The Islamic University of Gaza
Deanery of Graduate Studies
Faculty of Engineering
Construction Management Program

الجامعة الإسلامية – غزة
عمادة الدراسات العليا
كلية الهندسة
برنامج ادارة التشييد

A CONSTRUCTION MATERIALS MANAGEMENT SYSTEM FOR GAZA STRIP BUILDING CONTRACTORS

Submitted By

Eyad Abed El-Qader Al Haddad

Supervised By

Dr. Kamalain Sha`ath

A Thesis Submitted in partial Fulfillment of the Requirements for the Degree of Master Of Science in Construction Management

Gaza, Palestine

December 2006

Dedication

I would like to dedicate this to my wife and family for their infinite and kind support

Eyad Al Haddad

ACKNOWLEDGMENT

- I am grateful to my supervisor Dr. Kamalain Sha`ath for his professional advice, useful guidance, and excellent support through all stages of preparing this thesis. Dr sha`ath`s careful check and useful response have made a great contribution to the production of this thesis in its final form.
- My deep thanks to Prof. Adnan Enshassi and Dr. Rifat Rustom for their sincere support and help.
- Careful acknowledgment to my colleagues Eng. Magdy Mohesen for his advices during the study and for his assistance in preparing the system.
- My grateful thanks to all contractors who participated in filling questionnaires and provided important information for this study.

Abstract

A Construction Materials Management System for Gaza Strip Building Contractors

Effective construction materials management process is a key to success of a construction project. Nowadays, successful management of construction materials has to be based on thorough and updated information, and processed utilizing a well designed construction materials management software.

The aim of the thesis has been to explore the local practice in construction materials management and develop a construction materials management system to facilitate the management of construction materials mainly in the building construction. Construction materials management related literature has been generally reviewed; meanwhile some construction materials management software packages have been reviewed also.

A survey questionnaire supported by interviews is used to explore the local practice in construction materials management. One hundred and twenty questionnaires were distributed to contractors of first; second, and third class, eighty-four questionnaires were received and analyzed.

The researcher concluded that all contracting companies are interested in using some techniques of managing construction materials such as creating and updating database for materials categories, local and international suppliers. Also, the Israeli closure on Gaza Strip is the main element that affects materials availability and cost and causes increase the cost of main materials such as cement, reinforcement steel and aggregate.

The study shows that most of contracting companies are still managing construction materials manually. Shortage of user-friendly construction materials software packages and lack of qualified personnel in using computer-based materials management systems are considered the main obstacles in using computer in construction materials management.

The researcher explores Microsoft Excel capabilities and utilizes these capabilities in developing a Construction Materials Management Software which he names "construction materials management software"(CMMS).

CMMS is a PC-based software which has been designed to run under Microsoft Windows. Microsoft Excel is used in developing CMMS, as most companies in Gaza strip are familiar with it. Full description of CMMS has been given with detailed implementation procedures. CMMS has been evaluated to test its suitability to local practice. Evaluation of CMMS has addressed both conceptual and practical issues. One of the main recommendations of this research is to encourage local contracting companies to have a construction materials management software package and use it in determining the required quantities of construction materials in order to get materials in time and required quantities, save time and minimize error.

الملخص

نظام إدارة مواد التشييد لمقاولي البناء في قطاع غزة

الإدارة الفاعلة لمواد التشييد لأي مشروع يعتبر احد العوامل المهمة في نجاح هذا المشروع، في الوقت الحالي إدارة مواد التشييد الناجحة هي التي تعتمد على معلومات دقيقة ومحدثة تتم معالجتها بواسطة برنامج محوسب محكم لإدارة مواد التشييد.

غرض الدراسة هو التعرف على الواقع العملي المحلي لإدارة مواد التشييد في مشاريع البناء، وتطوير برنامج حاسوب متخصص في هذا المجال لكي يحسن من الممارسة المحلية في تشييد المباني، خلال البحث جرت مراجعة عامة للأدبيات المتعلقة بإدارة مواد التشييد. كما وتمت أيضا مراجعة لبعض برامج الحاسوب المتخصصة في إدارة مواد التشييد. لإجراء هذا البحث تم استخدام أسلوب الاستبانه المدعم بالمقابلة الشخصية حيث تم توزيع مائة وعشرون استبانه علي مقاولي الدرجة الأولي والثانية والثالثة وقد تم جمع أربع وثمانين استبانه منها.

