.
- The movement of the municipal engineer in the municipalities is limited by the availability of transport which is constrained by the work load of all other activities within the municipalities. This also is due to the availability of shared equipment.
F- Organizational Chart & Job Description:
- There is no sufficient technical staff employed by the municipalities. In each municipality; one engineer, on a full time or part time bases. However, his job description or duties do not include carrying out (O&M) of (R&T) activities.
- There is no sufficient maintenance teams for every municipality, regardless of the size and maintenance needs.
- There is no clear developed organizational chart for each municipality which demonstrates the existence of independent (O & M) department or section.
- Also, there is no clear organizational chart linking, technically, the several municipalities in each governorate. And there are no authorities responsible for technical or maintenance department at the ministry of local government.
- There is no job description for the municipality staff, and for the municipality’s engineer (if exists), particularly for those activities related to (O&M).
- The current municipal structure and the lack of job descriptions failed to define a coherent maintenance policy, thus leading to the actual, observable situation of maintenance activities.

G- Specialized Departments / Unit:
- There is no centralized (O&M) department for each governorate provided with modern techniques like (GIS/DSS) system, which is responsible for budgeting and carrying out the required (O&M) work in the municipalities of the governorate.

H- Codes Standards & Work Procedures/ Plan:
- There is no definite methods of repair or acceptable standards.

I- Documentation:
- It is divided into three categories as: (plans, reports, & reporting capabilities)
- No work schedules for (O&M) of (R&T) in each municipality.
- Most of municipal engineers are not prepared for the proper reports related to the maintenance activities conducted at the municipality, percentage of work completed and the state of equipment, etc.
- The lack of reports lead to a policy response from the management with the result than no clear, definite and directive instructions issues.
4.2.2 Technical Issues:

4.2.2.1 Operation:

A- What is currently, operated

- New elements of road pavements, which will be mentioned later, has been executed in the last year in the middle area, and there is a need to operate it according to special standard & our existing design criteria.

- Different traffic components such as: Traffic signs, Iron hand rails, road marking (painting), humps and cat eyes are operated and controlled through the cooperation between traffic department & engineering department in every municipality.

- Organizing & controlling the movement of people & trespassing on the side walk is regarded as the main responsibility of the environmental department, engineering department & traffic department. Now the work in this side is difficult due to our hard political situation.

B- Why to operate

- Operation is defined as "procedures & activities in actual delivery of the services"

- Operational objectives are functions of purpose of the facilities: controlling & organizing vehicles & people movement through these roads according to predetermined performance standard.

C - Who is operating what

- Each Municipality in the middle area is responsible for dealing & operating all the roads & traffic categories located inside the municipality's boundary.

- Traffic department & most of departments of municipalities like engineering, environmental health & illegal department are controlling & operating all vehicles & people movements along these roads.

- There is no special independent department in every municipality concerned with operation process in roads & traffic sector.

D- How is it being operated

In the perfect situation the information related to operations subdivides into that part of operations dealing with hardware facilities and that part of operations dealing with workers (software).
- Every municipality has special regulations, through which it will control & organize the operation process along the road pavement, sidewalks & traffic elements, through different departments & traffic department.
- The existing operational information system is working in manual manner without using any automatic control with software.
- There is no electric power, which is to be used through operation process.
- Without using any software programs, the work will be very difficult.

F - Elements that are currently, operated:
- The road pavement, side walk & traffic are divided into:
  - Carriage way (structural section consisting of: subgrade, subbase& base, base course & wearing course layer)
  - Sidewalk / footpath.
  - Curbstone.
  - Roads marking (painting).
  - (Iron Works) means gullies (drains), manholes, stop-tap cover, inspection champer covers, ... etc
  - Parking area.
  - Traffic signs.
  - Iron hand rails.
  - Electrical poles.
  - Telephone poles.

4.2.2.2 Maintenance:
A- What is being maintained now?
- Different items to be considered in road bed maintenance, side walk & traffic elements
  - Cracking.
  - Iron working failure.
  - Pavement structure failure.
  - Settlement in the road pavement.
  - Wearing course (road surface) failure, potholes or cracks will consists.
  - Loss of lateral support from edge of pavement.
  - Sidewalk structure failure.
  - Curbstone failure.
• Settlement in the tilling.
• Road marking (Painting)
• Traffic signs repair or damage.
• Humps failure.
• Cat eyes loss or damage.
• Hand rails damage or needs repair or painted.
• Electrical poles damage.
• Telephone poles damage.

B- Maintenance Methods

- In all middle area municipalities, most of road beds, side walks and traffic elements are repaired or maintained by random manner, through using some small tools, some unsuitable materials and unqualified workmanship without planning or any accurate system, related to the roads maintenance.

- Most of roads patching are maintained according to type of failure as follow:

➢ Road pavement failure - water damage poor drainage:

  • The way of maintenance:
    - Cutting the wearing course (road surface) around the damaged area.
    - If there is any moisture under the wearing course layer, it is indication that there is underground drainage problem. Usually excavation, searching & repairing will be done according to available material & experience.
    - Refilling the excavation by using unsuitable material, with insufficient compaction, without making any laboratory tests.
    - Trying to be 15 cm thick of compacted base course material less than (10-12cm) of the existing asphalt level.
    - Mostly, plain concrete with thickness of (10-12cm) will be used, because it is more available than hot bituminous mix.
    - Sometimes, if the municipality has any road project, which needs bituminous material, all asphalt patching areas will be prepared by using a hot bituminous mix with 7cm thickness after compaction, and through supplying additional quantity after spreading a suitable binder material (Mco or Rc2 over the edges).
Wearing course (road surface) failure, and appearance of potholes cracks:

- The way of maintenance:
  - Cutting the wearing course (road surface) around the damaged area.
  - If there is no moisture under the wearing course layer, the indication is that there is underground drainage problem.
  - More base course material will be added if there is any settlement.
  - Usually, temporary maintenance by using (10-12cm) plain concrete B(250)kg/cm² will be done.
  - If the municipality has any road project which needs bituminous material, all the temporary maintenance areas will be re-maintained by replacing plain concrete to a hot bituminous mixture, also all remaining damaged road surface damaged will be maintained.
  - It is seldom that the municipality supplies a hot bituminous mixture to maintain all Asphalt patching areas, because it is a small areas to be completed during the day.
  - It is difficult to keep the work ability of materials in a full compaction level & without full compaction, the life of the patching area will be reduced.
  - The areas patched first in the day may be poor because the temperature of the material is too low to achieve full compaction.

Side walk failure:

- The way of maintenance:
  - Determine the cause of failure.
  - If there is any moisture or water noticed around the failed areas, the following will be done:
    - repairing & maintaining the cause of failure that will be done by excavation the side walk layers & refilling the layers with compacting manner
    - Supplying & installing the additional quantity of the enter lock tilling if it is available.
  - Sometimes, plain concrete as a temporary maintenance will be done

- If the failure was beside any manhole:
  - First we must repair and maintain the manhole.
- Secondly, all the failure areas around the manhole will be compacted, using the existing materials.
- Finally, re-tilling the old tiles and casting the remaining areas with plain concrete.

➤ **Curbstone failure:**
- Some the mortar between the curbstone are broken when it is being under a heavy load. In this case, replacing the damaged curbstone will be done through available material & workmanship.
- Every long period some municipalities maintain & paint the broken parts of the curbstone by using reflecting painting material as a local Arabian product & by using available unqualified workmanship in randomly manner without any precise plan.

➤ **Traffic signs, handrails, humps & cat eyes damaged:**
- Any damage taking place for these items will be maintained by using some available tools, materials and untrained labors in randomly manner without any precise plan.

➤ **Marking lines & arrows (Disappeared):**
- There is no existing maintenance program related to this item.

➤ **Electrical & Telephone Poles Failure:**
- Any damage related to these items will be repaired through (electrical & communications) companies.

C- **Evaluation process:**
- First the maintenance staff will assign the location & the type of needed maintenance as follow:-
  - If there is any settlement or any moisture noticed in the surface level, this means that underground drainage problem will exist.
  - If there is any cracks or potholes in the wearing course layer without any settlement or any moisture appearing under the damaged wearing course, this means that the wearing course will need replacing by using a suitable material.
  - When there is any settlement beside (the manhole or any iron works), this means that the problem related to the manhole or the iron works parts will need to be maintained.
- If there is any settlement or movement in the side walk tiles with wet sand appearing on the surface level. This means that underground drainage problem will be exist.

- Another similar case but without any moisture (or wet sand) noticed, this indicates that, the side walk layers were heavy loaded, or poor compaction was applied in the side walk layers.

- If there is any movement or cracks in the curbstone, this means that heavy load will be applied.

- Movement of the handrails, cat eyes and traffic signs means that poor fixation will be done due to different causes.

- Disappearance to the painted lines or arrows indicates that the painted type product is not acceptable.

- In this term according to our existing system, there is no based data related to the history of a road pavement. This can be obtained from a core (or a trial hole), which will help the technical staff to know the type of road failure and how to achieve a good maintenance through precise decision & according to existing design criteria.

D- Who is doing what?:

- Most of maintenance in all municipalities is executed through the cooperation between different departments.

- "Joint services council", which was established two years ago in the middle area municipalities, helps the technical staff to provide them with some tools, equipment & materials that will be used to achieve the maintenance requirements.

- Usually, untrained labors are used to achieve all maintenance requirements.

- All departments’ chiefs, who are responsible for all maintenance works, have not any precise plan, and they are not experts in the roads & traffic maintenance sector.

- Through this existing system, we don’t have any quality plan & qualified workers to execute the maintenance works according to the workmanship standards & using these equipment in safe manner.
- There is no independent department responsible for all maintenance requirements.

E- What Technology:

» Road Management & (O&M) of Roads in the middle area:
  - There is no modern techniques related to the data information management system like GIS or any software programs.
  - There is no a precise system related to a sign the available roads & traffic inventory, to get a good integration link process between different components of roads & traffic.
  - Through using Autocad program, the technical staff can get some detailed information through storing as built drawing, which are used through maintenance works.
  - All the roads & traffic maintenance works are executed in traditional manner, by using small (tools, equipments & materials) without modern planning, scheduling and any modern techniques, like recycling system & others.
  - There is no laboratory tests through maintenance works, also, there is no system that will help the technical staff to get an accurate historical data information of road pavement components.

F- Codes To Follow:
  - There is no clear code available in the operation of maintenance works.
  - Usually in ironworks maintenance, (B.S) is used to get any iron part product.
    Sometimes, Arabian local code is used

• Existing standards in Middle Area Municipalities:
  - There is no unified national technical specifications for conducting repair and maintenance works of roads.
  - National standardized tender documents are not available for repair and maintenance road work, which can be utilized by the municipalities.
  - Detailed technical procedures are not available for the execution of any repair work whether patching, filling the cracks, surface dressing... etc, or for an asphalt overlay, if carried out by municipality direct labor.
4.2.3 Institutional Issues:

4.2.3.1 Institutional Units: - (Existing organizational set-up)

- Each municipality in the middle are has its own structure
- (Organizational staff).
- The attached figures No. (4.5, 4.6 & 4.7) indicate the organizational set-up of (Buraj, Nusairat & Mahgazi).

- **Description the existing situation:** (of Ai-Buraij municipality, as example area)

- The organizational set-up of Buraj Municipality consists of:
  1. Mayor of municipality and 5 council members.
  2. Legal advisor (coordinate with all chief department).
  3. Administrative department (secretary & typist).
  4. Engineering department (chief engineer, 2 assistance engineer, surveyor, 2 technical employees for water & sewage works and 3 workers used there when they are needed). with no well defined roles for road unit/ department
  5. Financial department (Chief accountancy & assistance of accountancy, revenue collection and store man).
  6. Environmental and health department (chief department, one Forman, 4 drivers, &8 workers).
  7. Public relationship department (deals with all municipal departments).
  8. "Joint services council" which was established two years ago did not take its role until now, due to:

- There is no managerial & technical staff, sufficient to apply (O&M) of (R&T) requirements. Also, there is no clear developed organizational chart, which demonstrates the relationship between the "joint service council" and middle area municipalities.

- Also, there is no sufficient (O&M) budgeting for (R&T)(including systems for (O&M) expenditures.

- The high administrative level, did not encourage to develop & improve the "Joint service council". 

68
Existing organizational set-up of
Buraij municipality

Municipal Council
(5 members)

Mayor of
municipality

Joint Services
Council

Cooperate with other municipalities

Legal affairs
(Legal Advisor)

Administration
Department

Secretary

Typist

Technical Office Manager

Financial Office Manager

Environmental Health department
(Chief Dept.)

Public Relationship Dept.

Assistance of Accounting

Cleaning & solid waste collection

Revenue Collection

Environmental & public health

Store man

Equipment & Workshop

Urban Planning & organization
(Surveyor)

Projects
(2 engineers)

Water
(2 tech. employees)

Sewage
(3 workers)

Figure No. 4.2, Existing organizational set-up of Buraij municipality
Existing Organizational Set-up of Nusairat Municipality

Figure No. 4.3, Existing organizational set-up of Nusairat municipality

70
Existing organization Set-up of Maghazi municipality

Figure No. 4.4, Existing organizational set-up of Maghazai municipality
4.2.3.2 Staff & Functional relationships:

- There is no independent department concerning with maintenance works.

- Through "Joint services council" limited role, the technical staff can get some available (equipments, tools & materials) to execute the maintenance works, and this is not available in every time because these equipments, tools & materials are limited & not sufficient for all middle area municipalities.

- "Joint Services Council" does not have a coherent & planned policy or strategy related to (O&M) works.

- One mechanical engineer who does not have a good experience in road & traffic maintenance works, and he is responsible for operation & maintenance of these equipment.

- Now, Mayor of Buraj municipality is considered the mayor of "Joint Services Council", this position is changed every year in periodic manner.

- This council has not a reasonable budget, which helps the technical staff to provide them with required materials.

- All road & traffic maintenance works are executed through cooperation among (engineering department, Health & environmental department, legal advisor support & joint services council), and by using available limited (equipment, tools, materials & un-quality workmanship) in randomly manner.

- In this randomly manner we will get poor maintenance works that get more time & cost.

4.2.3.3 Legal/Regulations:

- "Legal of Local Authorities" is used to control & organize the relationship between the municipality & all residents through the operation & maintenance works.

- Any resident causes any damage in the roads & traffic components will be responsible for this damage according to legal procedures.

- Thorough applying this law the municipality will committed the resident to maintain & repair the damaged parts of road according to the municipality supervision & directions.

- In this period of time, especially in our hard political & economic situation, some of residents do not like to apply these legal/regularities, & there is low percentage of commitment.
4.2.4 Comments on comparison between (O&M) management system of (R&T) in (Middle Area & Kuwait Area)

- Through this comparison, despite of the various gaps of the (financial, geographical, climatic, seasonal & culture), a great benefits was got through this comparison, that summarized in the points:
  - using GIS/DSS as a tool of management for (O&M) of (R&T) not to display mapping only, is considered the best way to manage all of infrastructure elements.
  - Also, through using GIS/DSS as a tool of management, a strong mechanism of applying (O&M) of (R&T), provided with modern techniques, that lead to have orders automatically generated.
  - A comprehensive training program related to (O&M) of (R&T), provided with site visits to show the modern system in other countries, should be done to encourage & develop the concerned people.
  - Using modern techniques like GIS/ DSS will help the different organizations to construct database, which help them to collect & store all the data required & more coordination between the organizations will be done without any conflict.
Table No. 4.11, Comparison between (O&M) management system of roads & traffic in (Middle Area & Kuwait Area) [23]

<table>
<thead>
<tr>
<th>No.</th>
<th>Subject</th>
<th>Middle Area</th>
<th>Kuwait Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-</td>
<td>Operation &amp; Maintenance of Roads &amp; Traffic</td>
<td>- Middle area existing situation components:</td>
<td>- The Kuwaiti (IMMS) consists of a number of components integrated together in a common system related to the roads &amp; traffic:</td>
</tr>
<tr>
<td></td>
<td>Components</td>
<td>• Roads Pavement and other furniture elements.</td>
<td>• Pavement management system (PMS)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Random maintenance manner.</td>
<td>• Bridge management system (BMS)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Sometimes small contracts with small budget are used.</td>
<td>• Right-of-way (furniture) features management system (RFMS)</td>
</tr>
<tr>
<td>2-</td>
<td>Using modern management techniques</td>
<td>- In middle area municipalities, most of the roads pavement, side walk &amp; traffic elements are operated &amp; maintained using some small tools, improper materials and by making use of unqualified workmanship without any good planning system.</td>
<td>- Maintenance administration of the Kuwaiti Ministry of public works (MPW) recognized art technologies &amp; modern management techniques, including (GIS).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- No using of any modern techniques, except some AutoCAD maps, that indicate the location of these roads.</td>
<td>- Computers would be used for data storage &amp; analysis.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- (GIS) is regarded as the overall system needed to provide integrated analysis &amp; maintenance planning.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- More cooperation between (MPW) &amp; other ministries must be done to avoid any potential conflicts.</td>
</tr>
</tbody>
</table>
| (GIS) Integration | - There is no modern techniques related to the data information management system like (GIS) Arc View or Geo-Media professional software program.  
- Through using AutoCAD, the technical staff can get some detailed information through storing as built drawing which are used through maintenance works.  
- There is no precise system related to the available roads & traffic inventory, to get a good integration like process between different components of roads & traffic.  
- Most roads & traffic maintenance works are executed in traditional manner, without using any modern integration system. |
|---|---|
| Arc View is a critical component of the Kuwaiti Infrastructure Maintenance Management System (IMMS).  
- It provides a spatial index to all infrastructure components & related common geographic base.  
- Arc View is linked to the (IMMS) infrastructure inventory & work management databases. This allows maintenance personnel to develop integrated maintenance programs.  
- Arc View allows coordination among (MPW) 7 other ministries & different work groups within (MPW).  
- Kuwaiti (IMMS) links the maintenance history & plans groups to be sure that they do not conflict.  
- Available roads & traffic inventory attribute data from existing map.  
- The Kuwaiti Data Information Management System (KUDAMS) are being electronically ported to the (IMMS) to serve base attribute information. |
<table>
<thead>
<tr>
<th>4-</th>
<th>Mechanism of applying the system</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- There is no modern techniques therefore, there is no accurate system that will help the technical staff to get an accurate historical data information of a road pavement &amp; traffic components</td>
</tr>
<tr>
<td></td>
<td>- Arc View can be used to graphically select particular roads &amp; traffic elements for maintenance &amp; have orders automatically generated for those selections.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5-</th>
<th>Applying training program</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Usually, untrained labors are used to achieve all maintenance requirements. Most of them are cleaning labors.</td>
</tr>
<tr>
<td></td>
<td>- Sometimes the “joint service council” carries out the maintenance work through small contracts with small budget, awarded to the lowest bidders.</td>
</tr>
<tr>
<td></td>
<td>- Comprehensive training program was made an integral part of the project.</td>
</tr>
<tr>
<td></td>
<td>- Training is planned to cover field data collection as software operation &amp; data analysis.</td>
</tr>
<tr>
<td></td>
<td>- Site training program includes site visits to maintenance departments operating similar systems in both the US &amp; Canada.</td>
</tr>
</tbody>
</table>
Chapter No. (5)

Proposed System for (O&M) of (R&T) for the Middle Area
Chapter (5)

Proposed System for (O&M) of (R&T) for the Middle Area

5.1 The Proposed System Components:

The proposed system consists of:

1. Road management system (RMS), which includes two models (PMS & RFMS) that apply five modules.

2. (GIS/DSS) software model, which has been established through surveying & gathering of the required data, and by linking different software programs namely; (AutoCAD map, Excel, Access, Geomedia)

3. Important twenty three specific decisions were designed & classified into three groups (Planning, Operation, & Maintenance).
   - Every decision consists of four important components:
     - Objectives.
     - Algorithm chart (detailed chart)
     - Data flow chart.
     - Special form.

Figure 5.1, Proposed System for (O&M) of (R&T) for the Middle Area
5.1.1 Road Management System (RMS):

Includes:

- Utilized to order the work.
- Assign contractors in house crews.
- Track the schedule of the work & the cost against standards and/or budgets.
- When the work is completed this information is transferred to the appropriate component system (PMS or RFMS), so that the list of pending projects can be adjusted.
- The (RMS) provides for monitoring, analyzing & optimizing daily maintenance & operational activities carried out by various maintenance crews (in-house or contract) for the component systems (PMS or RFMS).
- The work order, payment certificates & other forms meeting the requirements of the Joint Services Council.

5.1.2 Mapping System (MS):

Includes:

- In order to fully utilize the (O & M. System) with its individual system components (PMS or RFMS), the system provides for interface with major (GIS) systems including Geo-media.
- The system is designed to be closely integrated with Geo-media to allow the (GIS) to maintain location information and to provide the graphic query & display of (roads & traffic) description condition & performance information.

5.1.3 Right-of-Way Features Management System (RFMS):

It includes:

- Traffic signs & Traffic signals
- Other road features.
- Curbs and gutters.
- Pavement marking.
- Guard - rails.
- Side walks.

5.1.4 Pavement Management System (PMS):

It is divided into 5 modules:

A. Service request management module
B. Program planning module
C. Work order management module
D. Work load analysis module
E. Historical management module
A. Service Request Management Module:

- Gathering information from service request
- Track complaints & initiation/dispatch work assignments
- Review historical information related to service requests
- Assign a pre-defined response (work order)
- Work order information dispatching
- A request is being responded to by the appropriate personnel or contractor

Figure 5.2, Flow of information to get proper service request
B. Program Planning Module

More details of planning process in Fig. 5.4

Figure 5.3, The program planning module

Includes:
* Development of maintenance programs for:
  - Scheduled (preventative) & unscheduled activities.
  - To schedule periodic inspection activities

Figure 5.4, Linkage of operational & Maintenance through planning process [21]
C. Work Order Management Module:

- Manage work activity
  
  - Unscheduled maintenance
  
  - Scheduled (preventative) maintenance

  - Inventory screen
    - Get information needed

  - Assignment: the need staff, materials & equipment

- Open Work & work order history

- Work execution includes:
  
  - Track & report (work performed) that include:
    * Resources used & activity status on (R&T)

  - Produces payment certificates & other document related to the (R&T) work

Figure 5.5, Work Order Management Module

Through applying this module, periodic inspections can be automatically scheduled
D. Work Load Analysis Module:

- Provides the user with cost accounting summary

- Work cost efficiency for a specific job task

- Provide the necessary tools to analyze key activity performance information obtained through completed work order

- Performance Feedback Tool

- Allows the user to quickly & easily evaluate the multitude of individual job activities being performed for the road & traffic network.

- Work costs automatically recorded against the budgets & graphic displays indicate the budget status at any given time

Figure 5.6, Work Load analysis module
E. Historical Management Module:

- Provide controlled archiving of the work order data

Information on Repair Orders

Test Results

- This information is stored on-line for subsequent use by the various (roads & traffic) condition analysis module as well as for summarize work performed by various contractors &/or work crews.

Figure 5.7, Historical management module
Summary of O&M of R&T (RMS)

Road Management System (RMS)

- Pavement Management System (PMS)
- Right-of-way features management system (RFMS)

A. Service Request Management Module
- Gathering information of service request, track complaints, review historical information related to service requests & assign & dispatch work order information.
- A request is being responded to by appropriate personnel or contractor

B. Program Planning Module
- Schedule periodic inspection activities

C. Work Order Management Module
- Work execution stage includes: Track & Report work performed (Resources used and activity status).
- Produces payment certificates & other documents.
- Open work & work orders will feedback to inventory based.

D. Work Load Analysis Module
- Provides with cost efficiency.
- Work costs are automatically recorded against the budgets & graphic displays indicate the budget status at any given time.

E. Historical Management Module
- Controlled archiving of the work order data (repair or test result)

Fig 5.8, Summary of O&M of R&T (RMS)
5.2 Proposed Institutional Setup:

5.2.1 Joint Services Council

- This council was established two years ago, under an endorsed mandate.
- Mayors of three municipalities (Nusairate, Buraj & Maghazi) signed this agreement on 18/10/1999.
- This council was established with a framework capable of solving the serious institutional problems in O & M of R&T in the middle area.
- This council has the following objectives:

1. Managing, operating & maintaining the heavy equipment, that will be used to achieve different works related to maintain all infrastructure components.
2. Maintaining the (Roads and traffic) inside the three Municipalities borders, through a special policy aim to safe & protect the new roads & traffic components that are implemented in the middle area.
3. Maintaining the streets lighting through the three municipalities’ borders.
4. Managing the computer center and the training hall which are established in Nusairate Municipality, serve the three municipalities.
5. Operating & maintaining the water wells that provide the three municipalities with the required potable water supply.
6. Coordinate for all "Joint services" and works in the three municipalities.
7. Publishing the media reports about the different activities in the three municipalities and "joint services council"

Accordingly a new organizational chart for the joint services council is proposed to achieve the above mentioned objectives as show in Fig. 5.9
Figure 5.9, The proposed organizational structure of the "Joint Services Council" for Municipalities of (Nusairate, Buraij & Maghazi)"
Decision Support System as a base for GIS/DSS
Planning, Operation and Maintenance Proposed Charts On
The Network provided with Data Flow Charts

This part consist of twenty three proposed charts, it is classified as follow:
A- Planning group, consist of five charts
B- Operation group, consist of four charts.
C- Maintenance group, consist of eleven charts.
D- Additional charts, consist of three charts, where got from the questionnaire results.

- Every decision consists of : -
  
  - Objectives.
  - Algorithm chart (detailed chart).
  - Data flow chart.
  - Special form.

- All of these charts can be used through making suitable decisions about (O&M) of (R&T) proposed system in (R&T).
<table>
<thead>
<tr>
<th>Dec. No.</th>
<th>Decision Name &amp; Purpose</th>
<th>Decision Application &amp; Description</th>
</tr>
</thead>
</table>
| A-1     | Flexible pavement condition & what type of maintenance should be used | - Calculate (PSI) present serviceability index.  
- Classify the flexible pavement condition according to the (PSI) value.  
- Assign a suitable action, maintenance & materials. |
| A-2     | Concrete pavement condition & what type of maintenance should be used | - Calculate (PSI) present serviceability index.  
- Classify the concrete pavement condition according to the (PSI) value.  
- Assign a suitable action, maintenance & materials. |
| A-3     | What type of maintenance & through maintenance planning process | - Maintenance planning process should be done.  
- Find the optimum solution for maintaining pavement in a good condition through a limited period of time. |
| A-4     | Assigning the maintenance work scheduling type | - Maintenance work scheduling should be used.  
- Classify the maintenance work scheduling  
- Choose a suitable maintenance work scheduling |
| A-5     | Classifying the distress types of road pavement, how to maintain and what type of maintenance | - Classify the distress types of road pavement.  
- Calculate the deducty value (% ) (DV).  
- Assign the road condition type.  
- Choose a suitable type of maintenance. |
| B-1     | Assigning the action and program to apply safety consideration on highway | - Evaluate and classify the road status to be more safe.  
- Assign the dangerous area and the type of dangers along the road.  
- Choose a suitable action and maintenance Program. |
| B-2     | Finding the logical solutions related to traffic flow problems in the intersection. | - Study the traffic description flow status in the intersection.  
- Assign and classifying the problems.  
- Choose a suitable solutions and another alternatives. |
| B-3     | Classifying the accidents causes and what action will be done to prevent or reduce these accidents | - Study and classify the safety problems as:  
- Road Construction problems  
- Traffic Problems  
- Assign the suitable action, to be more safe. |
| B-4     | Finding the relation-ship between the speed & fuel consumption through using paved & unpaved roads | - Classify the types of road (paved or unpaved).  
- Classify the type of cars as (Car, Light vehicle and [bus & truck])  
- Calculate the relationship between speed & fuel consumption, through using special equations. |
| C-1     | Assigning a suitable action & maintenance program related to wearing course distress | - Evaluate the wearing course status & classify the causes of distress.  
- Assign the required action & maintenance program related to get a good wearing course status. |
<table>
<thead>
<tr>
<th>Dec. No.</th>
<th>Decision Name &amp; Purpose</th>
<th>Decision Application &amp; Description</th>
</tr>
</thead>
</table>
| C-2     | Classifying the causes of road pavement distress and choosing a proper action, according to the causes type of distress | - Assign the causes of road pavement failure.  
- Choose a proper action related to the causes of failure types. |
| C-3     | Classifying the road potholes No., and choosing a proper action & maintenance | - Assign & classifying the road potholes according to their (number) per 100 m.  
- Choose a suitable action & maintenance program that will be used. |
| C-4     | Classifying the road potholes Size, and choosing a proper action & maintenance | - Assign & classify the road potholes according to their (Size) (Small or Big).  
- Choose a suitable action & maintenance program that include a proper maintenance materials |
| C-5     | Evaluating the surface dressing status, and choosing a proper action & maintenance | - Assign & classify the causes of surface dressing distress according to three categories.  
- Choose a suitable action & maintenance |
| C-6     | Choosing a proper action & maintenance program related to sewerage flow running over the road surface | - Classify the causes of sewerage flow running over the road surface.  
- Assign a suitable action & maintenance program that will be used. |
| C-7     | Choosing a proper action & maint. Program related to storm water flow running over the road surface | - Classify the causes of storm water flow running over the road with thickness more than 7 cm.  
- Assigning a suitable action & maintenance program that will be used. |
| C-8     | Assigning a proper action, maintenance program and materials related to footway surface which needs patching. | - Assign & classify the footway surface area according to the size of patching.  
- Choose a proper action, maintenance program and material mixtures that will be used. |
| C-9     | Assigning a suitable action & maintenance program in Ironwork damages. | - Classify the causes of Ironwork damages.  
- Choose the required action & maintenance program that will be used to protect these parts of road to be more safe. |
| C-10    | Choosing a suitable action & maintenance program to protect the shoulders & side slope parts of the road | - Assign & classify the causes of shoulders & side slope defects.  
- Choose a proper action & maintenance program to get a good road status. |
| C-11    | Choosing a proper action & maintenance program to protect the road furniture and marking areas | - Assign & classify the causes & shape distress.  
- Choose the required action & maintenance program to protect these areas of the road. |
Planning
Chart No (1)
Alternative system

Start

Flexible Pavement

Read
SV
C
P

Calculate:-
PSI = 5.03 - 1.91 log (1 + SV) - 0.01(C + P)^0.5 - 1.38 RD^0.5

IF
PSI

3<PSI<4

good

2<PSI<3

fair

1<PSI<2

poor

0<PSI<1

very poor

Action:-
Asphalt Spreading & Aggregate (RM)

Action:-
Thin Asphalt Layer (AO1)

Action:-
Thick Asphalt Layer (AO2)

Action:-
Reconstruction (CR)

Definition:-
PSI = Present Serviceability Index
SV = mean slope variance in both wheel paths i.e. an assessment of surface irregularity.
C = lineal feet of major cracking per 1000 ft^2 area.
P = Bituminous patching in ft^2 per 1000 ft^2 area.
RD = mean rut depth in inches (both wheel tracks) measured with a 4ft straightedge (i.e. an assessment of permanent deformation).

Figure No. 5.10, Flexible Pavement Condition & what type of maintenance should be used, by determining the value of Present serviceability Index (PSI).
Data Flow chart No. 1
Planning Group

Flexible Pavement

- Fixed Data
  - Length, width & road area
  - Read By:
  - Surveying & measuring these fixed data by technical persons

- Periodical Data
  - SV, C, P & RD
  - Read By:
  - Visual Inspection.

GIS

- Programming Language:
  - Access.
  - Visual basic.
  - Excel
  - Delphi.
  - Others

- Calculate:
  \[ \text{PSI} = 5.03 - 1.91 \log (1 + SV) - 0.01 (C + P)^{0.5} - 1.38RD^{0.5} \]

- Out Put
  - Thematic Map about:
    a- Road Condition.
    b- Queries
    c- Road Condition reports.
    d- Decisions related to choose the type of maintenance & materials that should be used

Figure No. 5.11, Data flow chart No. 1 (Planning Group)
Group No. (1) : Planning Charts

Chart No. (1) : Alternative System

Decision Aim: Discussing the road flexible pavement condition and what the suitable type of maintenance

- Type of Required Data: - Fixed Data and Periodical Data
- Input:

Through this chart (PSI) Present Serviceability Index will be calculated by equation:

- Output: \( PSI = 5.03 - 1.91 \log (1+ SV) - 0.01 (C + P)^{0.5} \times 1.38RD^{0.5} \)

Where:

\( SV = \) Mean slope variance in both wheel paths i.e. an assessment of surface irregularity.

- \( C = \) Lineal feet of major cracking per 1000 ft² area.
- \( P = \) bituminous patching in ft² per 1000 ft² area.
- \( RD = \) mean rut depth in inches (both wheel tracks) measured with 4 ft straightedge (i.e. an assessment of permanent deformation).

**Calculation:**

- And If

<table>
<thead>
<tr>
<th>Road Condition</th>
<th>(Procedure) Maintenance type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 &lt; PSI &lt; 1</td>
<td>Very Poor</td>
</tr>
<tr>
<td>1 &lt; PSI &lt; 2</td>
<td>Poor</td>
</tr>
<tr>
<td>2 &lt; PSI &lt; 3</td>
<td>Fair</td>
</tr>
<tr>
<td>3 &lt; PSI &lt; 4</td>
<td>Good</td>
</tr>
</tbody>
</table>

- Finally we will know the road flexible pavement condition & maintenance type & aggregate.
**Definition:**

- **PSI** = Present Serviceability Index
- **SV** = mean slope variance in both wheel paths i.e. an assessment of surface irregularity.
- **C** = lineal feet of major cracking per 1000 ft² area.
- **P** = Bituminous patching in ft² per 1000 ft² area.
- **RD** = mean rut depth in inches (both wheel tracks) measured with a 4 ft straightedge (i.e. an assessment of permanent deformation).

**Calculate:**

\[
\text{PSI} = 5.41 - 1.8 \log(1 + \text{SV}) - 0.09(C + P)^5
\]

**IF**

- \( \text{PSI} \)

**Actions:**

- **3<PSI<4** good: Action: Asphalt Spreading & Aggregate (RM)
- **2<PSI<3** fair: Action: Thin Asphalt Layer (AO₁)
- **1<PSI<2** poor: Action: Thick Asphalt Layer (AO₂)
- **0<PSI<1** very poor: Action: Reconstruction (CR)

---

**Figure No. 5.12, Concrete Pavement Condition & what type of maintenance should be used, By determining the value of Present serviceability Index (PSI)**

---

95
Data Flow chart No. 2
Planning Group

Concrete Pavement

- Fixed Data
  - Length, width & road area
- Read By:
  - Surveying & measuring these fixed data by technical persons

- Periodical Data
  - SV, C, P & RD
- Read By:
  - Visual Inspection.
  - Automated Inspection.

- Programming Language:
  - Access.
  - Visual basic.
  - Excel.
  - Delphi.
  - Others

- Calculate:
  * PSI = 5.41 - 1.8 log (1+SV) - 0.09 (C+P)^0.5

GIS

- Database
  * Fixed Data
  * Periodical Data

- Geographic Map

- Output
  - Thematic Map about:
    a- Road Condition.
    b- Queries
  - Road Condition reports.
  - Decisions related to choose the type of maintenance & materials that should be used

Figure No. 5.13, Data flow chart
No. 2 (Planning Group)
Chart No. (2): Alternative System

Decision Aim: Discussing the road concrete pavement condition and what the suitable type of maintenance by using (PSI)

- Type of Required Data: - Fixed data and periodical data
- Input:

This chart shows concrete pavement condition, that is by determined the (PSI) present serviceability index, which calculate through different equation:

- Output (Equation): $\text{PSI} = 5.41 - 1.8 \log (1 + SV) - 0.09 (C+P)^{0.5}$
- The same procedures in the preceding chart will be done.
Planning Chart No. (3)

Start

Pavement Management System (PMS)

- A set of methods that help decision makers get:*
  * Optimum solution for maintaining pavement in a good condition through a limited period of time.

Y

IF Maintenance planning

Y

- Added full-length layer to existing surface to increase the structure strength to handle future traffic loads.

Y

- Removal & replacement of pavement.
  - Return the pavement to an acceptable level of service through different levels of maintenance costs.

Y

- New surface layers & repair to restore the pavement structure to a level equivalent to that which was originally present.

Y

- Protect the existing roads in a good condition & reduce the rate of deterioration

Y

- Pothole patching, spot sealing & other repairs not funded for specific planned

Action Program
Major Rehabilitation

Action Program
Reconstruction

Action Program
Restoration

Action Program
Preventative Maintenance

Action Program
Routine Maintenance

Figure No. 5.14, Maintenance Classification Chart
Data Flow chart No. 3
Planning Group
Pavement Management System

- **Fixed Data**
  - Length, width, coordinates (x,y), street name, street No. & Zone area
- **Read By**:
  - Surveying & measuring these fixed data by technical persons
  - Using graphical maps

- **Periodical Data**
  - Assigning and measuring the location type and size of the roads' distresses.
- **Read By**:
  - Visual Inspection through technical persons.
  - Automated Equipment.

- **Programming Language**:
  - Visual basic
  - Access.
  - Excel
  - Delphi.
  - Others

- **Classifying the roads according to their condition**

- **GIS**
  - **Data Base**
    - Fixed Data
    - Periodical Data
  - **Geographic Map**

- **Output**
  - Thematic Map about:
    - a- Road Condition.
    - b- Queries
  - Road Condition reports
  - Decisions related to choose the type of maintenance & materials that should be used

Figure No. 5.15, Data flow chart No. 1 (Planning Group)
Chart No. (3):

Decision Aim: Discussing of maintenance planning consideration & what action required.

- Type of Required Data: Fixed Data and Periodical Data

- Input:
- This chart discuss the maintenance planning operations, this will help decision makers to get:
- Optimum solution for maintaining pavement in a good condition through a limited period of time, where maintenance planning consist of:

- Output:

1. Added full length layer to existing surface to increase the structure strength to handle future traffic loads.

- Procedure: Action Should be used
  - Major rehabilitation.

- Output:

2. Removal & replacement of pavement, this will return the pavement to an acceptable level of service through different levels of maintenance costs.

- Procedure: Action Should be used
  - Reconstruction.

- Output:

3. New surface layer & repair to restore the pavement structure to a level equivalent to that which was originally present.

- Procedure: Action Should be used
  - Reconstruction.

- Output:

4. Protect the existing roads in a good condition & reduce the rate of deterioration.

- Procedure: Action Should be used
  - Preventative maintenance.

- Output:

5. Pothole patching, Spot sealing & other repairs not funded for specific planned.

- Procedure: Action Should be used
  - Routine maintenance.
Planning Chart No. (4)

Start
Maintenance work scheduling

Assign resources to accomplish work.

IF
Scheduling

Y

Y

- Scheduling

- order of precedence in assigning the specific work orders involving construction, modification, or rehabilitation such:
  * Top priority
  * Second priority
  * Routine priority.

- Based on work classification system like:
  - first priority (Emergency)
  - Second priority (Modification work)
  - Third priority (Preventive Maintenance)

- Reduce operation costs connected with travel as grouping work to be in the same geographical area

- All work orders sequentially as they received in equal priority

Action: -
- Establishing priority systems for Major Jobs.
- Top priority needs immediate action, because it is related to safety or security requirements.

Action: -
- Applying fixed priority by work classification.

Action: -
- Applying Convenience Assignment schedule.
- Through using this technique we can saving more money.

Action: -
- Using First-In-First-out (FIFO).
- This method lacks realism, because all maintenance work can not be assigned equal priority.

Figure No. 5.16, Scheduling Consideration Chart of Maintenance Work.
Data Flow chart No. 4
Planning Group

Maintenance work scheduling

- Fixed Data
  - Length, width, coordinates (x,y), street name, street No. & Zone area

- Read By:
  - Surveying & measuring these fixed data by technical persons
  - Using graphical maps

- Periodical Data
  - Assigning and measuring the location type and size of the roads’ distresses.

- Read By:
  - Visual Inspection through technical persons.
  - Automated Equipment.

Programming Language:
- Visual basic
- Access.
- Excel
- Delphi.
- Others

Classifying the maintenance works according to the priorities.

- Order of precedence in the assigning the specific work orders involving:
  - Action = Establishing priority systems for Major Jobs. Top Priority needs immediate action, because it is related to safety requirements.
  - Based on work classification system:
    - Action = Applying fixed priority by work classification
    - Reduce operation costs connected with travel as grouping work to be in the same geographical area.
    - Action = Applying convenience assignment schedule). through using this technique we can save money.
    - All work orders sequentially as they received in equal priority.
    - Action = using (First-In-First) (FIFO). This method lacks realism, because all maintenance work can not be assigned equal priority.

GIS

- Data Base
  - Fixed Data
  - Periodical Data

- Geographic Map

- Output
  - Thematic Map about:
    - Road Condition.
    - Queries
    - Road Condition reports.
  - Decisions related to choose the type of maintenance & materials that should be used.

Figure No. 5.17, Data flow chart No. 4 (Planning Group)
Chart No. (4):

**Decision Aim:** Discussing of maintenance work scheduling consideration & what actions required.

Type of Required Data: - Fixed Data and Periodical Data

- **Input:**
  - This chart describes the different stages of maintenance work scheduling and what the suitable action must be done in every stage as:

- **Output:**
  1- Order of precedence in assigning the specific work, and orders involving construction, modification or rehabilitation such:
    - Top Priority.
    - Second priority.
    - Routine priority.

- **Procedures:** Action Should used:
  - Establishing priority systems for major jobs, where top priority needs immediate action, because it is related to safety or security requirements.

- **Output:**
  2- Based on work classification system like:
    - First priority (Emergency).
    - Second priority (Modification work)
    - Third priority (Preventive Maintenance).

- **Procedures:** Action Should used:
  - Applying fixed priority by work classification.

- **Output:**
  3- Reduce operation costs connected with travel as grouping work to be in the same geographical area.

- **Procedures:** Action Should used:
  - Applying convenience assignment schedule, where through using this technique we can save more money.

- **Output**
  4- All work orders sequentially as they received in equal priority.

- **Procedures:** Action should be used:
  - Using first-In-First-Out (FIFO), where this method lacks realism, because all maintenance work can not be assigned equal priority.
Figure No. 5.18, Damage types in road pavement, how to maintain & what type of maintenance required
Data Flow chart No. 5
Planning Group

Read Road Surface Condition

- Fixed Data
  - Length, width & road area
  - Cost/m², coordinates (x, y), street name, street No. & Zone area
  - Read By:
    - Surveying & measuring these fixed data by technical persons

- Periodical Data
  - Different distresses area percentage.
  - Read By:
    - Visual Inspection.
    - Automated Inspection.