أوضحت نتائج هذا البحث بان معظم المقاولين مهتمين في استخدام بعض التقنيات لإدارة مواد التشييد لديهم كالقيام بعمل قاعدة بيانات وتحديثها لأسماء المواد والموردين لهذه المواد. كما واستنتج الباحث بأن الاغلاقات الأمنية لقطاع غزة تؤثر على وفرة المواد وأسعارها.

أيضا أوضحت النتائج أن معظم المقاولين ما زالوا يقومون بإدارة مواد التشييد يدويا أو حتى ذهنيا، وأن معظم العوائق التي تحول دون استخدام برامج إدارة المواد المتخصصة هي نقص في البرامج سهلة الاستخدام والمتخصصة في إدارة المواد، وعدم توفر الخبراء في استخدام هذه البرامج.

قام الباحث بتطوير برنامج حاسوب لإدارة مواد التشييد وسماه برنامج إدارة مواد التشييد "Construction Materials Management Software" (CMMS) معتمدا على الإمكانات الكبيرة الموجودة في برنامج مايكروسوفت اكسل.

برنامج إدارة مواد التشييد CMMS : مصمم للاستخدام بواسطة الحاسوب الشخصي وهو يعمل قي بيئة النوافذ (ويندوز)، كما تم استخدام برنامج (مايكروسوفت اكسل) في تطويره حيث أن معظم مقاولي قطاع غزة لديهم خبرة جيدة في استخدامات "الإكسل "، وشملت هذه الرسالة وصف كامل للبرنامج مع مثال توضيحي، هذا وتم عمل تقويم للبرنامج للتأكد من ملائمة للواقع المحلي من حيث الفكرة والتطبيق.

كان من التوصيات الرئيسية لهذا البحث، تشجيع المقاولين المحليين لاقتناء برنامج محوسب متخصص في إدارة مواد التشييد واستخدامه في تحديد الكميات اللازمة من المواد للحصول عليها في الوقت المناسب والكميات المناسبة وتوفير الوقت وتقليل الأخطاء.

TABLE OF CONTENTS

CHAPTER 3

METHODOLOGY

CHAPTER 4

SYRVEY RESULTS

CHAPTER 5

CONSTRUCTION MATERIALS MANAGEMENT SOFTWARE (CMMS)

CHAPTER 6

CONCLOUSION AND RECOMMENDATIONS

ANNEXES

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1
INTRODUCTION

1.1 General

In this research, the existing construction materials management practices of Gaza Strip contracting companies are investigated, and an attempt to improve it is conducted. The proposed improvements are formulated in development of a computerized materials management system. In this chapter, the rationale, research aim, research objectives, and outline methodology of the research are explained. The contents of this thesis are also summarized.

1.2 Rationale

Construction projects can be accomplished utilizing management processes. These processes include planning, organizing, executing, monitoring, and controlling (Ahuja et al 1994). During any construction project the three inter-related factors of time, money, and quality need to be controlled and managed. Successful completion of projects requires all resources to be effectively managed. Materials management is considered as a means to achieve better productivity, which should be translated into cost reduction.

Computer software systems are widely used in construction management in the developed countries. Yet, using computer applications is still in its early phase of development in the developing countries. Therefore, it is logical that computerization has emphasis in the process of improvement of project management practices in the developing countries. The majority of local contractors in Gaza Strip have poor experience in managing construction materials. Materials management software systems are not quite available and there is a shortage in qualified persons to use these software packages. The results obtained from studying the local practices in managing construction materials is used to develop a computerized materials management system in order to improve the capabilities of local contractors in handling materials management functions.