- Programming Language:
  - Access
  - Visual basic
  - Excel
  - Delphi
  - Others

- Calculate:
  - $DV = \sum \text{Different distresses area percentage}$
  - Road condition Type = $100 - DV\%$

  If

- < 20%:
  - Road Condition = Fail
  - Action = Reconstruction
- 20-40%:
  - Road Condition = Poor
  - Action = Reconstruction
- 40-60%:
  - Road Condition = Fair
  - Action = ($AO_2$)
- 60-80%:
  - Road Condition = Good
  - Action = ($AO_1$)
- 85-100%:
  - Road Condition = Very Good
  - Action = ($AO_1$)
- 100-85%:
  - Road Condition = Excellent
  - Action = (RM)

GIS

- Database:
  - * Fixed Data
  - * Periodical Data

- Geographic Map

- Output
  - Thematic Map about:
    a- Road Condition.
    b- Queries
  - Road Condition reports.
  - Decisions related to choose the type of maintenance & materials that should be used

Figure No. 5.19, Data Flow chart No. 5 (Planning Group)
Table No. 5.2, Surveying and Data Sheet Visual Inspection Form for A Flexible Pavement Condition

<table>
<thead>
<tr>
<th>Branch</th>
<th>Section</th>
<th>Sample unit</th>
<th>Surveyed by</th>
<th>Date</th>
<th>Sample Area</th>
<th>SF</th>
<th>Sketch</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Alligator Cracking</td>
<td>5- Depression</td>
<td>9- Oil Spillage</td>
<td>13- Rutting</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2- Bleeding</td>
<td>6- Jet Blast</td>
<td>10- Patching</td>
<td>14- Shoving</td>
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</tr>
<tr>
<td>3- Block Cracking</td>
<td>7- Jet. Reflection (PCC)</td>
<td>11- Polished Aggregate</td>
<td>15- Slippage Cracking</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>4- Corrugation</td>
<td>8- Long &amp; Trans. Cracking</td>
<td>12- Raveling / Weathering</td>
<td>16- Swell</td>
<td>17- Potholes</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Distress Severity</th>
<th>Quantity</th>
<th>Total</th>
<th>Density</th>
<th>Deduct Value</th>
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</thead>
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<tr>
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</tbody>
</table>

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Chart No. (5):

**Decision Aim:** Discussing of Damage types in road pavement, how to maintain and what type of maintenance required.

Type of Required Data: - Fixed Data and Periodical Data

- **Input:**
  - This chart classify the damages in road pavement into 19 type, but five famous of them are:
    1. Long & transverse cracking percentage.
    2. Patching & utility cut patching percentage.
    3. Rutting percentage.
    4. Potholes percentage.
    5. Alligator cracking percentage.

- **Output:**
  - Every percentage value of them can get through:

- **Calculation:**
  - Total type damage area = ( ) %
  - Total area of road

- Total different types damage percentage = deducy value (DV)

- Road condition type = 100% - DV %, Where:

- **Procedure:**  
  - Action (maintenance type):
    - Road Condition (100–85%)=Excellent => (RM) Spreading Ashpalt & Monadic Aggregate.
    - Road Condition (85–70%)=Very good => (RM2) Spreading Ashpalt & Duet Aggregate.
    - Road Condition (70–60%)=good => (AO1) Thin Ashpalt layer
    - Road Condition (60–40%) =Fair => (AO2) thick Ashpalt layer
    - Road Condition (40–20%)=poor => (CR) Reconstruction
    - Road Condition (< 20 ) = Fail => (CR) Reconstruction.
Operation Chart No (1)

Start

Read Road Status

IF Obstacles

Debree on Road

Action:
- Remove any Debree in A good quickly manner.

Program:
urgent

Notes:
- This includes mud, stones and rocks, trees, dead animals.
- Debree should be removed by the inspection team & not reported.

Broken Down Vehicles

Action:
- Inform Traffic Police in quickly manner

Program:
urgent

Notes:
- These are especially dangerous at night.
- Temporary reflective warning signs should be placed around the vehicle.

End

Figure No. 5.20, Safety Consideration on Highway, actions & programs.
Data Flow chart No. 1
Operation Group

Read Road status

- Fixed Data
  - Length, width, coordinates (x,y), street name, street No.& Zone area,

- Read By:
  - Surveying & measuring these fixed data by technical persons.

- Periodical Data
  - Measuring and assigning the broken areas a long the road surface
  - Assigning any debree material on the road and their location.

- Read By:
  - Technical persons by using visual inspection
  - Automated equipment

- Programming Language:
  - Visual basic
  - Access
  - Excel
  - Delphi
  - Others

- Classifying the different problems in the road according to the type of problem like (debree, and broken areas down vehicles)

- GIS

- Database
  - Fixed Data
  - Periodical Data

- Geographic Map

- Output
  - Thematic Map about:
    a- Road condition according to the preceding classification (debree on road & broken areas down vehicles).
    b- Queries
    - Road condition reports according to the preceding classification.
    - Decisions related to assign the type of action and programs that should be used.

Figure No. 5.21, Data flow chart No. 1 (Operation Group)
Group No. (2) : Operation Charts

Chart No. (1) :

*Decision Aim: Studying the safety consideration on highway what actions & programs*

Type of Required Data : - Fixed Data and Periodical Data

- **Input** :
  - This chart describe the dangerous that resulted through any obstacles on the highway.
- **If there is any debree on road** :
- **Procedure** : Action through urgent programs:
  - Remove any debree in A good quickly manner.
  - This includes mud, stones, rocks, tree & deal animals.
  - Debree should be removed by the inspection team & not reported.
- **Output** : If there is any Broken Down vehicles :
- **Procedure** : Action through urgent program :
  - Inform traffic police in quickly manner.
  - These are especially dangerous at night.
  - Temporary reflective warning signs should be placed around the vehicle
Start

Read Traffic Flow Status in the Intersection

IF Defect

Easily cars movement

No Action

Crowded cars movement

Installing new Traffic signs supported with police traffic

Installing new traffic Lights

IF Defect

Re-planning & Re-design of:
(The roads intersection dimensions & traffic flow movement)

If the intersection area allows to extent

Searching about another alternative sub-roads

Extension & reconstruction will do

Figure No. 5.22, Traffic flow intersection movement
Data Flow chart No. 2
Operation Group:
Read Traffic flow status in the intersection

- Fixed Data
  - Length, width, coordinates (x, y), street name, street No. & Zone area, Traffic signs, & traffic lights (location, No. & types) material & gutters sizes
  - **Read By:**
    - Surveying & measuring these fixed data by technical persons.

- On Line Data
  - Traffic flow rate, cars velocity and types of traffic flow passing in the intersection.
  - **Read By:**
    - Technical persons by using visual measuring.
    - Automated Equipment

- Periodical Data
  - Measuring the accidents No. & types throw the traffic flow movement
  - Assigning the different crowded problems against the traffic flow movement.
  - **Read By:**
    - Technical persons by visual inspection.
    - Automated Equipment

- **Programming Language:**
  - Visual basic
  - Access
  - Excel
  - Delphi
  - Others

- Calculate:
  - Re-planning & Re-designing of (the road intersection dimensions) traffic flow movement, & a suitable new dimensions & No. of signs may be got.

- GIS
  - - Data Base
    - * Fixed Data
    - *Online Data
    - *Periodical Data

- Geographic Map

- Output
  - Thematic Map about:
    - Road intersection condition
    - Queries
    - Reports related to the intersection solution problems.
    - Decisions related to assign the type of actions that should be used.

Figure No. 5.23, Data flow chart No. 2 (Operation Group)
Chart No. (2):

Decision Aim: Discussing traffic flow status in the intersection.

Type of Required Data: - Fixed Data, Periodical Data and Online data

- Input:
  - This chart deals & discuss the traffic flow status in the intersection, and classify the cars movement into two conditions:

- Output:
  1. Easily car movement.

- Procedures:
  - Action will be used:
    - No Action.

- Output:
  2. Crowded cars movement

- Procedures:
  - Action will be used:
    - Installing new traffic signs supported with police man traffic.
    - Installing new traffic lights.

- Output:
  After using these actions & crowded cars movement did not improve.

- Procedures:
  - Action will be used:
    - Re-planning & Re-design of: (the roads intersection) dimensions & traffic flow movement

- Output:
  If the intersection area allows to extent.

- Procedures:
  - Action will be used:
    - Extension & reconstruction will do.

- Output:
  If the intersection area did not allows to extents

- Procedures:
  - Action will be used:
    - Searching about another alternative sub-road.
Operation Chart No. (3)

Figure 5.24. Shows roads' accidents consideration & actions required.

Start

Read Road Condition related to the Roads' accidents

N

IF Defect

Y

Suitable road

IF Road construction problems

No Action

Y

Road construction problems

Traffic problems

IF Traffic problems

Narrow & crowded roads

Dangerous detours, causes unclear vision

Deformation include: - Holes, broken down vehicles, cracks, potholes, wheel rutting

Lack of roads' furniture like: (Traffic signals, painted lines, humps, sidewalks & others)

Untrained drivers

High speed

Action: Extension or construct a new bridge or tunnel

Action: Re-planning, redesign & reconstruction

Action: Good maintenance & repair

Action: Re-planning, redesign & rehabilitation of road furniture items.

Action: More training for drivers

Action: Controlling the speed by using modern techniques like Radar or others.
Data Flow chart No. 3
Operation Group:
Read Road Condition related to the roads' accidents

- Fixed Data
  - Length, width, coordinates (x,y), street name, street No. & Zone area, & signs No. & location hums, hand rails, painted lines & traffic lights No. & location.
  - Read By:
    - Surveying & measuring these fixed data by technical persons.

- On Line Data
  - Vehicles speed rate, & unclear areas through vehicles movement
  - Read By:
    - Technical persons by using modern measurement.
    - Automated Equipment

- Periodical Data
  - Assigning & Measuring deformation of road like:
    - (Holes, cracks, broken down vehicles area, potholes & rutting areas)
  - Read By:
    - Technical persons by visual inspection.
    - Automated Equipment

- Programming Language:
  - Visual basic
  - Access
  - Excel
  - Delphi
  - Others

- Calculate:
  - The roads condition through measuring & assigning the distresses areas a long the road surface.
  - Studying, re-planning and redesigning of the road (construction & furniture).

GIS

- Data Base
  - *Fixed Data
  - *Online Data
  - *Periodical Data

- Geographic Map

- Out Put
  - Thematic Map about:
    - a- Road condition according to the preceding classification (construction problems & traffic problems)
    - b- Queries
      - Reports of roads condition related to the roads accidents.
      - Decisions related to assign the suitable actions that should be used.

Figure No. 5.25, Data flow chart No. 3 (Operation Group)
Decision Aim: Discussing the Roads, accidents consideration & what actions required.
Type of Required Data: - Fixed Data, Periodical Data and On line data

- **Input:**
  - This chart deals with road condition related to roads' accidents where:

- **Output:**
  1. The road condition were accepted & suitable road.
  2. construction problems according to:

- **Output:**
  2. A – Narrow & crowded roads

- **Procedure:** - Action should be used:
  - Extension or construct a new bridge or tunnel

- **Output:**
  2. B – Dangerous detours, cases, unclear vision.

- **Procedure:** - Action should be used:
  - Re-planning, redesign & reconstruction.

- **Output:**
  3. C – Deformation include: (Holes, broken down vehicles, cracks, potholes & wheel rutting)

- **Procedure:** - Action should be used:
  - Good maintenance & repair.

- **Output:**
  3. Traffic problems:

- **Output:**
  3. A – Lack of roads' furniture like: (traffic signals, painted lines, humps, sidewalks & others)

- **Procedure:** - Action should be used:
  - Re-planning, redesign & rehabilitation of road furniture items.

- **Output:**

- **Procedure:** - Action should be used:
  - More training for drivers

- **Output:**
  3. C – High speed.

- **Calculation:** Action should be used:

- (Procedure)– Controlling the speed by using modern techniques like radar or others.
Figure No. 5.26, Relationship Between Speed and Fuel Consumption

V = Speed in km/h  
RS = rise in m/Km  
F = fall in m/Km  
GVW = Gross vehicle weight in tonnes  
FL = Fuel consumption in (milliliters/Km)
Data Flow chart No. 4
Operation Group:
Read: SC, SI, Sr, Rs, F, C, R, M, RD, PW, W, V

- Fixed Data
  • Length, width, coordinates (x,y), street name, street No. & Zone area, read by:
  • Surveying & measuring these data by technical persons.

- On Line Data
  • Sc, Si, St, Rs, F, C, DV and V.

- Temporary Data:
  • R, M, RD, PW

- Programming Language:
  • Visual basic
  • Access
  • Excel
  • Delphi
  • Others

- Calculate:
  A– Paved Road (Through special equations):
  • Velocity for car and fuel consumption.
  • Velocity for light vehicle and fuel consumption.
  • Velocity for busy & truck & fuel consumption.
  A– Un-Paved Road (Through special equations):
  • Velocity for car and fuel consumption.
  • Velocity for light vehicle and fuel consumption.
  • Velocity for bus, truck and fuel consumption

GIS

- Database
  *Fixed Data
  *Online Data
  *Periodical Data

- Geographic Map

- Output
  • Thematic Map about:
  a- Road status according to the preceding classification (pipes, manholes, & cover manholes) conditions.
  • Queries:
    • Reports related to the preceding classification.
    • Decisions related to assign the type of maintenance & program should be used.

Figure No. 5.27, Data flow chart No. 4
(Operation Group)
Chart No. (4):

**Decision Aim:** Discussing the Fuel consumption relationship.

- Type of Required Data:- Fixed Data, Temporary Data and on line data
- **Input:**
  - This chart discuss the relationship between (speed & Fuel consumption) for different types of cars through using different types of road surface like (Paved & unpaved roads) by using some equations with some factors.
  - More description of (equation & factors) that used are attached with this chart as follow:

**Description of speed & fuel consumption relationships:**

Vehicle speeds are calculated separately for different direction and for each half per cent increment in road gradient. On unpaved roads speeds are also calculated separately in the wet and dry seasons, the following variables are used:

- $Sc =$ observed free speed of passenger cars in Km/h.
- $Sl =$ observed free speed of light vehicle in Km/h.
- $St =$ observed free speed of truck in Km/h.
- $RS =$ rise m/Km.
- $F =$ fall in m/Km.
- $C =$ curvature.
- $R =$ roughness.
- $M =$ moisture content as a percentage.
- $RD =$ rut depth in mm.
- $PW =$ power to weight ratio in brake horsepower/tone.
- $W =$ road width in m.
- $DV =$ reduction in speed in Km/m when the road is less than 5 wide.
- $V =$ speed in Km/h.

**Output:**

**Equations:**

(Surface Type): -

* Paved: -

**Car:**

$V = Sc + (0.483 - 0.00833)Sc \cdot RS + (-0.025 - 0.0005Sc) \cdot F + (0.115 - 0.0022Sc) \cdot C - 0.00087 \cdot R$

$FL = 24 + 969/V + 0.0076 \cdot V^2 + 1.33 \cdot RS - 0.63 \cdot F + 0.0029F^2 \cdot 1.08$

**Light vehicle:**

$V = Sc + (0.763 - 0.01359SI) \cdot RS + (-0.082 + 0.00036SI) \cdot F + (0.087 - 0.00185SI) \cdot C - 0.00066 \cdot R$
FL = 72 + 949/V + 0.0048V^2 + 1.118(GVW*RS) - 1.18F + 0.0057F^2) * 1.08

**Bus & Truck:**

\[ V = 49.0 + (1.429 - 0.0286St) \text{ RS} + (-0.867 + 0.01318St) \text{ F} + (0.177 - 0.00346St) \text{ C} + (-1.9 + 0.04346St) \text{ PW} - 0.00106\text{R} \]

\[ FL = 29 + 2219/V + 0.203V^2 + 0.848(GVW*RS) - 2.6F + 0.0132F^2) * 1.13 \]

* Unpaved: *

**Car:**

\[ V = SC + (0.272 - 0.00573Sc) \text{ RS} + (-0.021 - 0.00058Sc) \text{ F} + (0.122 - 0.00285Sc) \text{ C} - 0.00089\text{R} - 0.13\text{M} - 0.19\text{RD} \]

**Light vehicle:**

\[ V = SI + (0.369 - 0.00845SI) \text{ RS} + (-0.088 + 0.00036SI) \text{ F} + (0.064 - 0.00198SI) \text{ C} - 0.00095\text{R} - 0.29\text{M} - 0.20\text{RD} \]

**Bus & Truck:**

\[ V = 45.0 + (0.363 - 0.01149St) \text{ RS} + (-0.055 + 0.00986St) \text{ F} + (0.061 - 0.00176St) \text{ C} + (-2.396 + 0.05401St) \text{ PW} - 0.0006\text{R} - 0.22\text{M} - 0.27\text{RD} \]
Maintenance
Chart No. (1)

Start

Read Wearing Course Status

IF Defect

Wearing Course & Running Surface may be adequate but there may be ruts of such depth as to be dangerous to vehicles passing through them on over taking movements.

Action: -

Wearing Course material is a relatively sound condition

Action: -

Wearing Course material has failed altogether.

Action: -
A suitable (surface dressing) provides good skid resistance

IF Surrounding Surface level permit to increase

Replacing material

Program: Recurrent

Over lay could be used

Program: Recurrent

Program: Periodic

End

Fig No. 5.28, Wearing Course Failure, actions & programs.
Data Flow chart No. 1
 Maintenance Group

Read Wearing Course Status

- Fixed Data
  • Length, width, coordinates (x,y), street name, street No. & Zone area,

- Read By :
  • Surveying and measuring the fixed data
  • By technical persons.
  • By using graphical map.

- Periodical Data :
  • Depth of ruts, wearing course materials is a relatively sound condition and wearing course material has failed altogether.

- Read By :
  • Technical persons by using visual inspection and automated equipment

- Programming Language :
  Visual basic - Access - Excel - Delphi - Others

- classifying and Assigning : the wearing course status through (measuring the ruts depth as to be dangerous to vehicles, wearing course sound condition status and wearing course material has failed altogether.

If

- Wearing course & running surface may be adequate but there may be dangerous ruts to vehicles passing through them. Or wearing course material is a sound condition.
  • Action-If surrounding surface level did not permit to increase (replacing material should be used )
  • If surrounding surface level permit to increase (over lay could be used)
  • Program = Recurrent.
- Wearing course material has failed altogether
  • Action = a suitable (surface dressing) provides good skid resistance should be used.
  • Program = periodical.

GIS

- Database
  * Fixed Data  * Periodical Data

- Geographic Map

- Out Put
  • Thematic Map about :
    a- Wearing course status according to the preceding classification (wearing course with dangerous ruts depth, wearing course with sound material and wearing course with failed material
    b- Queries :
      • Reports related to the preceding classification.
      • Decisions related to assign the type of action and program that should be used.

Figure No. 5.29, Data flow chart
No. 1 (Maintenance Group)
Group No. (3) : Maintenance Charts

Chart No. (1) :

**Decision Aim:** Maintenance of Wearing Course, what actions & program.

- Type of Required Data: Fixed Data and Periodical Data
- **Input** :
  - This chart classify the wearing course defect into three types according to :
- **Output** :
  1. Wearing course & running surface may be adequate but there may be ruts of such depth as to be dangerous to vehicles passing through then on over taking movements.
- **Procedures** :
  - Action will be used through recurrent program:
    - If surrounding surface level permit to increase, replacing material will be used.
- **Output** :
  2. Wearing course material is a relatively sound condition.
- **Procedure** :
  - Action will be used through recurrent program
    - If surrounding surface level permit to increase, replacing material will be used.
- **Output** :
  3. Wearing course material has failed altogether.
- **Procedure** :
  - Action will be used through Periodic program:
    - A suitable (surface dressing) provides good skid resistance.
Maintenance
Chart No. (2)

Figure No. 5.30, Road Pavement Failure & actions that should be done.

Start

Road Pavement Failure

Read Defect Through
Trial hole or road pavement investigation by coring:-
- Water damage or poor drainage
- Wheel rutting & wheel tracking (Base Course)

IF
Defect
(Due)

- Impeded drainage decreasing subgrade strength
- Increased traffic flow/weight
- Inadequate design

Action:
Reconstruction

Action:
Reconstruction

Action:
Reconstruction

If any (water or sewage pipe were damaged
- Repair pipes & prevent any leakage
- Restudy of traffic flow movement
- New Redesign of structure layers

Prevent the water below the (Road Pavement) to be low & not be allowed to rise into the construction layer, through making drainage path out

Redesign of structure layers through taking the new criteria related to flow weight
Data Flow chart No. 2
Maintenance Group:

Read Defect Through Trial hole
(water damage or poor drainage)

- Fixed Data
  - Length, width, coordinates (x,y), street name, street No. & Zone area, pavement layers types & thickness.
- Read By:
  - Technical persons by using trial hole and visual inspection.

- Online Data
  - Traffic flowtime & velocity.
- Read By:
  - Technical persons by measuring the No. of cars that passing on the road.
  - Automated equipment.

- Periodical Data
  - Inspection the storm water & sewage pipes, that laying under the road pavement layers.
- Read By:
  - Technical persons or automated equipment.

- Programming Language:
  - Visual basic - Access.
  - Excel - Delphi. - Others

- Calculation:
  - Redesign of structure road layers & assign the proper thickness of the pavement layers.
  - Assign the damaged water & sewage pipe location.

If

- Impeded drainage decreasing sub-grade strength:
  - Action = Reconstruction.
- If any (water or sewage were damaged):
  - Action = Repair pipes & prevent and leakage.
- Increased traffic flow/ weight:
  - Action =
    - restudy of traffic flow movement.
    - redesign of structure layers, through taking the new criteria related to the flow weight. Anc reconstruction should be used.
- Inadequate Design:
  - Action = New redesign of structure layers & reconstruction.

GIS

- Database
  - Fixed Data
  - Online Data
  - Periodical Data

- Geographic Map

- Output
  - Thematic Map about:
    a- Road pavement condition through (Impeded drainage, Increased traffic flow and Inadequate design)
    b- Queries
      - Reports related to the preceding classification.
      - Decisions related to assign the type of action should be used.