To the researcher knowledge, a little research effort has been done to investigate the construction materials management practices of Gaza Strip contracting companies. It is important to explore and evaluate these practices, and then offer recommendations and develop practical techniques to improve existing practices.

1.3 Research Aim

The aim of this research is to explore the existing common practices in construction material management for the building construction projects in Gaza strip. Also the research aims at developing a computerized materials management system that suites and, hopefully, improves the local practices.

1.4 Research Objectives

The aim of this research can be broken down into the following objectives:

- to review literature related to the construction material management, and also to review the relevant software packages.
- to investigate the local practices of construction material management in contracting companies in Gaza strip.
- to explore the influence of the Israeli closure on material prices, materials availability, and materials management.
- to assess the impact of computerization on construction materials management.
- to develop a computerized system in construction materials management to improve the common existing practices.
- to evaluate the system by experienced contractors.

1.5 Methodology Outline

The research is conducted through the following stages:

First stage: Literature Review

Materials management related literature was reviewed to identify the main topics and concepts that related to this research. This stage included also a review of available material management software packages. The researcher also explored the Microsoft Excel capabilities.

Second Stage: Field Survey

A survey of the local materials management practices of contracting companies in Gaza Strip was made. A structured questionnaire was used and the person in charge of managing construction materials in the company was interviewed. Statistical analysis for questionnaires was done by using Statistical Package for the Social Sciences (SPSS). Discussion for the obtained results was also made.

Third Stage: Model Formulation and Evaluation

A material management computerized system was developed based on the results obtained from the field survey, the review of material management software packages, and the exploring of the Ms Excel capabilities. This system was evaluated by experienced contractors after applying it on ongoing projects.

1.6 Thesis Contents

Apart from this chapter, there are other five chapters and nine annexes. Chapter 2 presents the literature review of material management in construction projects. Chapter 3 presents the Methodology. Chapter 4 presents research results. It includes the questionnaire design, the method of analysis, and analysis of the surveyed results and discussion of these results. Construction materials management software is discussed in detail in Chapter 5. The discussions include the concepts, the description, the implementation, and evaluation of the material management system. Chapter 6 presents conclusions, recommendations for the main parties involved in the construction industry, and recommendations for further studies.

There are nine Annexes, which supplement these chapters. They are:

Annex 1: The questionnaire (In Arabic).

Annex 2: The questionnaire (English Version).

Annex 3: A review of construction materials management software.

Annex 4: A sample of Activities List.

Annex 5: The system evaluation questionnaire (In Arabic).

Annex 6: The system evaluation questionnaire (English Version).

Annex 7: Recording incoming of construction materials device.

Annex 8: The Average waste percentage of construction material in different countries.

Annex 9: Help and method of use

CHAPTER 2
CONSTRUCTION MATERIALS MANAGEMENT

2.1 Introduction

Construction materials constitute a major cost component in any construction project. The total cost of installed materials (or value of materials) may be 50% or more of the total cost (Stukhart 1995, Bernold and Treseler 1991), even though the factory cost may be a minor part of the total, probably less than 20-30%. This is because the manufactured item must be stored, transported, and restored before it is put in place or "consumed" at the site. The total cost of materials will include, in addition to the manufacturer selling cost, the cost of procurement (cost of placing processing and paying the material, physical distribution, the distributor's cost, and the transportation of materials), and the site-handling costs (cost of receiving, storage, issuing, and disposal). The efficient procurement and handling of material represent a key role in the successful completion of the work. It is important for the contractor to consider that there may be significant difference in the date that the material was requested or date when the purchase order was made, and the time at which the material will be delivered. These delays can occur if the contractor needs a large quantity of material that the supplier is not able to produce at that time or by any other factors beyond his control. The contractor should always consider that procurement of materials is a potential cause for delay (Willis, 1986).

Poor planning and control of materials, lack of materials when needed, poor identification of materials, re-handling and inadequate storage cause losses in labor productivity and overall delays that can indirectly increase total project costs. Effective management of materials can reduce these costs and contribute significantly to the success of the project.

2.2 Background

The Webster's dictionary defines materials as "the elements, constituents, or substances of which something is composed or can be made." Ballot (1971) defines materials as the physical materials that are purchased and used to produce the final product and does not suggest that materials are the final product. In other words, materials are the parts used to produce the final product.

Bailey and Farmer (1982) define materials as the goods purchased from sources out of the organization that are used to produce finished products. Stukhart (1995) defines materials as the items that are used to produce a product and which include raw materials, parts, supplies and equipment items.

Chandler (1978) states that construction materials can be classified into different categories depending on their fabrication and in the way that they can be handled on site. He classifies the materials into five categories. They are:

- Bulk materials- these are materials that are delivered in mass and are deposited in a container.
- Bagged materials- these are materials delivered in bags for ease of handling and controlled use.
- Palleted materials- these are bagged materials that are placed in pallets for delivery.
- Packaged materials- these are materials that are packaged together to prevent damage during transportation and deterioration when they are stored.
- Loose materials- these are materials that are partially fabricated and that should be handled individually. Table 2.1 presents some examples of commonly used materials in construction and their classification.

Table 2.1: Classification of Materials (Adopted from Chandler, 1978)

Material	Bulk	Bagged	Palleted	Packaged	Loose
Sand	X				
Gravel	X				
Topsoil	X				
Paving Slabs					X
Structural Timber					X
Cement	X	X	X		
Concrete	X				
Pipes				X	X
Tiles				X	
Doors			X		
Electrical Fittings				X	

Stukhart (1995) states that the main categories of materials encountered in a construction project are engineered materials, bulk materials, and fabricated materials.

- Bulk materials- these are materials manufactured to standards and are purchased in quantity. They are bought in standard length or lot quantities.

Examples of such materials includes pipes, wiring, and cables. They are more difficult to plan because of uncertainty in quantities needed.

- Engineered materials- these materials are specifically fabricated for a particular project or are manufactured to an industry specification in a shop away from the site. These materials are used for a particular purpose. This includes materials that require detailed engineering data.
- Fabricated materials- these are materials that are assembled together to form a finished part or a more complicated part. Examples of such materials include steel beams with holes and beam seats.

Stukhart (1995) defines material management as the activities involved to plan, control, purchase, expedite, transport, store, and issue in order to achieve an efficient flow of materials and that the required materials are bought in the required quantities, at the required time, with the required quality and at an acceptable price.

Plemmons and Bell (1995) define material management as the plan and control of all activities to ensure the correct quality and quantity of materials and equipment to be installed as specified in timely manner, obtained at reasonable cost and are available when needed.

Dobler and Burt (1996) state that material management is designed to improve the activities related to the flow of materials. They add that material management should coordinate purchasing, inventory control, receiving, warehousing, materials handling, planning, and transportation.

2.3 Importance of Materials for a Project

Problems related to managing the flow of materials can be found in every organization. The efficient management of materials plays a key role in the successful completion of a project. The control of materials is a very important and vital subject for every company and should be handled effectively for the successful completion of a project. Materials account for a big part of products and project costs. The cost represented by materials fluctuates and may comprise between 20-50% of the total project cost and sometimes more. Some studies concluded that materials account for around 50-60% of the project cost (Stukhart, 1995 and Bernold and Treseler, 1991). Materials are critical in the operations in every industry since unavailability of materials can stop production. In addition, unavailability of materials when needed

can affect productivity, cause delays and possible suspension of activities until the required material is available.

Unavailability of materials is not the only aspect that can cause problems. Excessive quantities of materials could also create serious problems to managers. Storage of materials can increase the costs of production and the total cost of any project. When there are limited areas available for storage, the managers have to find other alternatives to store the materials until they are needed. Some of these alternatives might require re-handling of materials, which will increase the costs associated with them. Provisions should be taken to handle and store the materials adequately when they are received. Special attention should be given to the flow of materials once they are procured from suppliers.