Figure No. 5.31, Data flow chart No. 2 (Maintenance Group)
Chart No. (2):

*Decision Aim: Discussing the Road pavement failure & what actions that should be done.*

- **Type of Required Data:** Fixed Data, On Line Data and Periodical Data
- **Input:**
  - This chart deals with road pavement failure causes & what the actions should be done.
  - Through trial hole or road pavement investigation by coring we will get different causes like:
    - Water damage or poor drainage.
    - Wheel rutting & wheel tracking (Base Course)
- **Output:** If Defect due to:
  1. Impeded drainage decreasing sub-grade strength.
- **Procedures:** - Action should be used:
  - Reconstruction where include.
- **Output:** If any (water or sewage pipe were damaged):
- **Procedures:** - Action should be used:
  - Repair pipes & prevent any leakage.
- **Output:** If any (water or sewage pipe were not damaged):
- **Procedures:** - Action should be used:
  - Prevent the water below the (Road Pavement) to be low & not be allowed to rise into the construction layer, through making drainage path out
- **Output:**
  2. Increased traffic flow/ weight.
- **Procedures:** - Action should be used:
  - Reconstruction where include:
    - Restudy of traffic flow movement.
    - Redesign of structure layers through taking the new criteria related to flow weight.
- **Output:**
  3. Inadequate design.
- **Procedures:** - Action should be used:
  - Reconstruction where include:
    - New redesign of structure layers.
Maintenance Chart No. (3)

Start

Read potholes status

IF Criteria of pothole

<15 holes Per 100 m

Action Patch

Program Recurrent

15-40 holes Per 100 m

Action Patch & overlay

Program Special

>40 holes Per 100 m

Action Reconstruct the surface defect road layer only

Program Special

Notes: - The cause of potholes should be identified and rectified if possible. If it is not possible to provide an overlay, the road should be surface dressed.

END

* Figure No. 5.32, Size of potholes & types of maintenance in the road pavement, actions & programs. [21]
Data Flow chart No. 3
Maintenance Group

Read Potholes Status

- Fixed Data
  - Length, width & road area,
    Cost/M2, coordinates (x,y), street
    name, street No & Zone area

- Read By:
  - Surveying & measuring these
    fixed data by technical persons

- Periodical Data
  - Measuring the number
    of potholes in the road

- Programming Language:
  - Access.
  - Visual basic.
  - Excel
  - Delphi.
  - Others

- Calculate:
  * The number of potholes per/100 m.r =
    No. of potholes in the road * 100
    Length of road

If

- <15 holes per 100 m.r:
  - Action = Patch
  - Program = Recurrent

- 15-40 holes per 100 m.r:
  - Action = Patch & overlay
  - Program = special

- > 40 holes per 100 m.r:
  - Action = reconstruction
  - Program = special

GIS

- Data Base
  * Fixed Data
  * Periodical Data

- Geographic Map

- Output
  - Thematic Map about:
    a- Road Condition related to
      the holes No. / 100 m.r
    b- Queries
    - Road Condition reports related to
      the holes No./100m.r.
    - Decisions related to choose the
      type of maintenance & materials
      and program that should be used

Figure No. 5.33, Data flow chart
No. 3 (Maintenance Group)
Chart No. (3)

Decision Aim: Discussing the size of potholes and types of maintenance in the road pavement, what actions & programs.

- Type of Required Data: - Fixed Data and Periodical Data
- Input:
  - This chart discuss the size of potholes and types of maintenance in the road pavement according to:
- Output:

1. Potholes < 15 per 100 m.
   - Procedure: Action should be used through recurrent program
     - Patch

2. Potholes = (15 - 40) holes per 100 m.
   - Procedure: Action should be used through special program
     - Patch & overlay.

3. Potholes > 40 holes per 100 m.
   - Procedure: Action should be used through special program
     - Reconstruction
Figure No. 5.34, Emergency Patching with Bituminous Materials, actions & programs. [25]
Data Flow chart No. 4
Maintenance Group

Read Potholes Condition through assigning the area of potholes

- Fixed Data
  - Length, width & road area, Cost/M², coordinates (x,y), street name, street No & Zone area
- Read By:
  - Surveying & measuring these fixed data by technical persons

- Periodical Data
  - Measuring the number of potholes in the road
- Road By:
  - Visual Inspection.
  - Automated equipment

- Programming Language:
  - Access.
  - Visual basic.
  - Excel
  - Delphi.
  - Others

- Calculate:
  - Classifying the different potholes according to their sizes (small or Big)

GIS

- Data Base
  * Fixed Data  * Periodical Data

- Geographic Map

- Out Put
  - Thematic Map about:
    a- Road Condition related to the holes size (small or big)
    b- Queries
  - Road Condition reports related to the holes size (small or big)
  - Decisions related to assign the type of materials and program that should be used

Figure No. 5.35, Data flow chart No. 4 (Maintenance Group)
Chart No. (4):

**Decision Aim:** Discussing the road pavement emergency patching with bituminous materials, what actions & programs

- **Type of Required Data:** Fixed Data and Periodical Data
- **Input:**
  - In the first, road condition will be tested through measuring different potholes size and classified to
  - Large or small size.
  - Large or small size
  - Through small areas pothole
- **Procedure:** Action through periodic program (Deferred set material)
  - This material comes in (Scaled tubs)
  - This material is expensive but suitable & effective than others.
- **Output:**
  - Through big a pothole areas:
- **Procedure:**
  - Action through periodic programs:
    - Use Depot stock material
    - It is taken from the depot to fill the hole & make it safe.
Data Flow chart No. 5
Maintenance Group

Read surface dressing status

- Fixed Data
  - Length, width, coordinates (x,y), street name, street No. & Zone area.
  - Read By:
    - Technical persons by using visual Inspection.

- Periodical Data
  - Measuring the surface dressing condition, temperature too cold.
  - Read By:
    - Technical persons by using visual & automated inspection.

- Programming Language:
  - Visual basic - Access.
  - Excel - Delphi - Others

- Classifying the road surface dressing status according to the (site environmental, temperature causes & technical causes.)

GIS

Data Base

- Fixed Data - Periodical Data

-Geographic Map

Out Put

- Thematic map about:
  a- road surface dressing status.
  b- Queries

- Reports related to the preceding classification.
- Decisions related to assign the proper actions & program that should be used.

- Technical Causes:
  - Wrong size chipping used.
  - Wrong rate of spread of binder chosen.
  - Badly formulated binder.
  - Different rate of spread of binder.

- Action:
  - Use qualified technician staff & good special techniques & good specification.
  - Program = Periodic.

Figure No. 5.37, Data flow chart No. 5 (Maintenance Group)
Chart No. (5):  

Decision Aim: Discussing the cause of road surface dressing defects, what action & programs.

- Type of Required Data: Fixed Data and Periodical Data
- Input:
  - This chart describe the different cause of road surface dressing defects and divided them into three type of causes.
- Output:

  1- Site environmental causes:
     1-A / It is not suitable for surface dressing e.g. area of "Screwing traffic"
     1-B / Dirty / Dusty chipping.
- Procedure: Action should be used through using periodic program
  - Surface dressing works should do in suitable time with special materials which drying in quick time.

  2- Temperature causes:
     2-A / Temperature too cold.
     2-B / Wrong binder viscosity specified for temperature
- Procedure: Action should be used through using periodic program
  - Special surface dress material dealing with different temperature.

  3- Technical causes:
     3-A / Wrong size chipping used.
     3-B / Wrong rate of spread of (Bender) chosen.
     3-C / Badly formulated binder
     3-D / Different rate of spread of binder.
- Procedure: Action should be used through using periodic program
  - Use qualifies technician staff:
  - good special techniques & good specification.
Start

Read Road status related to Sewerage flow running over the road surface

IF Defect

High sewerage flow quantities
- Design problem, where the pipe diameter is not sufficient
  - Action: Re-planning, redesign & replacement the existing pipe with larger & suitable diameter
  - Program: Special

Additional flow quantities through mixing storm water with sewerage water
- Action: Inspection all manholes & closed its carefully
  - Program: Periodic

Damaged sewerage manholes
- Action: Replacement or repair the manholes
  - Program: Periodic

Collected sediments inside the manholes
- Action: Remove all depree & fine particles
  - Program: Periodic

Closed sewerage pipes
- Action: Replacement or repair the pipes
  - Program: Periodic

Closed sewerage pipes inside the sewerage pipes
- Action: Clean the inside pipe by using jitter machine
  - Program: Periodic

End
Data Flow chart No. 6
Maintenance Group:
Read Road Status when sewerage flow running over the road surface

- **Fixed Data**
  - Length, width, coordinates (x,y), street name, street No. & Zone area, sewerage pipe diameter and material.
- **Read By**:
  - Surveying & measuring these fixed data by technical persons.

- **Online Data**
  - Sewage flow rate, velocity and slope of pipes.
- **Read By**:
  - Measuring by technical persons through using as built drawing and automated equipment

- **Periodical Data**
  - Length, width, coordinates (x,y), street name, street No. & Zone area, sewerage pipe diameter and material.
- **Read By**:
  - Surveying & measuring these fixed data by technical persons.

**- Programming Language**:
  - Visual basic - Access.
  - Excel - Delphi - Others

**- Calculate**:
  - Redesign of the sewage pipes section and recalculation should be done, through using special equations.
  - Assigning and classifying the problems related to the pipes, manholes & cover manholes

**GIS**

**-Data Base**

<table>
<thead>
<tr>
<th>Fixed Data</th>
<th>Online Data</th>
<th>Periodical Data</th>
</tr>
</thead>
</table>

**-Geographic Map**

**-Output**

- Thematic Map about:
  - Road status according to the preceding classification (pipes, manholes, & cover manholes) conditions.
  - Queries
  - Reports related to the preceding classification.
  - Decisions related to assign the type of maintenance/program should be used

- **Closed Sewerage Pipes**:
  - Damaged sewage pipes
  - Action = Replacement or repair the pipes.
  - Program = periodic
  - Collected sediments inside the sewerage pipes
  - Action = Remove all debris & fine particles
  - Program = Periodic.

*Figure No. 5.39, Data flow chart No. 6 (Maintenance Group)*
Chart No. (6):

**Decision Aim:** Discussing the causes of sewage flow running over the road surface and how to avoid it, actions & programs.

- **Type of Required Data:** Fixed Data, Online Data and Periodical Data

- **Input:**
  - This chart divides & describes the problem into three cases, where sewage flow running over the road surface when:

- **Output:**
  1. **High sewage flow quantities:**
     1-A: Design problem related to pipe diameter is not sufficient.

- **Calculation:** Action should be used through special program:

  - **Procedure:**
    - Re-planning, re-design & replacement the existing pipe with suitable diameter.

  - **Output:**
    1-B / Additional flow quantities through mixing storm water with sewage water. Action should be used through using periodic program

  - **Procedure –** Inspection all manholes & closed its carefully.

- **Output:**
  2. **Closed Manholes:**

  2-A / Damaged sewerage manholes:

  - **Procedure:** *Action should be used through periodic program*
    - Replacement or repair the manholes.

  2-B Collected sediments inside the manholes

- **Procedure:** *Action through using periodic program*
  - Remove all depre & fine particles.

- **Output:**

  3. **Closed Sewerage pipes**

  3-A Damaged sewerage pipes

  - **Procedures:** *Action through using periodic program*
    - Replacement or repair the pipes.

- **Output:**

  3-B / collected sediments inside the sewerage pipes.

- **Procedures:** Action through periodic program
  - Clean the inside pipe by using jitter machine.
Maintenance Chart No. (7)

Figure No. 5.40, Road Status related to Storm water flow running over the road, actions & programs.

Start

Read Road Status related to Storm water flow running over the road

If storm water thick. > 7cm

High storm water flow quantities

Design problem, where the pipe diameter or the gutter size is not sufficient

Action: Re-planning, redesign & replacement the existing pipes or gutters with larger & suitable size

Program: Special

High rainfall quantities

Action: Increase the No. of gutters

Program: Special

Damaged storm water manholes or gutters

Action: Replacement or repair manholes and gutters

Program: Periodic

Closed manholes or gutters

Collected sediments inside the storm water manholes or gutters

Action: Remove all debris & fine particles

Program: Periodic

Closed storm water pipes

Damaged storm water pipes

Collected sediments inside the storm water pipes

Action: Replacement or repair pipes

Program: Periodic

Action: Clean the inside pipe by using jitter machine

Program: Periodic

End
**Data Flow chart No. 7**  
**Maintenance Group:**

**Read Road Status when storm water running over the road**

- **Fixed Data**
  - Length, width, coordinates (x,y), street name, street No. & Zone area, sewerage pipe diameter, material & gutters sizes
  - **Read By:**
  - Surveying & measuring these fixed data by technical persons.

- **On Line Data**
  - Sewage water rate, velocity and slope of pipes.
  - **Read By:**
  - Measuring by technical persons through using as built drawing and automated equipment

- **Periodical Data**
  - Inspection the storm water pipes, manholes & gutters status
  - **Read By:**
  - Technical persons by visual inspection & automated equipment

**Programming Language:**
- Visual basic
- Access
- Excel
- Delphi
- Others

- **Calculate**:
  - Redesign of the storm water pipes section and gutters size & renovation should be done, through using special equations.
  - Assigning and classifying the problems related to the (storm water pipes, manholes & gutters)

**GIS**

- **-Data Base**
  
<table>
<thead>
<tr>
<th><em>Fixed Data</em></th>
<th><em>Online Data</em></th>
<th><em>Periodical Data</em></th>
</tr>
</thead>
</table>

**-Geographic Map**

**-Output**
- Thematic Map about:
  - Road status according to the preceding classification (Storm water, pipes, manholes, gutters) conditions.
  - Queries
  - Reports related to the preceding classification.
  - Decisions related to assign the type of maintenance & program should be used.

**-Closed storm water Pipes:**
- Damaged storm water pipes
  - Action = Replacement or repair the manholes and gutters.
  - Program = Periodic
- Collected sediments inside the storm water manholes or gutters.
  - Action = Remove all debris & fine particles
  - Program = Periodic

**-Closed Manholes or gutters:**
- Design Problem: (The pipe diameter or the gutter size is not sufficient)
  - Action = Re-planning & redesign & replacement the existing storm water pipes or gutters with larger & suitable size.
  - Program = Special
- High rainfall quantities:
  - Action = Increase the No. of gutters
  - Program = Special

**-If**

**Figure No. 5.41, Data flow chart No. 7 (Maintenance Group)**

140
Chart No. (7):

**Decision Aim:** Discussing the causes of storm water flow running over the road surface and how to avoid it, action & program.

- **Type of Data Required:** Fixed Data, On Line Data and Periodical Data
- **Input:**
  - This chart divides the problem into three cases, when storm water flow running over the road surface and increase thick 7 cm where:
  - **1- High storm water flow quantities:**
    - **Output:**
      - 1-A / Design problem related to pipe diameter or gutter size is not sufficient.
      - **Calculation:** Action through using special program.
      - **Procedure:** Re-planning, redesign & replacement the existing pipes or gutters with larger & suitable size.
    - **Output:**
      - 1-B / High rainfall quantities
      - **Procedure:** Action through using special program
        - Increase the No. of gutters.
  - **2- Closed manholes or gutter:**
    - **Output:**
      - 2-A / Damaged storm water manholes or gutters
      - **Procedure:** Action through using periodic program
        - Replacement or repair manholes & gutter.
    - **Output:**
      - 2-B / Collected sediments inside the storm water manholes or gutters.
      - **Procedure:** Action through using periodic program
        - Remove all deepre & fine particles.
  - **3- Closed storm water pipes:**
    - **Output:**
      - 3-A / Damaged storm water pipes.
      - **Procedure:** Action Should be used through using periodic program.
        - Replacement or repair pipes.
    - **Output:**
      - 3-B Collected sediments inside the storm water pipes
      - **Procedure:** Action Should be used through using periodic program.
        - Clean the inside pipe by using jitter machine.
Maintenance
Chart No. (8)

Start

Read Footway surface Condition

Small area needs patching

IF Defect

Large area needs patching

Action:
- Used Macadam, 3mm. Fine Graded Wearing Course.
- This was known as Fine cold Asphalt.

Program:
Routine

End

Action:
- Used Macadam, 6mm. Size Dense Wearing Course.
- Or used small size tiled or block pavement

Program:
Routine

Action:
- Used Macadam, 6mm. Size Medium Graded Wearing Course
- Or used tiled or block pavement

Program:
Routine

Figure No. 5.42, Footing Patching by using different Bituminous Mixtures Suitable, actions & programs. [21]
Data Flow chart No. 8
Maintenance Group

Read Footway Surface Condition

- Fixed Data
  - Length, width & road area
  - Cost/m3, coordinates (x, y), street name, street No. & Zone area
- Read By:
  - Surveying & measuring these fixed data by technical persons

- Periodical Data
  - Measuring the different patching area along the road
- Read By:
  - Visual Inspection.
  - Automated Inspection

- Programming Language:
  - Access.
  - Visual basic.
  - Excel
  - Delphi.
  - Others

- Classifying the different patching according to their sizes (small area, medium area and large area) need patching

If

- Small area needs Patching:
  - Action = used Macadam, 3mm. (Fine Graded Wearing Course). This was known as (fine cold asphalt)
  - Program = Routine
- Medium area needs Patching:
  - Action = used Macadam, 6mm. (Size Dene Wearing Course).
  - Program = Routine
- Large area needs Patching:
  - Action = used Macadam, 6 mm. (Size Medium Graded Wearing Course).
  - Program = Routine

GIS

- Data Base
  - Fixed Data
  - Periodical Data

- Geographic Map

-Out Put
  - Thematic Map about:
    - Road Condition related to the footway patching size (small, medium and large area) need patching
    - Queries
  - Footway condition reports related to the patching size (small, medium and large area)
  - Decisions related to choose the type of maintenance & materials that should be used

Figure No. 5.43, Data flow chart No. 8 (Maintenance Group)
Chart No. (8):

Decision Aim: Footing patching by using different Bituminous mixtures suitable, what actions & programs.

- Type of Required Data: Fixed Data and Periodical Data
- Input:
  - This chart describes the dangerous that resulted through any obstacles on the highway.
  - This chart deals with footway surface condition and classified into three states:
- Output:

1- Small areas need patching:

- Procedure: Action through routine program:
  - Used Macadam, 3mm. Fine Graded wearing course, this was known as fine cold asphalt.
- Output:

2- Medium area needs patching:

- Procedure: Action through routine program:
  - Used Macadam, 6mm. Size Dense Wearing Course.
- Output:

3- Large area needs patching:

- Procedure: Action will be used through routine program:
  - Used Macadam, 6mm. Size Medium Graded wearing course.
Maintenance Chart No. (9)

- Ironwork Damage & How to avoid it:-
  - It means (gulleys (drains), manholes, stop-tap covers, inspection champer covers, etc...)

Start

Read Ironwork Damage

IF Damage

- Ironwork lifted poorly will "move & settle making the road unsafe.

Action:
- Re-fixation the fittings in a good manner by using qualify staff.

Program:
Routine

- Ironwork did not surround with good fresh concrete for strength & bedded on an approved mortar, especially if chambers/gulley were performed in plastic material.

Action:
- Excavate the area around the fittings & fill it with fresh concrete & bedded with an approved mortar.

Program:
Routine

- Ironwork did not install in correct way due to use poor workmanship in installation.

Action:
- Repair or reinstallation in a good manner by using qualifies workmanship people.

Program:
Routine

End

Figure No. 5.44, Ironwork Damage & How to avoid it, actions & programs
Data Flow chart No. 9
Maintenance Group

Read Ironwork Parts Status

- Fixed Data:-
  - Coordinates, street name, street No. & Zone area
- Read By :-
  - Surveying & measuring these fixed data by technical persons

- Periodical Data :-
  - Inspection all patching areas than include ironwork parts (gullies or drains, manholes, stop-tap covers and chamber covers...etc)
- Read By :-
  - Technical persons through visual inspection in the site.

- Programming Language :-
  - Visual basic. - Access
  - Excel - Delphi. - Others

- Classifying the ironwork status according to (Ironwork lifted poorly, ironwork didn't surround with good fresh concrete and didn't install in correct way ) The patching distress includes this defects

- Ironwork lifted poorly: -
  - It will move and settle making the road unsafe.
  - Action = re-fixation the fittings in a good manner by using qualify staff.
  - Program = Routine
- Ironwork didn't surround with good fresh concrete:
  - It will remain in poor strength & bedded on an approved mortar.
  - Action = Excavate the area around the fittings & fill it with fresh concrete & bedded with an approved mortar.
  - Program = Routine
- Ironwork didn't install in correct way:
  - It is occur due to use poor workmanship in installation.
  - Action = Repair or reinstallation in a good manner by using qualifies workmanship.
  - Program = Routine

GIS

- Data Base

  * Fixed Data
  * Periodical Data

- Geographic Map

- Out Put

  - Thematic Map about :
    a- Road Condition related to the footway patching size (small, Medium and large area) need patching
    b- Queries
    - Foot way condition reports related to the patching size (small, Medium and large area)
  - Decisions related to choose the type of maintenance & materials that should be used.

Figure No. 5.45, Data flow chart No. 9 (Maintenance Group)
Chart No. (9):

Aim: Discussing: the Ironwork damage and how to avoid it:

- Type of Required Data: Fixed Data and Periodical Data
- Input:
  - It means (gullies (drains), manholes, stop-tap covers, inspection chamber covers, etc), actions & programs.
- Input:
  - This chart deals with Iron work that mentioned above, failure, how to avoid it.
  - Iron work damage classified into three types.
- Output:
  1. Ironwork lifted poorly will "move & settle making the road unsafe"
- Procedure: - Action should be used through routine programs:
  - Re-fixation the fittings in a good manner by using quality staff.
- Output:
  2. Ironwork did not surrounded with good fresh concrete for strength & bedded on an approved mortar, especially if chambers/ gully were performed in plastic material.
- Procedure: - Action should be used through routine programs:
  - Excavate the area around the fittings & fill it with fresh concrete & bedded with an approved mortar
- Output:
  3. Ironwork did not install in correct way due to use poor workmanship in installation.
- Procedure: - Action should be used:
  - Repair or reinstallation in a good manner by using qualifies workmanship people.
Start

Read shoulder & side slope status

IF Defect

- Deformation
  - Action: Fill
  - Program: Routine
- Scour
  - Action: Fill
  - Program: Routine
- High vegetation growth
  - Action: Cut
  - Program: Routine

END

Figure No. 5.46, Shoulders and sideslope defects, actions & programs.
Data Flow chart No. 10
Maintenance Group

Read shoulder and side slope status

- Fixed Data
  - Length, width, coordinates (x,y), street name, street No. & Zone area
- Read By:
  - Surveying & measuring these fixed data by technical persons
  - Using graphical maps

- Periodical Data
  - Assigning the location problems that occur to the shoulder & side slope like deformation, scour and high vegetation growth problems.
- Read By:
  - Technical persons by using visual inspection manner

- Programming Language:
  - Visual basic
  - Access
  - Excel
  - Delphi
  - Others

- Classifying the maintenance works according to the priorities.