It is obvious that materials should be obtained at the lowest cost possible to provide savings to the company (Damodara, 1999). In the late 1970's, construction companies experienced an increase in costs and a decrease in productivity. Owners of these companies thought that these increases in cost were due to inflation and economic problems. Further research concluded that these companies were not using their resources efficiently and that the decrease in productivity was also attributable to poor management (Stukhart, 1995). Material management has been an issue of concern in the construction industry. 40% of the time lost on site can be attributed to bad management, lack of materials when needed, poor identification of materials and inadequate storage (Baldwin et. al, 1994).

The need for an effective materials planning system becomes mandatory. Some companies have increased the efficiency of their activities in order to remain competitive and secure future work. Many other firms have reduced overheads and undertaken productivity improvement strategies. Considerable improvement and cost savings would seem possible through enhanced materials management. Timely availability of materials and systems are vital to successful construction. Materials management functions are often performed on a fragmented basis with minimal communication and no clearly established responsibilities assigned to the owner, engineer or contractor.

Better material management practices could increase efficiency in operations and reduce overall cost. Top management is paying more attention to material

management because of material shortages, high interest rates, rising prices of materials, and competition. There is a growing awareness in the construction industry that material management needs to be addressed as a comprehensive integrated management activity.

2.4 What is Material Management?

Different researchers provide different definitions for material management. Therefore, different definitions can be found in different references. Basically, material management is concerned with the planning, identification, procuring, storage, receiving and distribution of materials. The purpose of material management is to assure that the right materials are in the right place, in the right quantities when needed. The responsibility of one department (i.e. material management department) for the flow of materials from the time the materials are ordered, received, and stored until they are used is the basis of material management.

Ballot (1971) defines material management as the process of planning, acquiring, storing, moving, and controlling materials to effectively use facilities, personnel, resources and capital. Tersine and Campbell (1977) define material management as the process to provide the right materials at the right place at the right time in order to maintain a desired level of production at minimum cost. The purpose of material management is to control the flow of materials effectively. Beekman-Love (1978) states that a material management structure should be organized in such a way that it allows for integral planning and coordination of the flow of materials, in order to use the resources in an optimal way and to minimize costs.

Chandler (1978) states that material management systems should be implemented to plan, order, check deliveries, warehousing, controlling the use of materials, and paying for materials. He adds that these activities should be interrelated. Ammer (1980) defines material management as the process in which a company acquires the materials that it needs to achieve their objectives. This process usually begins with the requisition of materials from the supplier until the material is used or incorporated into a product. Bailey and Farmer (1982) define material management as a concept concerned with the management of materials until the materials have been used and converted into the final product. Activities include cooperation with designers,

purchasing, receiving, storage, quality control, inventory control, and material control. Gossom (1983) indicates that a material management system should have standard procedures for planning, expediting, transportation, receipt, and storage to ensure an efficient system for materials control. Cavinato (1984) states that material management involves the control of the flow of goods in a firm. It is the combination of purchasing with production, distribution, marketing and finance. Arnold (1991) states that material management is a function responsible for planning and controlling of materials flow. He adds that a materials manager should maximize the use of resources of the company.

Materials management is an important element in project planning and control. Materials represent a major expense in construction, so minimizing procurement or purchase costs presents important opportunities for reducing costs. Poor materials management can also result in large and unavoidable costs during construction. First, if materials are purchased early, capital may be tied up and interest charges incurred on the excess inventory of materials. Even worse, materials may deteriorate during storage or be stolen unless special care is taken. For example, electrical equipment often must be stored in waterproof locations. Second, delays and extra expenses may be incurred if materials required for particular activities are not available. Accordingly, insuring a timely flow of material is an important concern of project managers. Materials management is not just a concern during the monitoring stage in which construction is taking place. Decisions about material procurement may also be required during the initial planning and scheduling stages. For example, activities can be inserted in the project schedule to represent purchasing of major items such as elevators for buildings (Dubler and Burt, 1996).

The availability of materials may greatly influence the schedule in projects with a fast track or very tight time schedule. Sufficient time for obtaining the necessary materials must be allowed. In some cases, more expensive suppliers or shippers may be employed to save time. Materials management is also a problem at the organization level if central purchasing and inventory control is used for standard items. In this case, the various projects undertaken by the organization would present requests to the central purchasing group. In turn, this group would maintain inventories of standard items to reduce the delay in providing material or to obtain lower costs due to bulk purchasing (Cavinato, 1994).

This organizational materials management problem is analogous to inventory control in any organization facing continuing demand for particular items. Materials ordering problems lend themselves particularly well to computer based systems to insure the consistency and completeness of the purchasing process. In the manufacturing realm, the use of automated materials requirements planning systems is common. In these systems, the master production schedule, inventory records and product component lists are merged to determine what items must be ordered, when they should be ordered, and how much of each item should be ordered in each time period. The heart of these calculations is simple arithmetic: the projected demand for each material item in each period is subtracted from the available inventory.

When the inventory becomes too low, a new order is recommended. For items that are non-standard or not kept in inventory, the calculation is even simpler since no inventory must be considered. With a materials requirement system, much of the detailed record keeping is automated and project managers are alerted to purchasing requirements (Stukhart, 1995).

The role that a materials manager plays in an organization is strictly economical since the materials manager should keep the total cost of materials as low as possible. The person in charge of handling materials should keep in mind the goals of the company and insure that the company is not paying extra money for materials. The goal of every company is to make a profit. This is the basis for company survival, costs should not exceed income, but keeping in mind customer's expectations.

The typical tasks associated with a material management system are (Tersine and Campbell (1977), Ammer (1980), Stukhart (1995)):

- Procurement and purchasing
- Expediting
- Materials planning
- Materials handling
- Distribution
- Cost control
- Inventory management / Receiving/ Warehousing
- Transportation

Purchasing and procurement deals with the acquisition of materials to be used in the

operations. The primary function of purchasing and procurement is to get the materials at the lowest cost possible, but keeping in mind quality requirements. Expediting is the continuous monitoring of suppliers to ensure on time deliveries of materials purchased. The purpose of materials planning is to procure the materials for the dates when they are needed, storage facilities, and handling requirements. The primary function of materials handling is to manage the flow of materials in the organization. The manager has to assure that the costs associated with handling materials are kept to a minimum. In cost control, the manager has to insure that the costs to buy materials are kept to a minimum. In other words, the manager has to insure that he is buying the products at the lowest possible price. The inventory management deals with the availability of materials. Transportation involves using the safest most economical means to transport the materials to the site where they are needed.

Figure 2.1 depicts the different phases of the material management process including the relationship and interdependency between the different activities in each phase. From this figure it can be seen that decisions taken at each phase in the system, directly affect the activities of the phases that follow.