If

- Deformation Problem:
  - Action = Fill
  - Program = Routine
- Scour Problem:
  - Action = Fill
  - Program = Routine
- High vegetation growth:
  - Action = Cut
  - Program = Routine

GIS

- Database
  - Fixed Data
  - Periodical Data

- Geographic Map

- Output
  - Thematic Map about:
    a- Road shoulder & side slope condition according to the preceding classification (deformation, scour and high vegetation growth).
    b- Queries
    - Road shoulder & side slope condition reports according to the preceding classification.
    - Decisions related to assign the type of maintenance and programs that should be used.

Figure No. 5.47, Data flow chart No. 10 (Maintenance Group)
Chart No. (10):

*Decision Aim:* Discussing of shoulders and side slope maintenance what actions & programs

- Type of Required Data: - Fixed Data and Periodical Data
- **Input:**
  - This chart describe & divide the damages in the shoulders & sideslope into three types as:
- **Output:**
  1- Deformation
  - **Procedure:** Action Through routine program
    - Fill.
  2- Scour
  - **Procedure:** Action Through routine program
    - Fill.
  3- High Vegetation
  - **Procedure:** Action should be used through routine program
    - Cut.
Maintenance Chart No (11)

Start

Read Road Furniture & marking status

IF Defect

IF

Missing

Action Replace

Program Routine

Damaged or Unreadable

Action Repair or replace

Program Routine

Dirty or Corroded

Action Clean or repaint

Program Routine

END

Notes:-
Includes warning signs, information signs, guardrail

* Figure No. 5.48, Road furniture and marking defects: actions & programs
Data Flow chart No. 11
Maintenance Group

Read Road Furniture & Marking status

- Fixed Data
  • Length, width, coordinates (x,y), street name, street No. & Zone area, sign (No., Types and location) Humps (No. & Location), Hand rails (length & location) and painted lines (length and location)
  • Read By:
    • Surveying & measuring these fixed data by technical persons.

- Periodical Data
  • Assigning the location problems that occur to the road furniture & marking parts like (Missing, damaged or unreadable dirty or corroded) problems. side slope like (deformation, scour & High vegetation growth) problems.
  • Read By:
    • Technical persons by using visual inspection manner.

- Programming Language:
  Visual basic - Access,
  Excel - Delphi - Others

- Classifying the different problems in the road furniture and marking parts according to the type of problem like (Missing, Damaged or Unreadable) & Dirty or Corroded

- Missing Problem
  • Action = Replace.
  • Program = Routine.

- Damaged or Unreadable Problem:
  • Action = Repair or replace
  • Program = Routine

- Dirty or Corroded problem
  • Action = Clean or repaint
  • Program = Routine.

GIS

- Data Base
  - Fixed Data
  - Periodical Data

- Geographic Map

- Output
  - Thematic Map about:
    a- Road furniture and marking condition according to the preceding classification (missing, damaged or unreadable and dirty or corroded).
    b- Queries
      • Road furniture and marking condition reports according to the preceding classification.
      • Decisions related to assign the type of maintenance and programs that should be used.

Figure No. 5.49, Data flow chart No. 11 (Maintenance Group)
Chart No. (11):

*Decision Aim*: Discussing the type of defect related to right of way (road of furniture & marking) and type of maintenance required.

- Type of Required Data: - Fixed Data and Periodical Data
- **Input:**
  - This chart describes the different defects in the road furniture and marking according to:
- **Output:**
  1. Missing
    - **Procedure**: Action should be used through routine program
      - replace
  - **Output:**
  2. Damaged or unreadable
    - **Procedure**: Action should be used through routine program
      - repair or replace
  - **Output:**
  3. Dirty or corroded
    - **Procedure**: Action should be used through routine program
      - Clean or repaint
Additional charts

Maintenance Chart: (No. 1)

Seasonal Factors Charts

Start

Road Pavement Defect

Yes

If Defect

No

- Road Furniture Defect

- Seasonal Factors effects

No Action

- Pavement layers defect (sub-grade, base, sub-base, base course, binder and wearing course)

Yes

- Seasonal Factors effects

Temperature Differences
Rain Fall
Frost Status
Dirty/dusty status

Temperature Differences
Rain Fall
Frost Status

Dirty/dusty status

- Action:
  - Using special painted materials to resist (the storm water, temperature differences, frost & dusty status)

- Action:
  - Using special materials dealing with different temperatures & suitable binder viscosity.
  - Using special equipment may be used in different temperatures.

- Action:
  - Using special materials against the storm water effects & drying in quick time.
  - Using modern technique to protect the maintenance area during the maintenance period

- Action:
  - Using special materials against the coldest temperatures
  - Using modern technique & equipment that will be used to resist the frost status.

- Action:
  - Using special asphalt mixture which drying in quick time before dirty and dusty effect

- Program: Special
- Program: Special
- Program: Special
- Program: Special
- Program: Special

End

Figure No. 5.50, Additional maintenance chart No. 1 (seasonal factors chart)
Data Flow chart No. 1
Maintenance Group: (Additional Charts)

Read Road Pavement Status

- Fixed Data
  - Length, width, coordinates (x,y), street name, street No. & Zone area,

- Read By:
  - Technical persons by using visual surveying and measuring.
  - By using graphical map.

- Periodical Data
  - Assigning & measuring roads, distresses according to the (location, type of size) and measuring the site temperature and the atmospheric status during the maintenance period.

- Read By:
  - Technical persons by using visual inspection and automated equipment

- Programming Language:
  - Visual basic
  - Access
  - Excel
  - Delphi
  - Others

- Assigning and classifying: the maintenance type and material that should be used through (Seasonal factors effects)

- Road Furniture Defect:
  - Seasonal Factor effects:
    - Temperature differences: - Rain fall.
      - Frost status: - Dirty/dusty status
    - Action: Using special painted materials to resist (the storm water, temperature difference, frost & dusty status
    - Program = special.
  - Pavement layers defect:
    - Seasonal Factor effects:
      - Temperature differences:
        - Action: Using special materials & special modern equipment that may be used in differences temperature.
        - Program = special.
    - Rain fall:
      - Action: Using special materials against the storm water effects & drying in quick time. Using special modern techniques to protect the maintenance area during the maintenance period.
      - Program = special.

- GIS

- Data Base
  - Fixed Data
  - Periodical Data

- Geographic Map

- Output
  - Thematic Map about:
    - Road condition.
    - Queries:
      - Reports related to the seasonal factors effects to the maintenance manner.
      - Decisions related to the maintenance type materials and program should be used through the (Seasonal factors effects)

- Frost status
  - Action: Using special materials & equipment that resist the frost effect.
  - Program = special.

- Dirty/Dusty status:
  - Action: Using special asphalt mixture which drying in quick time before dirty & dusty effect.
  - Program = special.

Figure No. 5.51, Additional Data flow chart No.1 (Maintenance Group)
Planning Group
Additional Chart (No. 2):
Road Structural Remaining Life Charts

Start

Road Pavement Distresses

Read Road Pavement distresses status through:
* Restudy of structural remaining life of the road according to:
  Traffic flow/weight and redesign the road pavement section. And
  reviewing the current road pavement condition.

If the structural remaining life

(Short Time)

Action:
- Re-planning and Re-designing should be done

Program =
- Reconstruction

Medium Time

Action:
- Choosing a suitable routine type of maintenance according to the type of road’s distress.

Program =
- Routine maintenance

(Long Time)

Action:
- Choosing a proper preventative type of maintenance according to the type of road’s distress.

Program =
- Preventative maintenance

End

Figure No. 5.52, Additional Planning chart No. 2
(Chart of Road structural remaining life)
Data Flow chart No. 2
* Planning Group: Additional Chart No. (2)

Road pavement distresses evaluation.

- Fixed Data:
  - Length, width, coordinates (x,y), street name, street No. & Zone area.
- Read By:
  - Technical persons by using visual measuring and graphical map.

- On Line Data:
  - Traffic flow weight.
  - Velocity.
- Read By:
  - Visual & Automated Inspection.

- Periodical Data:
  - Assigning & measuring the different distresses along the road (location, type & size).
  - Visual and automated Inspection.

- Programming Language:
  - Visual basic
  - Access.
  - Excel
  - Delphi.
  - Others

- Calculate:
  - Evaluate and measure the structural remaining life of the road, through making redesign to the road pavement layers through our knowing of the traffic flow weight.

GIS

- Data Base
  * Fixed Data
  * Online Data
  * Periodical Data

- Geographic Map

- Out Put
  - Thematic Map about:
    a- Roads condition.
    b- Queries
  - Reports related to the structural remaining life of the road to the type of maintenance.
  - Decisions related to assign the suitable maintenance type and program that should be used.

Figure No. 5.53, Additional Data flow chart No. 2 (Planning Group)
Maintenance Group
Additional Chart (No. 3):
Bridge & Culvert Condition Chart

Start

Road Bridges & Culverts Condition

If Defect

Yes

Furniture Damage or Missing

No

If Defect

Yes

No Action

Structural Damage

Action:
- Replace any missing furniture parts

Program = - Urgent

Action:
- Repair, replace, clean or repaint should be done

Program = - Urgent

Action:
- Settlement in the expansion joints due to:
  - Increased traffic flow weight
  - Different settlement in the bridge footing specially in the out falls scoured areas.

Action:
- Different distresses in the bridge surface or any damages in the bridge or culvert body.

Program = - Preventative maintenance

End

Figure No. 5.54, Additional maintenance chart No. 3 (bridge & culvert condition)
Data Flow chart No. 3
Maintenance Group : Additional Chart (No. 3)

Read Bridges & Culverts Condition

- Fixed Data:
  - Length, width, coordinates (x,y), street name & No. & Zone area.
- Read By:
  - Technical persons by using visual measuring and graphical map.

- On Line Data:
  - Traffic flow weight and traffic flow type.
- Read By:
  - Automated equipment & visual measuring.

- Periodical Data:
  - Assigning & measuring the different distresses along the bridge & culvert (location, type & size).
  - Assigning the missing parts
- Read By:
  - Automated equipment & visual measuring through technical persons.

- Programming Language:
  - Visual basic - Access.
  - Excel - Delphi - Others

- Calculate:
  - Redesign & recalculation of the bridge or culvert structural.
  - Assigning the structural remaining life of the bridge or culverts.

- Structural damage:
  - Different distress in the bridge surface or any damage in the bridge or culvert.
  - Action = Continuously maintenance should be done.
  - Program = Preventative & Routine.
  - Settlement in the expansion joint due to:
    - Increased traffic flow weight.
    - Settlement in the bridge footing, specially in the out falls scoured areas
  - Action = Special treatment in the expansion joints areas of fixed settlement cases.
  - Redesign & reconstruction of not fixed settlement cases.
  - Program = Urgent.

GIS

- Data Base
  *Fixed Data
  *Online Data
  *Periodical Data

- Geographic Map

- Out Put
  - Thematic Map about:
    - Roads condition.
    - Queries
  - Reports related to the bridge culverts conditions & maintenance.
  - Decisions related to the actions & program that should be used.

- Furniture Damage or missing:
  - Missing any thing related to furniture parts or fittings.
  - Action = replace any missing furniture parts
  - Program = Urgent
  - Damaged, Unreadable and dirty parts.
  - Action = Repair, replace, clean or repaint should be done.
  - Program = Urgent.
5.3 Analysis of the questionnaire

5.3.1 The Surveying Sample:

The sample included twenty respondents in different areas of Gaza strip, and they were distributed as follows:
1- Eight samples represented municipalities through director Eng. (MSc or BSc).
2- Four samples represented universities thorough senior Eng. (PHD or more).
3- Four samples represented miniseries through concerned persons (PHD or more and MSc or BSc).
4- Four samples represented other organizations like (PECDAR, UNRWA, World Bank and Private company.)

Table No. (5.3) indicates the sample distribution Where:

- About 40% of respondents are from municipality, 20% university, 20% from ministry, and 20% from others. These results are shown in more details in figure No. (5.56)

![Figure No. 5.56, The distribution of study sample by category type](image)

- About (0%) of respondents have (1-5 years) experience, a bout 50% have (5-10 years) experience, and a bout 45% have (more than 15 years) experience.

These results are shown in figure No. (5.57)

![Figure No. 5.57, The distribution of study sample by category of experience](image)
- About 30% of respondents are senior Eng. (PHD of More), about 70% are Director Eng. (MSc or BSc) and about 0% are technician persons (less than BSc). These results are shown in figure No. 5.58

![Pie chart showing the distribution of position and qualification level]

Figure No. 5.58, The distribution of study sample by category position level

**Table No. (5.3), Sample distribution**

<table>
<thead>
<tr>
<th>No.</th>
<th>Task</th>
<th>Categories</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Type of Firm/Institution</td>
<td>Municipality</td>
<td>40%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>University</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ministry</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Others</td>
<td>20%</td>
</tr>
<tr>
<td>2</td>
<td>Firm Experience</td>
<td>1 to 5</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 to 10</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 to 15</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>More than 15</td>
<td>45%</td>
</tr>
<tr>
<td>3</td>
<td>Position and Qualification level</td>
<td>Senior Eng. (PHD or More)</td>
<td>30%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Director Eng. (MSc or BSc)</td>
<td>70%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Technician (Less than BSc)</td>
<td>0</td>
</tr>
</tbody>
</table>

5.3.2 Analysis technique:

Through our surveying and analyzing the answers of the questionnaire; the scores for each answer starting from zero till one hundred; Then the average of these scores will be taken. As example, the respondent can select the answer of a question No. 9, one from the 5 options (very strongly, strongly, fair, little & non).

This means that, may get five different answers from five respondents, in this case the score of this question will be the average of the five answers \((100+75+50+25+0)/5 = 50\).
Another example is that the respondent can select the answer of a question No. 15, from the four options (High willingness, Medium willingness, poor willingness and No. willingness at all). This means that, may get four different answers from four respondents. In this case the score of this question will be the average of four answers \((100+66.6 + 33.3+0) / 4 = 50.\)

5.3.3 Results

After gathering the data and analyzing the questionnaire; Table No.(5.4) indicates the results in the form of percentage in the four types (Municipality, University, Ministry and Other) individually and the average percentage of them, where this is done for each question. Also, there are some facts of the results:

Graphs from No. (5.56 to 5.58 ) is conducted for more illustration about an important tasks related to (O & M) in (R &T) management for five categories (Municipality, University, Ministry, Other and the average).

In results of table No.(5.4) & through in the task No. (1) that the municipalities persons said that the proposed decisions are adequate to cover (O&M) activities about 100% , than the universities persons possible percentage about 75%, the ministries & others persons positive percentage (75%) & the average percentage about = 81.25%.

Also, In task No. (2) related to “Using GIS/DSS for (O&M) in (R&T) management”, it is clear that the lowest percentage was for ministry persons. While each of persons from the municipalities, universities and others persons, got about 25%, and the average was about 18.75%.

In results of table No. (5.4) and through the task answer No. (4) related to reasons of no applying GIS/DSS for (O&M) in (R&T) management, it is clear that municipalities persons respondents, in sub task No. b (Unqualified users staff) got a percentage of (75%) which was regarded as the highest percentage compared with other sub tasks answers (a,c,d,e & f) Also, it is clear that ministry persons respondents, in sub tasks answers No. b&d (Unqualified staff and small size of existing data) got a percentage of (75%), which was the highest percentage compared with other sub tasks (a,c,e,f). The highest average percentage was for sub task answer No. b (Unqualified staff), (50%), and the lowest average percentage was for sub task No. a (Increased cost), (3.25%).

Also, through the task answer No. (5) related to description of your knowledge of GIS/DSS, it is clear that the highest percentage, (56.25%) was for other persons,
and the average percentage was about (42.18%). In the same time in task answer No. (6) related to getting training in (O&M) using GIS/DSS, all of respondents scores were low and the average percentage was about (9.37%).

Through the task answer No. (7) related to having a proper inventory system, the (university and ministry persons) got the lowest percentage (0%), compared with (municipalities and others persons), who got the highest percentage, (25%), and (12.5%) was the average percentage.

Through the task answer No. (8) related to methods of gathering the inventory database, the persons of municipality and other persons had a proper inventory system, and that was clear in the preceding responding task answer No. (7). They got the highest percentage, (25%), in sub task answer No. b (By using modern software programs), & the highest average percentage (12.5%) in the same sub task.

Through the task answer (a) related to methods of solving the operation problems, the municipalities persons got the highest percentage, (62.5%), in sub task answer No. a (By continuously updating the operation system).

Through the task answer No. (10) related to methods of solving the maintenance problems, the municipalities persons got the highest percentage, about (75%), in sub task answer No. a (By continuously updating the maintenance system). Also in the same task, other persons got the highest percentage, about (50%), in sub task answer No. d (Others).

Through the task answer No. (11) related to having independent department deals with (O&M) of (R&T), the municipalities and ministries persons got the highest percentage, about (25%), while the persons from universities and other persons got the lowest percentage, (0%).

Finally, through the task answer No. (12) related to willingness to improve your GIS/DSS skills, municipalities persons got the highest percentage, about (95.8%), and the universities persons got the lowest percentage, about (66.6%), and the average responds percentage was about (82.05%).
<table>
<thead>
<tr>
<th>No.</th>
<th>Task</th>
<th>Municipality</th>
<th>University</th>
<th>Ministry</th>
<th>Others</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The proposed decisions are adequate to cover (O&amp;M) activities</td>
<td>100%</td>
<td>75%</td>
<td>75%</td>
<td>75%</td>
<td>81%</td>
</tr>
<tr>
<td>2</td>
<td>Using GIS/DSS for (O&amp;M) in (R&amp;T) management.</td>
<td>25%</td>
<td>25%</td>
<td>0%</td>
<td>25%</td>
<td>19%</td>
</tr>
<tr>
<td>3</td>
<td>Reasons of applying GIS/DSS for (O&amp;M) in (R&amp;T) management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a-To produce base maps only</td>
<td>12.50%</td>
<td>13%</td>
<td>0%</td>
<td>12.50%</td>
<td>9%</td>
</tr>
<tr>
<td></td>
<td>b- As an effective management tool</td>
<td>5%</td>
<td>0%</td>
<td>0%</td>
<td>12.50%</td>
<td>4%</td>
</tr>
<tr>
<td></td>
<td>c- To improve performance</td>
<td>12.50%</td>
<td>0%</td>
<td>0%</td>
<td>12.50%</td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td>d- To reduce and save cost</td>
<td>12.50%</td>
<td>0%</td>
<td>0%</td>
<td>12.50%</td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td>e- Others</td>
<td>12.50%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>3%</td>
</tr>
<tr>
<td>4</td>
<td>Reasons of no applying GIS/DSS for (O&amp;M) in (R&amp;T) management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a- Increased cost</td>
<td>12.50%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>3%</td>
</tr>
<tr>
<td></td>
<td>b- Unqualified users (staff)</td>
<td>75%</td>
<td>25%</td>
<td>75%</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td>c- Weak level of periodic inspection &amp; recording</td>
<td>62.50%</td>
<td>25%</td>
<td>50%</td>
<td>0%</td>
<td>34%</td>
</tr>
<tr>
<td></td>
<td>d- Small size of existing data</td>
<td>62.50%</td>
<td>25%</td>
<td>75%</td>
<td>0%</td>
<td>41%</td>
</tr>
<tr>
<td></td>
<td>e- Low administrative level</td>
<td>50%</td>
<td>0%</td>
<td>0%</td>
<td>25%</td>
<td>19%</td>
</tr>
<tr>
<td></td>
<td>f- Others</td>
<td>0%</td>
<td>0%</td>
<td>25%</td>
<td>50%</td>
<td>19%</td>
</tr>
<tr>
<td>5</td>
<td>Description of your knowledge of GIS/DSS</td>
<td>37.50%</td>
<td>43.75%</td>
<td>31.25%</td>
<td>56.25%</td>
<td>42%</td>
</tr>
<tr>
<td>6</td>
<td>Getting training in (O&amp;M) using GIS/DSS</td>
<td>12.50%</td>
<td>0%</td>
<td>0%</td>
<td>25%</td>
<td>9%</td>
</tr>
<tr>
<td>7</td>
<td>Having a proper inventory system</td>
<td>25%</td>
<td>0%</td>
<td>0%</td>
<td>25%</td>
<td>13%</td>
</tr>
<tr>
<td>8</td>
<td>Methods of gathering the inventory database</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a- by using modern inspection measurements(visual &amp; automated equipment)</td>
<td>12.50%</td>
<td>0%</td>
<td>0%</td>
<td>25%</td>
<td>9%</td>
</tr>
<tr>
<td></td>
<td>b- By using modern software programs to arrange &amp; analyze the data</td>
<td>25%</td>
<td>0%</td>
<td>0%</td>
<td>25%</td>
<td>13%</td>
</tr>
<tr>
<td></td>
<td>c- Others</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>9</td>
<td>Methods of solving the oper. Problems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a- By continuously updating the operation system.</td>
<td>62.50%</td>
<td>0%</td>
<td>25%</td>
<td>25%</td>
<td>28%</td>
</tr>
<tr>
<td></td>
<td>b- By special training, for concerned staff</td>
<td>37.50%</td>
<td>0%</td>
<td>25%</td>
<td>25%</td>
<td>22%</td>
</tr>
<tr>
<td></td>
<td>c- by using different modern software program like (GIS/DSS) &amp; Others</td>
<td>12.50%</td>
<td>0%</td>
<td>0%</td>
<td>25%</td>
<td>9%</td>
</tr>
<tr>
<td></td>
<td>d- Others.</td>
<td>0%</td>
<td>0%</td>
<td>50%</td>
<td>25%</td>
<td>19%</td>
</tr>
<tr>
<td>10</td>
<td>Methods of solving the maintenance problems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a- By continuously updating the Operation system.</td>
<td>75%</td>
<td>0%</td>
<td>25%</td>
<td>0%</td>
<td>25%</td>
</tr>
<tr>
<td></td>
<td>b- By special training, for concerned staff</td>
<td>37.50%</td>
<td>0%</td>
<td>25%</td>
<td>25%</td>
<td>22%</td>
</tr>
<tr>
<td></td>
<td>c- by using different modern software program like (GIS/DSS) &amp; Others</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>25%</td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td>d- others.</td>
<td>0%</td>
<td>0%</td>
<td>25%</td>
<td>50%</td>
<td>19%</td>
</tr>
<tr>
<td>11</td>
<td>Having independent department deals with (O&amp;M) of (R&amp;T)</td>
<td>25%</td>
<td>0%</td>
<td>25%</td>
<td>0%</td>
<td>13%</td>
</tr>
<tr>
<td>12</td>
<td>Willingness to improve your GIS/DSS skills</td>
<td>95.60%</td>
<td>66.60%</td>
<td>74.95%</td>
<td>91.65%</td>
<td>82%</td>
</tr>
</tbody>
</table>
5.3.4 Discussion and Analysis of the questionnaire:

Each institution/firm respondent was asked some important questions related to (O&M) in (R&T) using GIS/DSS. And through this answer of the questionnaire, the meeting and interviews of all the respondents were done.