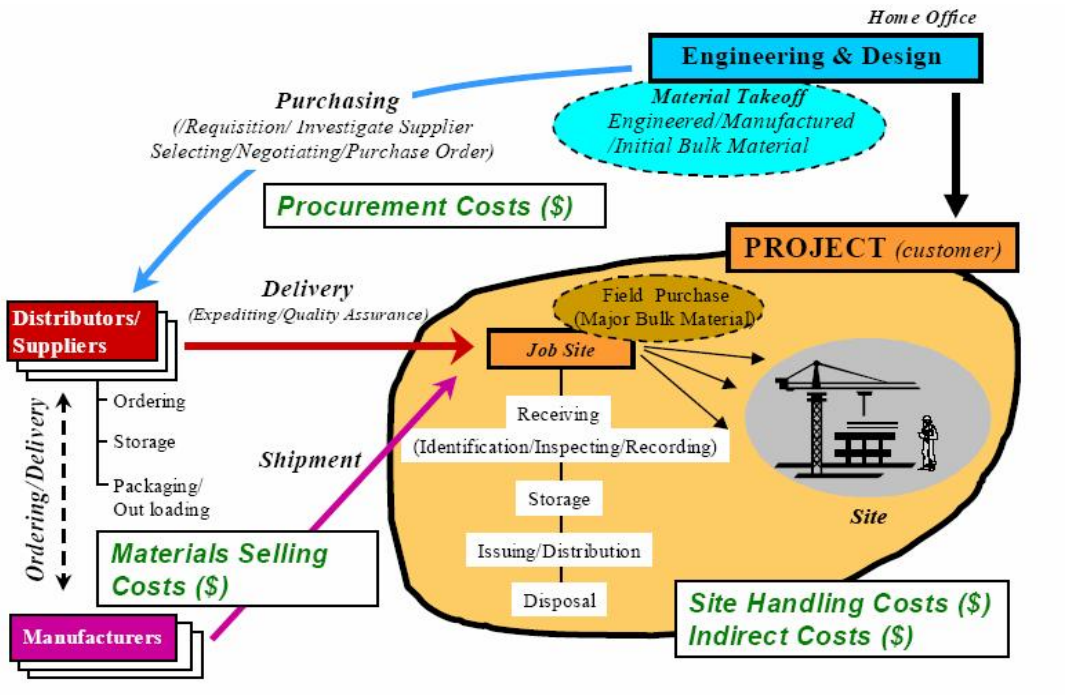


Figure 2.1: Typical Materials Management in Construction (Source: Thabet , 2001)

2.5 Need for Material Management Systems

The costs associated with material management are hidden in other activities or included as overhead costs. Stukhart (1995) states that studies from the Construction Industry Cost Effectiveness Project (CICEP) concluded that senior management have not recognized the contribution of material management to cost issues in projects, that personnel involved in material management activities do not receive an adequate training, and that the computer systems used by companies are not good sources of information for materials control. Historically, managers had paid more attention to the costs associated with personnel, equipment and plant and little attention has been given to materials. For manufacturing organizations, the costs related to materials have increased and had become the largest expenditure of the organization; therefore more attention has been placed into activities related to materials (Tersine, 1978). The cost of materials has escalated to twice the cost of labor between 1975 and 1980 inducing companies to pay more attention to activities related to materials (Bernold and Treseler, 1991).

Navon 2002 developed and evaluated an automated model for management and control of materials ordering, purchasing, and supply and use. In order to evaluate the model under real conditions, the model was implemented in a prototype system and used in ongoing construction projects. The model provides a comprehensive approach, encompassing materials purchasing aspects, their delivery to the site and their dispatching for use in the building. The model can reduce the time needed for materials management, reduce wastage caused by manually ordering the materials and ensure that materials on site on time, in the right quantity and according to specifications.

Figure 2.2 illustrates a typical flow of materials, and material activities in an organization. From the figure, it can be seen that decisions taken at early stages in the material management flow might affect other activities and decisions to be made in later stages. For example, if the proposals from suppliers are not analyzed (i.e. step 6 in the purchasing activities), then the selection of suppliers might be affected (i.e. step 3 in the supply management activities).

Coordination is needed in order to reduce the impact that a decision at a certain stage might have in other activities. Communication is essential among members of the team to avoid conflicts and to take the better decisions regarding materials flow.