Therefore more discussion and analysis will be done for each task, which will help to put some recommendations to improve the current situation related to (O&M) in (R&T) using GIS/DSS, which is concentrated in the middle area of Gaza Strip.

1- The results concerned with task No. (1) in data analysis table No. (5.4) related to evaluate the proposed decisions, if it is adequate to cover (O&M) activities or not, indicates that 100% was for municipalities persons, 75% was for universities, ministries and other persons and 81.25% was the average. These results show that:

- The average answer percentage, about (81.25%), was high percentage, compared with other task. This reflect that efficiency of the proposed decisions was high.
- Some important points were added to task respondents like:
  - Side drains: [ditch depth, scour, erosion].
  - Bridge & culverts: [structural damage, out fall scoured]
  - Structural remaining life [by non-destructive assessments, ...]
  - Traffic loading data [for the structural maintenance of layers]
  - Seasonal factors effected decisions [temperature, rain, frost, ...]

- Therefore, three additional charts are added to this study to cover the preceding points. The municipalities persons got a percentage of about (100%), which is the highest percentage compared with other answers. This mean that, there is no additional suggestions about the proposed decisions and this reflect the differences of qualification level among the municipalities persons and (universities, ministries and others). These results are shown in more details in figure No. 5.59

![The proposed decisions are adequate to cover (O&M) activities](image)

Figure No. 5.59, The distribution of study sample by a proposed decisions, which are adequate to cover (O&M) activities

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2-The result concerned with questions No. 6&7 in the questionnaire was related to:

- arranging the proposed decisions according to their importance and to their use (usage) frequency; show that:

**Table No. 5.5, Arrangement of the proposed planning group charts according to their importance and their use (Usage) frequency:**

<table>
<thead>
<tr>
<th>Planning group charts No.</th>
<th>A₁</th>
<th>A₂</th>
<th>A₃</th>
<th>A₄</th>
<th>A₅</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrangement according to their importance</td>
<td>50%</td>
<td>8.33%</td>
<td>100%</td>
<td>58.33%</td>
<td>33.33%</td>
</tr>
<tr>
<td>Arrangement according to the use (usage) frequency</td>
<td>58.33%</td>
<td>33.33%</td>
<td>75%</td>
<td>33.33%</td>
<td>50%</td>
</tr>
</tbody>
</table>

- Through this table arrangement, show that:

- The chart No. A₃ related to the maintenance planning process, is the highest percentage, about (100% & 75%), of the arrangement to their importance & to their use (usage) frequency respectively. And As chart is related to maintenance scheduling process the second highest percentage about (58.33%) of the arrangement to their importance, and A₁ chart related to the flexible pavement condition and what type of maintenance should be used, is the second highest percentage about (58.33%) of the arrangement to their use (usage) frequency.

- This is logical data, because this reflect, the importance of planning process through maintenance works. Also, this reflect the people interest in planning issues through the maintenance works.

- Also, the results reflect the importance of maintenance scheduling process, which is the second highest percentage.

- The results reflect the people interest in evaluating the flexible pavement condition and assign the type of maintenance that should be used.

**Table No. 5.6, Arrangement of the proposed operation group charts according to their importance and their use (Usage) frequency:**

<table>
<thead>
<tr>
<th>Operation group charts No.</th>
<th>B₁</th>
<th>B₂</th>
<th>B₃</th>
<th>B₄</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrangement according to their importance</td>
<td>77.8%</td>
<td>11.11%</td>
<td>52.22%</td>
<td>15.7%</td>
</tr>
<tr>
<td>Arrangement according to the use (usage) frequency</td>
<td>77.8%</td>
<td>66.7%</td>
<td>44.44%</td>
<td>11.11%</td>
</tr>
</tbody>
</table>

- Through this results arrangements, show that:

- The chart No. B₁ related to assigning the action and program needed to apply safety consideration on the highway, is the highest percentage, about (77.8%),
of the arrangement to their importance and to their use (usage) frequency. This reflect, the importance of safety consideration on the highway, which is considered as a highest priority for people.

- Also, the chart No. B3 related to classifying the accidents causes and what action should be done to prevent or reduce the accidents, is the second highest percentage, about (52.22%), of the arrangement to their importance. This show the importance of preventing or reducing the accidents.

- The chart No. B2 related to the traffic flow problem in the intersection and finding the logical solutions is the second highest percentage, about (66.7%), of the arrangement to their use (usage) frequency. This show and reflect the people interest in traffic flow problems in the intersection, than other remaining charts. This will help the operational staff to prevent or reduce the accidents and to save their time.

Table No. 5.7, Arrangement of the proposed maintenance group charts according to their importance and their use (Usage) frequency:

<table>
<thead>
<tr>
<th>Maintenance group charts No</th>
<th>C₁</th>
<th>C₂</th>
<th>C₃</th>
<th>C₄</th>
<th>C₅</th>
<th>C₆</th>
<th>C₇</th>
<th>C₈</th>
<th>C₉</th>
<th>C₁₀</th>
<th>C₁₁</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrangement according to the importance(%)</td>
<td>71.51</td>
<td>81.33</td>
<td>50</td>
<td>63.33</td>
<td>33.33</td>
<td>66.7</td>
<td>78.7</td>
<td>43.33</td>
<td>20</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Arrangement according to the use (usage) frequency(%)</td>
<td>72</td>
<td>77</td>
<td>63.33</td>
<td>60</td>
<td>43.33</td>
<td>80</td>
<td>70</td>
<td>26.7</td>
<td>16.7</td>
<td>6.7</td>
<td>33.33</td>
</tr>
</tbody>
</table>

- Through this results arrangements, show that:

- Chart No. C2 related to “classifying the causes of road pavement distress, and choosing a proper action according to the causes of distress”, is the highest percentage, about (81.33%) and (77.0%), of the arrangement to their importance and frequent use respectively. This reflect the importance and the people interest in evaluating the road condition and in assigning the suitable maintenance to the roads distress. This will lead to choose & use a proper materials & equipment through the maintenance works.

- Also, the chart No. C7 related to “choosing a proper action & maintenance program for storm water flow running over the road surface”, is the second highest percentage about (78.7%) of the arrangement to their importance. This reflect the importance of storm water effects to the people and the road pavement surface during the rainfall period.
The chart No C6 related to "choosing a proper action and maintenance program for sewage flow running over the road surface" is the second highest percentage, about (80%), of the arrangement to their frequent use. This show and reflect the people interesting with sewage flow effects to the road pavement through running over the surface which causes different distresses on the road surface, that will need more maintenance and more cost.

The results concern with task No. (2) in results table No. (5.4) related to "using GIS/DSS for (O&M) in (R&T) management", indicates that 25% was for municipalities persons, 25% was for universities persons, 0% was for ministries persons, 25% was for other persons, and 18.75% was the average. These results show that:

- The average percentage, about 18.75, was low compared with other tasks.
- Also, the ministries persons percentage 0% was the lowest compared with (municipalities persons, universities persons and others persons). This has lead to know that this task did not require for the ministries persons like others.

These results are shown in more details in figure No. 5.60

![Figure No. 5.60, The distribution of study sample by using GIS/DSS for (O&M) in (R&T) management](image)

- Through the results concerned with task No. (3) in results table No. (5.4) related to "Reasons of applying GIS/DSS for (O&M) in (R&T) management indicates that the average highest percentage, about 9.37% ,was law compared with the other tasks. This percentage related to the sub task "To produce maps only".

This will lead to showing the weakness level of GIS/DSS concept for (O&M) in (R&T) management, for different people. Also, this low percentage, about
9.37%, show that most of institutions/firms in Gaza strip will need a special training on (GIS/DSS) applications with more concentration on (O&M) in (R&T) management, to be more familiar with this topic.

- Through the results concerned with task No. (4) in results table No.(5.4) related to “reasons of no applying GIS/DSS for (O&M) in (R&T) management” indicates that the highest average percentage about (50%) was related to sub task No. b “unqualified users (staff)” and the second highest average percentage about (40.6%) was related to sub task No. d “small size of existing data”. Also, in the same task No. 4 the ministry highest percentage about (75%) was related to sub tasks No. (b & d).

This lead to emphasize that the real causes of not applying GIS/DSS in (R&T) management in the ministries and the low percentage, about (25%), for the (municipalities persons, universities, others persons) and (18.75%) for the average, are indicated through the highest average percentage about (50% & 40.6%) related to the sub tasks No. (b & d) “unqualified staff & small size data” respectively.

- The highest ministry percentage, about (75% & 75%), was related to the same sub tasks No. (b & d). These results are shown in details in figure No. (5.61)

![Figure No. 5.61, The distribution of study sample by reasons of no applying GIS/DSS for (O&M) in (R&T) management](image)

- Using results concern with task No. (5) in results table No. (5.4) related to “Description of GIS/DSS knowledge”. Through different percentages shown in the mentioned table, show that:

  * The average percentage of answers, about (42.18), was not high percentage, compared with other tasks. Also it is shown that other persons percentage ,
about 56.25%, is the highest percentage compared with other categories (municipalities persons, universities persons & ministries persons).

This means that our GIS/DSS knowledge did not reach the required level. Also, Others persons are more qualified than persons of other categories. This help them to understand the concept of GIS/DSS than others.

- Through the results concerned with task No. (6) in results table No. (5.4) related to “Getting training in (O&M) using GIS/DSS”, show that the highest percentage, about (25%), was related to other persons, in spite of the low average percentage, about (9.37%). This will lead to see the weak level of applying GIS/DSS.

- The results concern with task No. (7) in results table No.(5.4) related to “Having a proper inventory system”, indicates the following: 25% of municipalities persons, 0% of universities persons, 0% of ministries persons and 25% of others persons. These results show that:
  
  • The average percentage, about 12.5%, was low compared with the other tasks.
  • Also, the (university persons and ministry persons) got a percentage of about 0%, and it was the lowest one compared with other categories. This has lead to know that inventory system did not require the (universities and ministries persons) like (municipalities and others persons), because the (universities & ministries persons) have small data compared with (municipalities and others persons)

- The results concerned with task No. (8) in results table No. (5.4) related to “Methods of gathering the inventory data base”, indicates that the highest average percentage, about 12.5%, was related to sub task No. b “By using modern software programs to arrange & analyze the data”

This has lead to the importance of using modern software programs through gathering the inventory database.

- The low (percentage, 12.5%), has lead to know that small No. of Institutions have inventory data base due to sub tasks No. (b & d) in task No. (4) “Unqualified users( staff) & small size of existing data”

- The results concerned with task No. (9) in results table No. (5.4) related to “Methods of solving the operation problems” indicates that the highest average percentage, about (28.12%), was related to sub task No. a “By continuously
updating the operation system”. Also the second (highest average percentage about (21.87%) was related to sub task No. b “By special training, for concerned staff”. This reflect that, all of (institutions/firms) staff need more special training of GIS/DSS application. The lowest average percentage about (9.37%) was related to sub task No. c “By using different modern software program like (GIS/DSS)”

This has lead to the fact that most of categorized persons preferred to solve their operation problems by continuously updating the existing operation system than using (GIS/DSS), due to the two preceding reasons in sub task No. (b & d) in task No. (4) “unqualified users (staff) and small size of existing data”. In the same time there is a highest percentage of the task No. (9) results was through the sub task answer No. (a) related to the municipalities persons in the same task. This has lead to know that this task is required for the municipalities than other categories, specially most of the municipalities have a special roads network, which need of continuos operating.

- The results concerned with task No. (10) in results table No. (5.4) related to “Methods of solving the maintenance problems” indicates that the highest average percentage (25%) was related to sub task No. (a) “By continuously updating the maintenance system”. In the other side the lowest average percentage about (6.25%) was related to sub task No. C “By using different modern software program like (GIS/DSS). Also, the highest percentage of the results in this task was related to the municipalities category in sub task No. (a) “By continuously updating the maintenance system about (75%).

The results seem to be similar to the preceding results in the task No. (9) with some differences in the percentage values.

This emphasize that operation and maintenance requirements are considered correlative issues, and if there is no operation, there is no need for maintenance. These results are shown in more details in figure No. (5.62)
The distribution of study sample by methods of solving the maintenance problems

- The results concerned with task No.(11) in results table results No. (5.4) are related to "Having independent department deals with (O&M) of (R&T)". Through different percentages shown in the mentioned table; show that:

  • The average answer percentage about (12.5%) was law percentage, compared with other tasks. Also, the (universities & others categories (municipalities & ministries persons). This has lead to know that independent department deals with (O&M) of (R&T) didn’t require for the (universities & others) than other categories.

- The results concerned with task No.(12) in results table No.(5.4) related to "Willingness to improve GIS/DSS skills" indicates that the average percentage about (82.05%) was high percentage compared with the other task, this will help any (institution/firms) to start of applying the GIS/DSS system in (O&M) of (R&T) management. Also, the highest percentage about (95.8%) was related to the municipalities persons category. This reflect the needs of applying GIS/DSS system is very important for all concerned staff. These results are shown in figure No. (5.63).
Figure No. 5.63, The distribution of study sample by willingness to improve GIS/DSS skills

- The results concerned with "attaching of an organizational structure chart for the institutional arrangement, providing experience level for persons who are dealing with (O&M) in (R&T) management" indicates that one municipality (Gaza Municipality) from eight ones, and one ministry (Public works ministry) of (R&T), and the other categories (university & others) have not independent department. Also, the remaining seven municipalities do not have independent department dealing with (O&M) of (R&T). But the (O&M) requirements are dealt with by engineering department in each municipality. Also, the three remaining ministries do not have independent department that deals with (O&M) of (R&T).

Through the above two institutions, which have independent department dealing with (O&M) of (R&T), show that:

* In Gaza Municipality, which have independent department which consist of:

A. Department of roads maintenance:
   - Chief department [engineer who has more 15 years experience]
   - Chief roads maintenance division [have 10 years experience]
   - Roads controlling official [have 10 years experience]
   - Chief metal division [have more 15 years experience]
   - Metal technical persons No. (4) [have a good experience]

B. Traffic engineering department:
   - Chief of traffic engineering department
   - Electronic engineer [have 10 years experience]
   - Chief assistant traffic lights unit [have a good experience].
Chapter No. (6)

General Information of Documentation of Practical Part
By Using Geomedia Software Tool
Chapter No. (6)

General Information of (GIS & Geomedia) & Documentation of Practical part by using Geomedia Software Tool

6.1 Introduction [17]

6.1.1 What is GIS?

- A Geographic Information System (GIS) is an organized collection of computer hardware, software, geographic data and personnel designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographically referenced information.

- Simply put, a GIS combines layers of information about a place to give a better understanding of that place. What layers of information that combine depends on the purpose to be used.

- A complete GIS requires: 1- Hardware 2- Software 3- Data 4-People and 5- Training to interpret changes over times & space. A GIS map can combine many layers of information. GIS allows dynamic changes to be visible and has the ability to combine data from several different sources.

- As on a paper map, a digital map created by GIS will have dots, or points that represent features such as cities; lines that represent features such as roads, and small areas, or polygons, that represent features such as lake.

- The difference is that this information comes from a database and has information attached to it.

- The database stores where the point is located, how long the road is, and even how many square miles a lake occupies. Each of these features is stored in separate layer, which can be made visible or invisible.

6.1.2 Why is layering so important?

- The power of a GIS over paper maps is your ability to select the information that need to see according to what goal are trying to achieve. A business person try to map customers in a particular town will want to see a very different information than a matter engineer who wants to see the water pipelines for the same town. Both may start with a common map -- a street and neighborhood map of the town-- but the information they add to the map will differ.
6.1.3 What is a GIS Database?
- A database is a logical collection of interrelated information related to a particular subject or purposes which is managed and stored as a unit.
- A GIS database includes information and data for spatial features as they relate to location and shapes of features recorded as points, lines, polygons, pixels, and grids and the descriptive information stored as attributes for those features.

6.2 Application of Geographic Information System (GIS) [17]
- The ability of GIS to search databases and perform geographic queries has saved many companies and organizations millions of dollars.
- GIS have helped decrease the time taken to:
  - Answer customer requests.
  - Find land suitable for development.
  - Search for relationships among crops, soils and climate.
  - Locate the position of breaks in electrical circuits.

6.2.1 Improving organizational integration:
- Many organization that have implemented GIS have found that one of the main benefits is improved management of their own organization and resources. Because GIS have the ability to link data sets together by geography, they facilitate interdepartmental information sharing and communication. By creating a shared database one department can benefit from the work of another- data can be collected once and used many times.
- As communication increases among individuals and departments, redundancy is reduced, productivity is enhanced, and overall organizational efficiency is improved.
- In utility company the customer and the infrastructure databases can be integrated so that when there is planned maintenance, affected customers can be sent a computer – generated standard letter.

6.2.2 Making better decisions with GIS:
- The old adage “better information leads to better decisions“ is as true for GIS as it is for other information systems.
- A GIS, however, is not an automated decision making system, but is a tool to query, analyze, and map data in support of the decision making process.
- GIS technology has been used to assist in tasks such as presenting information at planning inquiries, helping resolve territorial disputes.

- GIS can be used to help reach a decision about the location of a new housing addition that has minimal environmental impact, is located in a low risk area, and is close to a population center.

- The information can be presented succinctly and clearly in the form of a map and accompanying report, allowing decision makers to focus on the real issues rather than trying to understand the data. Because GIS products can be produced quickly, multiple scenarios can be evaluated efficiently and effectively.

6.2.3 GIS will manage a lot of subjects such as:

A Maintenance subject:
- Study on road management information system.
- Study on the effective use of construction by products.
- Securing pedestrian space friendly to humans.
- Optimization of pavement maintenance management system by:
  - Evaluation of the carrying capacity of a pavement via a non-static method on a vehicle travelling at highways speeds without impeding traffic.
  - Recognition and location of road signs.
  - GIS-database function of information from different measurement & sensors.
- Measures against low-temperature cracking in asphalt pavement.
- Test and surveys on the optimization of pavement in cold climates.
- Assessment of the deterioration and service life of bridges.
- Study on airport runways and structures in cold climates.

B - Traffic In GIS:
- Develop a cooperative working relationship with the appropriate agencies countrywide.
- Receive authorization from the cities to receive data.
- Write software application and programs to integrate existing data.
- Increase analysis and modeling method and reporting capabilities.
- Input all necessary layers of information into countrywide GIS database for efficient accident retrieval.
- Develop a city prototype program with a selected city within the country.
- Investigate feasibility and benefits of installing other traffic and transportation demand-management.
- Mobilize efforts toward using global positioning system (GPS) hardware within the country.
- Investigate and initiate other new technological forms of data input/output and communication.
- Explore and identify other data entry options.
- Final builds and expanding renewable system.
6.3 GIS Information resources (Designing, classifying, gathering and arranging) [13]

6.3.1 Spatial Information “Maps”:
A - Mainly maps:
- Detailing maps more than (1:2500), their resources are supervision agencies of the cities.
- Topography maps (1:2500 – 1:100,000), their resources are surveying authority.
- States, countries or world maps with different scale, their resources are special or governmental agencies.
- Maps and projects, their resources are special or governmental agencies.

B - Entering the mainly maps to the (GIS):
- By using digitizer.
- By using scanner.

Table No. 6.1, Entering the mainly maps to the (GIS)

<table>
<thead>
<tr>
<th>By using scanner</th>
<th>By using digitizer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>linear data (vector data).</td>
</tr>
<tr>
<td>Raster (surveying data.</td>
<td>- Small size data.</td>
</tr>
<tr>
<td>- Large size data.</td>
<td>- Proper for small project.</td>
</tr>
<tr>
<td>- Proper for large project.</td>
<td>- Needs more training.</td>
</tr>
<tr>
<td>- No needs large training.</td>
<td>- The accuracy depends on the skills.</td>
</tr>
<tr>
<td>- The accuracy depends on the equipment and skills.</td>
<td>- Available in the cheaper systems.</td>
</tr>
</tbody>
</table>

- Available in the expensive systems

6.3.2 Atmospheric Pictures :
- With different scales
  - 1 : 1000, used in detailing maps.
  - 1 : 5000 – 1 : 1000, used in detailing maps and cities.
  - 1 : 20,000 - 1 : 10,000, used in topography maps and cities.
  - 1 : 40,000, used in topography maps and regional planning.
  - 1- 100,000, used in spotting studies.

*** Aerospace viewed:
- Online systems.
- Global position systems (GPS).

6.3.3 Descriptive Information :
- Statistical information.
- Sites information.
- Office information.
- Questionnaire information.
- Other information.
6.4 “GIS Software Tool” Geo-Media [30]

6.4.1 Introduction:

Geo-Media is an information integrator, serving as a visualization and analysis tool and as a platform for custom GIS solutions.

Geo-Media gives an access to the leading GIS products, so anyone can view and analyze multiple data sources simultaneously, all in one environment. Also, anyone can spend his time actually working with data instead of trying to access it.

A universal GIS client, Geo-Media’s live data connections that allow organizations to maintain GIS data and ensure that the data is always up to date. Anyone can integrate data automatically using on-the-fly coordinate transportation and feature definition.

- Geo-Media Professional: (Description & Applications):

  Geo-Media professional is the first product specifically designed to collect and manage spatial data using standard databases.

  Geo-Media professional (Pro) is the only GIS software using Microsoft windows © technology that combines so many powerful tools in a single product. It’s the perfect tool for collecting GIS data, population an enterprise database, and turning information into precise, finished maps for distribution and presentation.

  Geo-Media professional will help to communicate GIS information faster and work more efficiently than ever before. Also, deals with Microsoft word, excel, powerpoint, © access, and other applications. Any person can even integrate CAD files and other GIS data from multiple products into a single database.

- Geo-Media (Pro) provides the following benefits:
  
  • Data Capture, automation, and maintenance.
  
  • Enterprise data management.
  
  • Spatial analysis.
  
  • Map production.
  
  • Industry-standard development environment.

6.4.2 Why we choose “Geo-Media professional” in our study in the middle area of Gaza Strip:

Geo-Media professional extends Geo-Media’s efficiency and speed to data collection and maintenance by providing capture and editing tools that are easier, faster, and more intelligent than traditional GIS applications. Also, it considers
intelligent tools for data capture automation, and maintenance. Built directly on windows with the GIS user in mind.

Geo-Media (pro) combines the power of Geo-Media’s spatial technology with a robust CAD – Like drafting environment, providing unique tools for GIS data capture and editing. More than a drawing tools.

Geo-Media (Pro) actually adds intelligence to the features by integrating graphics with attribute data.

Capturing and maintaining data has never been easier than with Geo-Media (pro). The familiar windows interface and new, powerful windows based capabilities our time and effort. With integrated vector and raster smart snaps, we can capture vector data from raster images. As we move the cursor, snap points are identified automatically, ensuring accurate heads-up digitizing without requiring to zoom around the data.

Geo-Media (pro) includes highly productive tools to helpus capture clean, accurate data the first time and minimize editing. Automatic vector breaking and coincident geometry digitizing enable any one to avoid traditional problems such as slivers and intersections without roads.

Geo-Media (pro) considers as (a GIS package) to capture & maintain data in easier manner than Arc View tools which consider as (a presentation package), where more used for presentation purposes.

6.4.3 Coordinate System:
A system of intersecting coordinate lines- meridians and parallels on flat surface on which features from the curved surface of the earth are mapped and used to measure spatial location.

6.4.3.1 Define coordinate system file for a Geo-Workspace:
A - Storage Space Tab:

Allows to define the storage units & storage type for the output coordinate system.
- Dialog Box Options:
  • Base storage Type:
- Allows to select the base storage type for the output data:
  l- Geographic:
  - Expresses coordinates as longitude and latitude.
2- Projection: (It was chosen system in this study)
   - Expresses coordinates as X, Y. X normally points east on the plane of the
     map, and Y normally points north at the point chosen for the map’s origin.
   - The X coordinate is called easting, and the Y coordinate is called
     northing. Projected coordinate systems differ in how they represent the
     curved surface of the earth on the flat surface of a map.

- **Advanced Parameters:**
  Opens the “Advanced storage parameters” dialog box, which allows to specify
  the storage parameters for the base storage type you selected.

**B - Projection Space Tab:**
- Allows to select a projection algorithm and to define projection parameters
  that are unique to the selected algorithm.

- **Dialog Box Options:**

- **Projection Algorithms:** (Cassini – Soldner was chosen in this study)
   - Allows to select from the list of valid projection algorithms for the data
     servers.
   - Cassini – Soldner is considered a proper projection algorithm for our work in
     Geo-Media (pro) program, where it was chosen.

- **Projection Parameters:**
  - opens the projection parameters dialog box. The gadgets on the projection
    parameters dialog box change depending on the projection algorithm you
    chose. This button is disabled if we select rectangular grid as our projection
    algorithm.

**C - Geo-Graphic Space Tab:**
- Allows to select an associated datum and reference ellipsoid. It also allows to
  define elliptical parameters associated with the selected ellipsoid. Standard
  ellipsoids are linked to a predefined spheroid model.

- **Dialog Box Options:**

- **Geometric Datum:** (Palestine 1923 was chosen in this study)
  - Allows to select the geodetic datum for the projection algorithm we chose.
  - Palestine 1923 considers the proper option for our area, therefore we were
    chosen.
- When we select a geodetic datum, the associated referenced ellipsoid appear in the reference Ellipsoid box.

- **Reference Ellipsoid:**
  - Displays the reference ellipsoid associated with the geodetic datum we selected.
  - We can change the ellipsoid only if the geodetic datum is set to user defined (non-standard).

- **Ellipsoid parameters:**
  - Opens the Reference Ellipsoid parameters dialog box. This box allows to review the parameters for the Ellipsoid. Default parameter values are supplied per datum and Ellipsoid selection.
6.5 Documentation of Geo-Media Practical Work

6.5.1 The shape of database that is required to cover this study:

Table No. 6.2, The shape of database of roads in the middle area
(Nus., Bur., & Magh.)

<table>
<thead>
<tr>
<th>Data No. For (Nus., Bur., &amp; Magh. Roads)</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Street No.</td>
</tr>
<tr>
<td>2</td>
<td>Street Name</td>
</tr>
<tr>
<td>3</td>
<td>Zonc Name</td>
</tr>
<tr>
<td>4</td>
<td>Length (m)</td>
</tr>
<tr>
<td>5</td>
<td>Carriage way width (m)</td>
</tr>
<tr>
<td>6</td>
<td>Sidewalk width (m)</td>
</tr>
<tr>
<td>7</td>
<td>Total width (m)</td>
</tr>
<tr>
<td>8</td>
<td>Road area (m²)</td>
</tr>
<tr>
<td>9</td>
<td>Rank (main-second)</td>
</tr>
<tr>
<td>10</td>
<td>Road surface material</td>
</tr>
<tr>
<td>11</td>
<td>Traffic signs No.</td>
</tr>
<tr>
<td>12</td>
<td>Iron handrails (m.r)</td>
</tr>
<tr>
<td>13</td>
<td>Humps (No.)</td>
</tr>
<tr>
<td>14</td>
<td>Cost/m³ S</td>
</tr>
<tr>
<td>15</td>
<td>Total cost ($)</td>
</tr>
<tr>
<td>16</td>
<td>Constructed year</td>
</tr>
<tr>
<td>17</td>
<td>Current street situation</td>
</tr>
<tr>
<td>18</td>
<td>Street have side of walk</td>
</tr>
<tr>
<td>19</td>
<td>Street No. of lanes</td>
</tr>
<tr>
<td>20</td>
<td>Street have mid</td>
</tr>
<tr>
<td>21</td>
<td>Mid length</td>
</tr>
<tr>
<td>22</td>
<td>X – Start point</td>
</tr>
<tr>
<td>23</td>
<td>Y – Start point</td>
</tr>
<tr>
<td>24</td>
<td>X – End point</td>
</tr>
<tr>
<td>25</td>
<td>Y – End point</td>
</tr>
</tbody>
</table>
Table No. 6.3, The shape of database related to the different types of roads distresses in Al-Buraj area.

<table>
<thead>
<tr>
<th>Data No. For Buraj Roads</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>Alligator cracking (%)</td>
</tr>
<tr>
<td>27</td>
<td>Long &amp; transverse cracking (%)</td>
</tr>
<tr>
<td>28</td>
<td>Patching &amp; utility cut patching (%)</td>
</tr>
<tr>
<td>29</td>
<td>Potholes (%)</td>
</tr>
<tr>
<td>30</td>
<td>Rutting (%)</td>
</tr>
<tr>
<td>31-42</td>
<td>Different type of roads’ distresses</td>
</tr>
<tr>
<td>43</td>
<td>Deduct value (%)</td>
</tr>
<tr>
<td>44</td>
<td>Road condition percentage (%)</td>
</tr>
<tr>
<td>45</td>
<td>Road condition type</td>
</tr>
</tbody>
</table>

6.5.2 Mechanism of numbering the Middle Area roads by using (GIS) system

- Every road in the middle area selected municipalities (Nus, Bur., & Magh.) was given a special number according to the follow:

  • Assigning and classifying the roads into four types like:
    - Main paved roads.
    - Main unpaved roads.
    - Secondary titled roads.
    - Secondary unpaved roads.
    
    Every type of these roads was drawn inside independent layer.

  • All roads were classified through numbering process according to the following basis:

    - The road No. was started with the first letter of the zone area as: (N, B, or M) that represented (Nusairate, Buraij, & Maghzai areas).
    - All roads were classified according to the preceding classification and were indicated through database table No. (6.3) in (data No. column) through array No. (1, 2, 3, 9, 10) that represented the (street No., Street Name, Zone Name, rank (main or second) and road surface material).
- Using this classification and numbering, any type of road can be displayed by display on this layer and display off other layers, and by clicking the right mouse bottom on any road line, the above data table will appear, which includes street number and all stored data.

- All of these drawn roads are assigned through using (Auto Cad Map) program, and getting a special file including roads coordinates.

- By using Geo-media professional program, the road coordinates are assigned & jointed by using special (Icon) that has a name (Define coordinate system file) according to the attached screen picture in figure No. (6.1).

Figure No. 6.1, The definition of coordinate system
- Also, through using another (Icon) with name (define CAD server Schema File), All of AutoCAD map roads layers file are jointed and stored in a special folder.
- Assigning, classifying and numbering all of roads in (Nusairate, Buraij & Maghzai Area) according to the above classification.
- Surveying, gathering and documenting all necessary required data related to Geometric roads, roads pavement structure and road furniture including all of traffic components, according to attached data flow (Assets).
- Assuming roads condition criteria according to attached assumed criteria table. No. (6.4)
- Expected roads condition from (2002 to 2010) year, can be get through using this criteria table, that is shown in tables No. (6.5 and 6.6).
- Placing all of these gathered data in a special tables form through using excel program & stored in a special folder, as a flow data that attached with (Assets).
- A new database will be opened, named and stored through using access program.
- Above Excel file will be opened, and by clicking on the upper icon with name (Data) and another lower icon with name (convert to MS Access).
- Excel file will be changed to Access file with the same abovename.
- Geo-media professional program will be opened in a new file. This file will be named and stored in the same proceeding folder.
- From upper warehouse list & clicking on (New Connection, Icon) where proceeding AutoCAD map file, which is changed to Access file, will be read as (Read only) file.
- Changing this file from (Read only) file to (Read & Write) file by using upper warehouse list and clicking on (New warehouse) and (Import form warehouse).
- In the same way recalling the above excel file which is changed to Access file.
- There are two files that changed to Access files. The first one includes original AutoCAD map file, indicates dealing roads.
- The Second includes original Excel file. It reflects all gathered data related to all roads.
- By using upper list (Analysis) and (Joint) Icon-proceeding two files will be jointed. According to the attached screened picture in figure No. 6.2.
Figure No. 6.2, How to join more files with others by using Geomedia program

- Through joint manner, every layer takes a special name, as example:

The layer with (Main Paved Roads) name, will be changed to new name, Main-Paved-Roads-Attribute), this will be done to all layers.

Changing the four road layers related to the roads that is required to deal with the geo-media screen, to facilitate making any related query, and to get & show any required decision through:

- Using the upper list (Warehouse)
- Clicking on (Output to Feature Class) Icon.
  - Through using these two above Icons (A&B), renaming the roads layers will be done as example:

(Main Paved Roads Attribute) will be changed to (Main paved roads Feature), and (Display feature class in map window). Icon will be marked, to bring & show a new feature layers on the geo-media screen drawing.

- Clicking by right mouse on an old layers and marking the (Hide legend Entry) Icon. All old layers will be hidden, and only a new (Roads feature layers) will appear according to the attached screen in figures No. 6.3 and 6.4.

Figure No. 6.3, The main roads of Buraij area by using Geomedia program

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Figure No. 6.4, More details of intersection in Buraij area by using Geomedia program

- By dealing with these (Roads feature layers), many queries related to these roads features, can be constructed through using the upper list (Analysis), and clicking on (New query) Icon. Any road layer can be marked by clicking (filter) Icon and assigning the shape, which is required to appear on the geo-media screen. Finally name and store any constructed Query in the description space.

- Any query can be constructed or detailed by using this attached screen in figure No. 6.5.

Figure No. 6.5, How to construct query related to the road condition by using Geomedia program
- Also, any query can be constructed by using the upper list & by clicking on (Add Thematic) Icon. Mark any road layer, any feature which is required to deal with and any feature of this road.

- Mark any road layer and any feature that is required to deal with, like: (Total Cost) feature.

- By clicking on (Range) Icon, different total cost ranges of roads can appear according to the required total cost values.

- Through the integration process, all of the components may be viewed on one map so that integrated project may be developed for maintenance and rehabilitation of the road networks.

6.5.3 Theoretical Background & Justification about using special criteria for roads condition

- This assuming criteria were used to assign the road condition type after assigning the road condition percentage and depreciated percentage values for roads per year.

- Finally, maintenance type and required materials should be used.

- The pavement condition Index (PCI) was used as a guide to propose this criteria.

- Also, proposed depreciated value was assigned through our experience of the middle area roads nature, traffic flow/weight and structures remaining life this roads.

- Proposed maintenance type as assigned through studying and classifying of the available materials that may be used in the different maintenance types.
### Applied DSS on GIS Environment

#### Sample Decision (s)

Table No. 6.4, Criteria for Roads Condition

<table>
<thead>
<tr>
<th>Road Condition Percentage (%)</th>
<th>Road Condition Type</th>
<th>Depreciated Percentage (%) in Road Condition Per Year</th>
<th>Proposed Maintenance Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>100-85</td>
<td>Excellent</td>
<td>3</td>
<td>Spreading Asphalt &amp; monadic aggregate (RM₁)</td>
</tr>
<tr>
<td>85-70</td>
<td>Very Good</td>
<td>4</td>
<td>Spreading Asphalt &amp; dual aggregate (RM₂)</td>
</tr>
<tr>
<td>70-60</td>
<td>Good</td>
<td>6</td>
<td>Thin asphalt layer (AO₁)</td>
</tr>
<tr>
<td>60-40</td>
<td>Fair</td>
<td>8</td>
<td>Thin asphalt layer (AO₂)</td>
</tr>
<tr>
<td>40-20</td>
<td>Poor</td>
<td>11</td>
<td>(CR) Reconstruction</td>
</tr>
<tr>
<td>&lt; 20</td>
<td>Fail</td>
<td>15</td>
<td>(CR) Reconstruction</td>
</tr>
</tbody>
</table>
Table No. 6.5, Roads Condition in (2002):

<table>
<thead>
<tr>
<th>St. No.</th>
<th>Damage Type</th>
<th>Alligator Cracking (%)</th>
<th>Long &amp; Transverse cracking (%)</th>
<th>Patching &amp; Utility cut patching (%)</th>
<th>Potholes (%)</th>
<th>Rutting (%)</th>
<th>Deduct value (%)</th>
<th>Road Condition Percentage (%)</th>
<th>Road Condition Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>B/01</td>
<td></td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>10</td>
<td>90</td>
<td>Excellent</td>
</tr>
<tr>
<td>B/2A</td>
<td></td>
<td>4</td>
<td>6</td>
<td>10</td>
<td>5</td>
<td>10</td>
<td>35</td>
<td>65</td>
<td>Good</td>
</tr>
<tr>
<td>B/2B</td>
<td></td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>2</td>
<td>5</td>
<td>15</td>
<td>85</td>
<td>Excellent</td>
</tr>
<tr>
<td>B/03</td>
<td></td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>10</td>
<td>90</td>
<td>Excellent</td>
</tr>
<tr>
<td>B/04</td>
<td></td>
<td>2</td>
<td>3</td>
<td>15</td>
<td>20</td>
<td>10</td>
<td>50</td>
<td>50</td>
<td>Fair</td>
</tr>
<tr>
<td>B/05</td>
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<td>1</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>15</td>
<td>85</td>
<td>Excellent</td>
</tr>
<tr>
<td>B/06</td>
<td></td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>13</td>
<td>87</td>
<td>Excellent</td>
</tr>
<tr>
<td>B/07</td>
<td></td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>6</td>
<td>14</td>
<td>86</td>
<td>Excellent</td>
</tr>
<tr>
<td>B/08</td>
<td></td>
<td>5</td>
<td>5</td>
<td>15</td>
<td>25</td>
<td>20</td>
<td>70</td>
<td>30</td>
<td>Poor</td>
</tr>
<tr>
<td>B/09</td>
<td></td>
<td>4</td>
<td>6</td>
<td>10</td>
<td>8</td>
<td>7</td>
<td>35</td>
<td>65</td>
<td>Good</td>
</tr>
<tr>
<td>B/10</td>
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<td>1</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>8</td>
<td>92</td>
<td>Excellent</td>
</tr>
<tr>
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<td>2</td>
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<td>5</td>
<td>3</td>
<td>13</td>
<td>87</td>
<td>Excellent</td>
</tr>
<tr>
<td>B/12</td>
<td></td>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>15</td>
<td>85</td>
<td>Excellent</td>
</tr>
<tr>
<td>B/13</td>
<td></td>
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<td>4</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>15</td>
<td>85</td>
<td>Excellent</td>
</tr>
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<td>B/14</td>
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<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>14</td>
<td>86</td>
<td>Excellent</td>
</tr>
<tr>
<td>B/15</td>
<td></td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
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</tr>
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<td>0.5</td>
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</tr>
<tr>
<td>B/17</td>
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<td>5</td>
<td>10</td>
<td>10</td>
<td>30</td>
<td>20</td>
<td>75</td>
<td>25</td>
<td>Poor</td>
</tr>
<tr>
<td>B/18</td>
<td></td>
<td>10</td>
<td>12</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>42</td>
<td>58</td>
<td>Fair</td>
</tr>
</tbody>
</table>
Table No. 6.6, Expected Roads Condition in (2003):

<table>
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<tr>
<th>St. No.</th>
<th>Damage Type</th>
<th>Alligator Cracking (%)</th>
<th>Long &amp; Transverse cracking</th>
<th>Patching &amp; Utility cut patching (%)</th>
<th>Potholes (%)</th>
<th>Rutting (%)</th>
<th>Deductivity value (%)</th>
<th>Road Condition Percentage (%)</th>
<th>Road Condition Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>B/01</td>
<td></td>
<td>2.6</td>
<td>1.3</td>
<td>2.6</td>
<td>1.3</td>
<td>5.2</td>
<td>13</td>
<td>87</td>
<td>Excellent</td>
</tr>
<tr>
<td>B/2A</td>
<td></td>
<td>4.7</td>
<td>7.0</td>
<td>11.7</td>
<td>5.9</td>
<td>11.7</td>
<td>41</td>
<td>59</td>
<td>Fair</td>
</tr>
<tr>
<td>B/2B</td>
<td></td>
<td>1.2</td>
<td>2.4</td>
<td>6</td>
<td>2.4</td>
<td>6</td>
<td>18</td>
<td>82</td>
<td>Very Good</td>
</tr>
<tr>
<td>B/03</td>
<td></td>
<td>1.3</td>
<td>2.6</td>
<td>1.3</td>
<td>2.6</td>
<td>5.2</td>
<td>13</td>
<td>87</td>
<td>Excellent</td>
</tr>
<tr>
<td>B/04</td>
<td></td>
<td>2.3</td>
<td>3.5</td>
<td>17.4</td>
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<td>58</td>
<td>42</td>
<td>Fair</td>
</tr>
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<td>B/05</td>
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<td>1.2</td>
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<td>3.6</td>
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<td>18</td>
<td>82</td>
<td>Very Good</td>
</tr>
<tr>
<td>B/06</td>
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</tr>
<tr>
<td>B/07</td>
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<td>1.2</td>
<td>2.4</td>
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<td>17</td>
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</tr>
<tr>
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<td>5.8</td>
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<td>17.3</td>
<td>29.0</td>
<td>23.1</td>
<td>81</td>
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<td>Fail</td>
</tr>
<tr>
<td>B/09</td>
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<td>7.0</td>
<td>11.7</td>
<td>9.4</td>
<td>8.2</td>
<td>41</td>
<td>59</td>
<td>Fair</td>
</tr>
<tr>
<td>B/10</td>
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<td>1.4</td>
<td>1.4</td>
<td>4.1</td>
<td>1.4</td>
<td>2.7</td>
<td>11</td>
<td>89</td>
<td>Excellent</td>
</tr>
<tr>
<td>B/11</td>
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<td>1.2</td>
<td>2.5</td>
<td>2.5</td>
<td>6.1</td>
<td>3.7</td>
<td>16</td>
<td>84</td>
<td>Very Good</td>
</tr>
<tr>
<td>B/12</td>
<td></td>
<td>2.4</td>
<td>2.4</td>
<td>3.6</td>
<td>4.8</td>
<td>4.8</td>
<td>18</td>
<td>82</td>
<td>Very Good</td>
</tr>
<tr>
<td>B/13</td>
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<td>2.4</td>
<td>4.8</td>
<td>2.4</td>
<td>2.4</td>
<td>6</td>
<td>18</td>
<td>82</td>
<td>Very Good</td>
</tr>
<tr>
<td>B/14</td>
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<td>2.4</td>
<td>3.6</td>
<td>4.9</td>
<td>4.9</td>
<td>17</td>
<td>83</td>
<td>Very Good</td>
</tr>
<tr>
<td>B/15</td>
<td></td>
<td>3.6</td>
<td>1.3</td>
<td>3.8</td>
<td>3.8</td>
<td>2.5</td>
<td>15</td>
<td>85</td>
<td>Excellent</td>
</tr>
<tr>
<td>B/16</td>
<td></td>
<td>1.6</td>
<td>1.6</td>
<td>0.8</td>
<td>1.12</td>
<td>2.88</td>
<td>8</td>
<td>92</td>
<td>Excellent</td>
</tr>
<tr>
<td>B/17</td>
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<td>11.5</td>
<td>11.5</td>
<td>34.4</td>
<td>22.9</td>
<td>86</td>
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<td>Fail</td>
</tr>
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<td>6</td>
<td>6</td>
<td>11.9</td>
<td>50</td>
<td>50</td>
<td>Fair</td>
</tr>
</tbody>
</table>
Figure No. 6.6: (Description of query No. 2)
Map showing the description of Query No. 2 which shows all of (Nusairat-Buraij & Maghazi) main roads in blue color line & Al-Buraij main roads in a good condition with expected rutting % >= 15 inspected in 2009 in red color.
Figure No. 6.7: (Description of query No. 7)
Map showing the classifying of the total cost of main roads according to the attached different ranges through different show colors.
Figure No. 6.8: (Description of query No. 9)
Map showing the main Fair roads in (Nusairat-Buraj & Maghazi) areas with each total cost ≤ 300000 $, that indicate in red color through the all main roads that indicate in blue color.
6.6 Description of (GIS) Geo-media Program Queries :

6.6.1 Query No. 1:

1-A : Query Name :
(Poor Buraj main Roads Condition, Inspected in 2002)

1-B: Description:

- Through this query, by using GIS geomedia program; will get all Buraj main roads, which is in poor status and inspected in 2002 year.

- On Geomedia Computer screen and by pressing on any center line of these roads; will get more information related to different features of these roads. Also, will get more details about different types of distress percentage.

- Also; will get a proper maintenance way & materials that should be used in this road.

- Finally, can decide when these roads need to be maintained by available materials and budgets.

6.6.2 Query No. 2: -

2-A : Query Name :
(Good Buraj main roads condition with expected rutting percentage> 15, inspected in date 2009 )

2-B: Description :

- Through this query, by using GIS geo-media program; will get all Buraj main roads in a good status & with expected rutting percentage>15 in inspected year (2009).

- By dealing with geomedia and pressing on any center line of these roads ; will get more information related to different features of this road. Also; will get more details about different types of distress with limited rutting percentage > 15.

- A proper maintenance way & materials that should be used, can be shown through pressing on center line of these roads.

- Finally; will have a good future vision about how & when to maintain these roads.
6.6.3 Query No. 3
3-A: Query Name:
(Deduct value < 20 for Buraij main roads in inspected year (2002))
3-B: Description:
- Through this query, by using GIS geomedia program; will get all Buraij main roads in a very good & excellent status that was inspected in year (2002).
- By dealing with geo-media and pressing on any center line of these roads; will get more information related to different features of this road. Also; will get more details about different types of distress.
- A suitable maintenance way & materials are shown by pressing on center line of these roads.
- Finally, will have a good future vision about how & when to maintain these roads, and what required budgets.

6.6.4 Query No. 4:
4-A: Query Name:
(Poor road condition with rutting percentage > 10 in inspected year 2006)
4-B: Description:
- Through this query, by using GIS geo-media program; will get all Buraij main roads in poor status that will be inspected in year (2006).
- By dealing with geomedia and pressing on any center line of these roads; will get more information related to different features of this road. Also; will get more details about different types of distress.
- A suitable expected maintenance way & materials are shown by pressing on center line of these roads, with more concentration of rutting maintenance.
- Finally; will have a good future vision about how & when to maintain these roads, and what are the expected and required budgets in (2006) year.

6.6.5 Query No. 5:
5-A: Query Name:
(Buraij main roads that need reconstruction in inspected year 2006)
5-B: Description:
- Through this query, by using GIS geo-media program; will get all Buraij main roads that need reconstruction and will be inspected in year (2006).
- By dealing with geo-media and pressing on any center line of these roads; will get more information related to different features of this road. Also; will get more details about different types of distress.

- Expected maintenance way & materials are shown through pressing on center line of these roads.

- Finally; will have a good future vision about how & when to reconstruct these roads, and what are the expected required budgets in (2006).

6.6.6 Query No. 6:

6-A: Query Name:
(Buraij main paved road with potholes percentage > 10 in inspected year 2007)

6-B: Description:
- Through this query, by using GIS geo-media program; will get all Buraij main roads with potholes percentage > 10, which will be inspected in year (2007).

- By dealing with geomedia and pressing on any center line of these roads, will get more information related to different features of this road. Also, will get more details about different types of distress.

- A Suitable expected maintenance way & materials are shown through pressing on center line of these roads, with more concentration of rutting maintenance.

- Finally; will have a good future vision about how & when to maintain these roads, and what are the expected required budgets in (2007) year.

6.6.7 Query No. 7:

7-A: Query Name:
(Classifying & arranging the total cost of main roads according of different ranges)

7-B: Description:
- Through this query, by using GIS geo-media program, will get all main roads with total cost according of these ranges:
  30000$ to 80000$
  80000$ to 150000$
  150000 to 200000$
  200000 to 280000$

- This will help to evaluate the existing main roads in easy manner by adding every range with special color and shape.

- will have a good future vision about size assets of main roads.
6.6.8 Query No. 8:
8-A: Query Name:
(Burajj main roads with Alligator cracking percentage > 16 in inspected year 2002)
8-B: Description:
- Through this query, by using GIS geo-media program; will get all Burajj main roads with Alligator cracking percentage > 16 which are inspected in year (2002).
- On Geomedia Computer screen and by pressing on any center line of these roads; will get more information data related of different features of these roads. Also; will get more details about different types of distress percentage.
- A Suitable expected maintenance way & materials are shown through pressing on center line of these roads, with more concentration on Alligator cracking maintenance.

6.6.9 Query No. 9:
9-A: Query Name:
(Burajj main roads with total cost < 100.000$, road condition = poor and inspected year = 2002)
9-B: Description:
- Through this query, by using GIS geo-media program; will get all (Nusairat - Burajj and Maghazi) main roads with total cost of each road <= 300.000$, road condition = fair and inspected year = 2002.
- On Geomedia Computer screen, and by pressing on any center line of these roads; will get more data related to different features of these roads. Also; will get more details about different types of distress percentage that lay through (60-40%) of total area of Al Burajj Roads.
- A proper maintenance way & materials are show by pressing on center line of Al-Burajj fair condition roads, where can find total cost for each road <= 300.000$.

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Chapter No. ( 7 )
Conclusions & Recommendations
Chapter No. (7)
Conclusions and Recommendations

7.1 Conclusions:

It can be concluded that (O&M) in (R&T) in the Gaza Strip, specially in the Middle Area, are evaluated and described.

The research indicates that the previous studies about (O&M) in (R&T) using GIS/DSS in the Gaza Strip didn’t take its role for finding a complete (O&M) system that deal with the Middle Area requirements, and towards the (O&M) in (R&T) issues by using modern techniques like (GIS/DSS).

Identifying and studying the existing (O&M) status, have lead to indicate the following :-

- There is no planned policy or strategy related to (O&M) of (R&T).
- The experience & training municipal engineers & technical staff is not sufficient to the required maintenance activities & it is an obstacle to monitor the maintenance needs.
- Small & random budget are used to cover (O&M) expenditures.
- Using small equipment, small tools, small materials and staff without using automated equipment or modern techniques.
- There is no independent departments deal with (O&M) of (R&T). Also, there is no job description for the municipalities staff.
- No reports or records related to (O&M) of (R&T) are used in the Middle Area municipalities.

Extensive efforts were provided to evaluate the efficiency of existing (O&M) system through:

- meeting & interviews with the municipalities concerned staff.
- surveying & collecting the required data of existing roads & traffic in the pilot area (Nusirate, Buraj & Maghazi).
- Surveying & measuring all data of existing distresses of Al-Buraj roads as an example area.
This study shows the Middle Area (O&M) proposed system related to (RMS), which consists of models of (PMS & RFMS), where, this models consist of five modules.

Twenty three decisions were proposed to serve and help the users to take the proper decisions in the suitable time towards (O&M) of (R&T) requirements. This proposed decisions were designed and divided into three groups (Planning, Operation and maintenance) and represented by algorithm charts, data flow ones and specific forms, to serve the users to take the proper decisions.

Also, the study concentrated on some essential issues related to the proposed (O&M) system that deals with (R&T), using GIS/DSS.

All of the Middle Area roads were assigned and divided into four categories. By using software programs (Geo-media, Access, Excel and AutoCAD), all of roads were evaluated and inspected through visual inspection manner, where all of the roads distresses were assigned, classified and measured through using (PCI) measurement and special proposed criteria.

Al-Buraij area were taken as an example, and more details were done for Al-Buraij main paved roads. By using the above software programs, inventory data base were constructed, and all of these data can be displayed & many queries can be get.

Proposed institutional setup provided with detailed chart, related to develop and improve the “Joint Service Council”, which constructed two years ago, to cover the technical and institutional dimension requirements. By using the above proposed system, users can deal with (O&M) of (R&T) issues and can do a proper action through using a suitable materials in a suitable time.

This study found out if the proposed decisions were adequate to cover (O&M) activities, and showed the three additional decisions that should be added to cover some main points like:

- Seasonal factors effects [temperature, rain, frost, …etc]
- Structural remaining life [by non-destructive assessments, etc]
- Bridges & culverts defects [Structural damage, out falls scoured, …etc]

Also, through this study, the proposed decisions were arranged according to their importance & frequent use.
The study reveals that there was lack of the special training related to GIS/DSS software program, which are needed to increase knowledge and skills of GIS/DSS in Gaza Strip.

The finding of this study show that there was weakness in the capacity building of different institutions (municipality, university, ministry and others). This will lead to badly affect performance of (O&M) of (R&T), especially inside the concerned institutions like:

1- municipalities

2- Some ministries; Local government, housing and public works.

These findings give signals for decision makers to do their best to support the capacity building for (O&M) of (R&T) independent department.

The last issue that was investigated in this study is the willingness to improve the GIS/DSS skills. Despite the low average percentage of "using GIS/DSS for (O&M) in R(R&T) management", the research show that there was a high average percentage of "willingness to improve GIS/DSS skills". These findings give strong signals for high administrative level to do their best towards encouraging concerned people to get more training about GIS/DSS, which help them to solve different (O&M) of (R&T) problems.
7.2 Recommendations:

This study leads to the following recommendations that may help in producing a proper system related to (O&M) in (R&T) using GIS/DSS, which can be used in the roads of the middle area in the Gaza Strip:

1- There is deep need for developing (O&M) in (R&T) using GIS/DSS in the middle area of Gaza Strip.

2- It is recommended to separate (O&M) of (R&T) through independent department which deals with all issues related to this subject.

3- To increase the capacity of the concerned staff of (O&M) of (R&T), it is recommended that the high management levels in municipalities or some ministries like “Housing and Public works Ministry and Local Government Ministry” should train their concerned staff through a special valuable training programs with more concentration on GIS/DSS software program. Especially the study has shown that most of the concerned staff have a high willingness to improve their GIS/DSS skills.

4- More care must be given to build a proper database inventory system in every municipality in the middle area and in every concerned ministry like “Housing & Public work ministry and local Government ministry”, by using modern software programs (GIS/DSS), to arrange & analyze the data. Also modern inspection measurements (visual, automated equipment) should be used to get an accurate data related to the road condition, which leads us to assign the suitable maintenance and materials that should be used.

5- It is recommended that it is more valuable and significant to use the Pavement Condition Index (PCI), which provides a measure for the present condition of the pavement, and it is numerical indicator that rates the surface condition of the pavement. Also, it gives an accurate results and information like the actual situation.

6- The road maintenance should be made in a suitable time, until decreasing the road distress and before it needs more cost for repair and maintenance.

7- Through the (O&M) in (R&T) management, planning consideration should be applied and regarded as a highest priority.
8. Through the roads operation process and proposed decisions, safety consideration should be taken as a priority to protect and save people life through using the proper roads.

9. It is recommended to make continuous control on roads condition by classifying the causes of road pavement distress and by choosing a suitable maintenance and materials that should be used according to the type of distress.

10. Seasonal effects like: (Temperature differences, rain fall, frost status and dirty/dusty status ...etc) should be taken into consideration through any (O&M) process related to the (R&T), where this will affect the chosen type of maintenance and materials that should be used. Also, system of operation may be affected and changed.

11. Through any road maintenance process, road structural remaining life should be taken into consideration to assign the suitable maintenance program (preventative, routine and reconstruction... etc), which should be used.

12. More care should be given to conduct the storm water system and the sewage flow system in order to protect the road pavement surface from their effect.

13. It is necessary to increase the awareness of residents to deal correctly with the surface of road pavement and furniture parts, and to find a suitable mechanism to increase the awareness of residents about the laws and regulations related to any damage that may occur to the road surface or any resident’s encroachments on streets.

14. Construct a firm mechanism to prevent illegal and fraud usage of roads such as: (increasing the car speed, passing through reverse direction or through closed road, untrained drivers without license and using un-valid car ...etc)
References


2. Associated Consulting Engineers (Palestine- West Bank) and Home Engineering Un Ltd (Gaza-Gaza Strip), Project Management and Monitoring Office (PMO), Study and preparation the required maintenance strategy, Arab center for Engineering studies (ACES), June, 1999.


7. Five Municipalities and Two Village Councils Records.


Web sites:


31. www.cedex.es/ceo/documenti/survey/htm

32. www.vertek.ara.com
# List of Annexes

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Annex 1

Islamic University Gaza
Civil Engineering Department

Questionnaire of “Proposed O&M System for Roads & Traffic Using GIS/DSS”
(Evaluation The Attached Proposed Decisions)

“Owners View Points”

M.Sc. Thesis in Construction Management

Prepared By

Mahmoud Tabasha

Supervised By

Prof. Zaher Kuhail

December, 2002
Introduction

Dear Sir,

- This questionnaire aims at examining and evaluating the proposed O&M system of (R&T) using GIS/DSS through evaluation the attached proposed decisions, and answering the questions, from the: “Owners’ sector view points”

- We would like you to fill this questionnaire with relevant facts as much as possible.

- All data obtained from this questionnaire will be used only for research purposes conducted by the faculty of engineering at the Islamic University of Gaza and will be strictly confidential.

- Abbreviations:
  
  GIS/DSS:- Geographic Information System/Decision Support System  
  O&M :- Operation & Maintenance  
  R&T :- Roads & Traffic
1- Name of firm / Institution: ________________________________

2- Type of firm / Institution:

☐ Ministry  ☐ Municipality  ☐ University  ☐ Others

3- Year of establishment: ________________________________

4- Position and qualification level:

☐ Senior Eng. (PhD or More)
☐ Director Eng. (MSc or BSc)
☐ Technician (Less than BSc)

• Note: Please, read these attached suggested decisions, and try to answer questions No. (5 to 7).

5- Are the attached proposed decisions adequate to cover (O&M) activities?

Yes ☐ No ☐

(5-A) If No, what are your suggestion(s) for additional decisions.

____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

6- Try to arrange the attached suggested decisions according to their importance. (Please, try to use decisions numbers throughout your arrangement)
7- Try to arrange the attached suggested decisions according to their use (usage) frequency. (please, try to use decisions numbers throughout your arrangement)

8- Do you use GIS/DSS for (O&M) in (R&T) management?
   Yes ☐          No ☐

(8-A) If Yes, why are you interested in applying GIS/DSS for (O&M) in (R&T) management?
   ☐ To produce base maps only.
   ☐ As an effective management tool.
   ☐ To improve performance.
   ☐ To reduce and save cost.
   ☐ Others (Identify) ________________________________

(8-B) If No, why are you not interested in applying GIS/DSS for (O&M) in (R&T) management?
   ☐ Increased cost.
   ☐ Unqualified users (staff).
   ☐ Weak level of periodic inspection and recording.
   ☐ Small size of existing data.
   ☐ Low administrative level.
   ☐ Others (Identify) ________________________________

9- How do you describe your knowledge of GIS/DSS?
   Very strong ☐ strong ☐ Fair ☐ little ☐ Non ☐
10- Have you got any training in (O&M) using GIS/DSS?
   Yes □   No □

(10-A) If Yes, list the topics of training.

_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

11- In your institution, do you have a proper database-inventory system?
   Yes □   No □

(11-A) If yes, How do you gather the inventory database?
   □ By using modern inspection measurements (visual, automated & un-automated equipment)
   □ By using modern software programs to arrange & analyze the data
   □ Others (Identify) ________________________________

_________________________________________________________________
_________________________________________________________________

12- In your Institution, (O&M) of (R&T):

A- Operation :-

(12-A-1) What is currently, operated?

_________________________________________________________________
_________________________________________________________________

(12-A-2) How is it being operated?

_________________________________________________________________
_________________________________________________________________
(12-A-3) How do you solve the operation problems?

☐ By Continuously updating the operation system.
☐ By special training, for concerned staff.
☐ By using different modern software programs like (GIS/DSS and others)
☐ Others (Identify) __________________________________________

B- Maintenance: -

(12-B-1) What is being maintained?

______________________________________________________________

(12-B-2) How do you solve the Maintenance problems?

☐ By Continuously updating the maintenance system.
☐ By special training, for concerned staff.
☐ By using different modern software programs like (GIS/DSS and others)
☐ Others (Identify) __________________________________________

13- In your institution, have you independent department deals with (O&M) of (R&T)?

Yes ☐  No ☐

14- Please, try to attach an organizational structure chart for your institutional arrangements, providing experience level for persons who are dealing with (O&M) in (R&T) management.

15- What about your willingness to improve your GIS/DSS skills?

High willingness ☐  Medium willingness ☐
poor willingness ☐  No willingness at all ☐

__________________________

__________________________

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<th>Dec. No.</th>
<th>Decision Name &amp; purpose</th>
<th>Decision Application &amp; Description</th>
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| A-1     | Flexible pavement condition & what type of maintenance should be used | - Calculating (PSI) present serviceability index.  
- Classifying the flexible pavement condition according to the (PSI) value.  
- Assigning a suitable action, maintenance & materials. |
| A-2     | Concrete pavement condition & what type of maintenance should be used | - Calculating (PSI) present serviceability index.  
- Classifying the concrete pavement condition according to the (PSI) value.  
- Assigning a suitable action, maintenance & materials. |
| A-3     | What type of maintenance through maintenance planning process | - Maintenance planning process should be done.  
- Finding the optimum solution for maintaining pavement in a good condition through a limited period of time. |
| A-4     | Assigning the maintenance work scheduling type. | - Maintenance work scheduling should be used.  
- Classifying the maintenance work scheduling  
- Choosing a suitable maintenance work scheduling |
| A-5     | Classifying the distress types of road pavement, how to maintain and what type of maintenance | - Calculating the distress types of road pavement.  
- Calculating the deductive value (%) (DV).  
- Assigning the road condition type.  
- Choosing a suitable type of maintenance. |

| B-1     | Assigning the action and program to apply safety consideration on highway | - Evaluate and classify the road status to be more safe.  
- Assigning the dangerous area and the type of dangerous along the road.  
- Choosing a suitable action and maintenance Program. |
| B-2     | Finding the logical solutions related to traffic flow problems in the intersection | - Studying the traffic description flow status in the intersection.  
- Assigning and classifying the problems.  
- Choosing a suitable solutions and another alternatives. |
| B-3     | Classifying the accidents causes and what action will be done to prevent or reduce these accidents | - Studying and classifying the safety problems as:  
- Road Construction problems  
- Traffic Problems  
- Assigning the suitable action, to be more safe. |
| B-4     | Finding the relation-ship between the speed & fuel consumption through using paved & unpaved roads | - Classifying the types of road (paved or unpaved).  
- Classifying the type of cars as (Car; Light vehicle and [bus & truck])  
- Calculating the relationship between speed & fuel consumption, through using special equations. |
| C-1     | Assigning a suitable action & maintenance program related to wearing course distress | - Evaluate the wearing course status & classify the causes of distress.  
- Assigning the required action & maintenance program related to get a good wearing course status. |
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| C-2     | Classifying the causes of road pavement distress and choosing a proper action, according to the causes type of distress | - Assigning the causes of road pavement failure.  
- Choosing a proper action related to the causes type of failure |
| C-3     | Classifying the road potholes No. and choosing a proper action & maintenance | - Assigning & classifying the road potholes according to their (number ) per 100 m.  
- Choosing a suitable action & maintenance program that will be used. |
| C-4     | Classifying the road potholes Size, and choosing a proper action & maintenance | - Assigning & classifying the road potholes according to their (Size) (Small or Big).  
- Choosing a suitable action & maintenance program that include a proper maintenance materials |
| C-5     | Evaluation the surface dressing status, and choosing a proper action & maintenance | - Assigning & classifying the causes of surface dressing distress according to three categories.  
- Choosing a suitable action & maintenance |
| C-6     | Choosing a proper action & maintenance program related to *sewerage* flow running over the road surface | - Classifying the causes of sewerage flow running over the road surface with thickness more than 7 cm.  
- Assigning a suitable action & maintenance program that will be used. |
| C-7     | Choosing a proper action & maint. Program related to *storm water* flow running over the road surface | - Classifying the causes of storm water flow running over the road surface with thickness more than 7 cm.  
- Assigning a suitable action & maintenance program that will be used. |
| C-8     | Assigning a proper action, maintenance program and materials related to footway surface which needs patching. | - Assigning & classifying the footway surface area needs patching according to the size patching.  
- Choosing a proper action, maintenance program and material mixtures that will be used. |
| C-9     | Assigning a suitable action & maintenance program in Ironwork damages. | - Classifying the causes of Ironwork damages.  
- Choosing the required action & maintenance program that will be used to protect these parts of road to be more safe. |
| C-10    | Choosing a suitable action & maintenance program to protect the shoulders & side slope parts of the road | - Assigning & classifying the causes of shoulders & side slope defects.  
- Choosing a proper action & maintenance program to get a good road status. |
| C-11    | Choosing a proper action & maintenance program to protect the road furniture and marking areas | - Assigning & classifying the causes & shape distress.  
- Choosing the required action & maintenance program to protect these areas of the road. |
## Annex 2

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