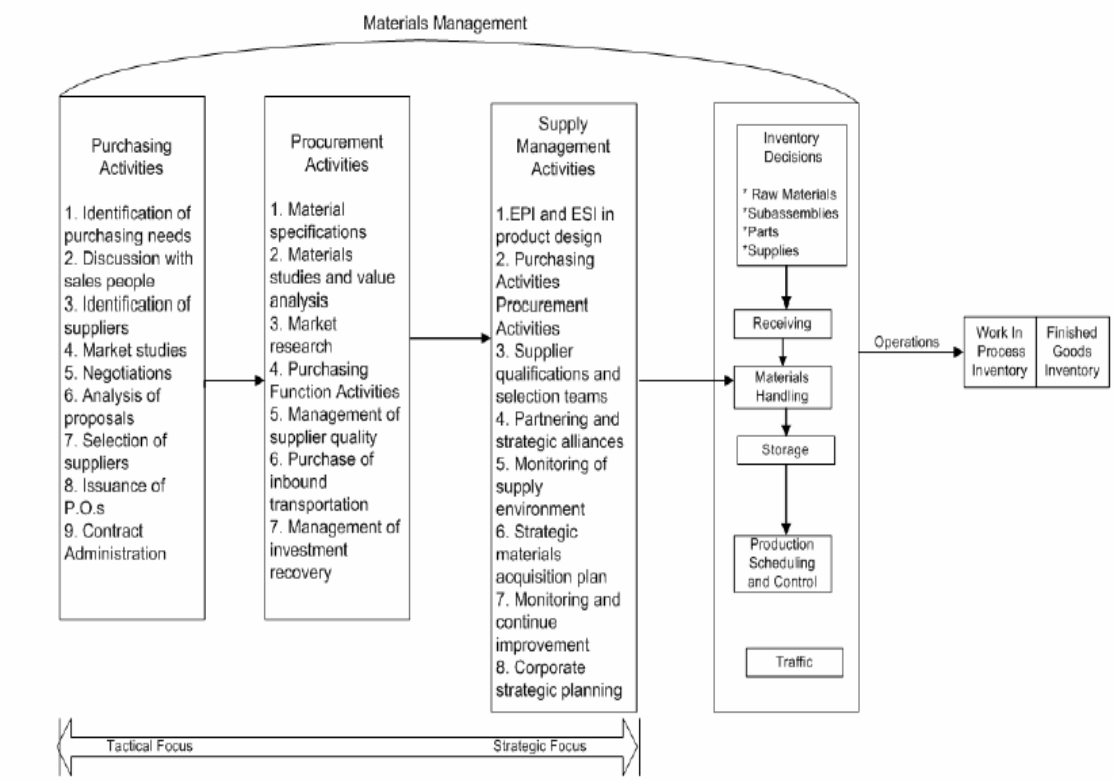


Figure 2.2: Relationship of Purchasing/Procurement/supply management with material management (Adopted from Dobler and Burt, 1996)

2.6 Goals of Material Management

As it was mentioned previously, the role of the materials manager is strictly economical within an organization. This section will describe some of the aspects that the materials manager should keep in mind to handle all activities related to materials appropriately.

Cavinato (1984) states that the objectives of a material management system should include lowest final cost, optimum quality, assurance of supply, and lowest administrative costs. The materials manager should obtain the materials needed at the lowest cost possible.

By buying products at the lowest possible costs, operating costs can be reduced and profits can be increased. Proper handling and storage of materials can reduce the total cost of materials; therefore the materials manager should ensure that materials are handled properly and stored in the most adequate places. Quality is a very important aspect that the materials manager has to keep in mind. When specifications require a

high quality product, quality could become the most important objective. Suppliers play an important role in any organization. Many companies rely greatly on outside suppliers for the materials needed for production. Good relations with suppliers might be decisive for a company to be in business.

Companies that have good relations with suppliers could be more successful in attracting customers than companies that have bad relations with suppliers. When a company has good relations with its suppliers it could benefit from cost reductions, cooperative environment from the employees of the supplier, and willingness to help with materials ordered and orders pending. When a company has bad relation with their suppliers it might be possible that it experiences late deliveries or wrong materials delivered. This will have an impact on the total cost of the product, possibly increasing the total costs, and delaying the completion of the final product. Materials acquisition from the procurement time until it is received in the field can have a significant impact on the schedule of a construction project. Based on the studies presented, it is clear that effective management of materials can minimize the impact that lack of materials or improper management of materials could have on the overall schedule and cost of the project. The materials manager should assure that effective and economical transportation are used to transport materials to the site.

2.7 Benefits of Material Management

An effective material management system can bring many benefits for a company. Previous studies by the Construction Industry Institute (CII) concluded that labor productivity could be improved by six percent and can produce 4-6% additional savings (Bernold and Treseler, 1991). Among these benefits are:

- Reducing the overall costs of materials
- Better handling of materials
- Reduction in duplicated orders
- Materials will be on site when needed and in the quantities required
- Improvements in labor productivity
- Improvements in project schedule
- Quality control
- Better field material control

- Better relations with suppliers
- Reduce of materials surplus
- Reduce storage of materials on site
- Labor savings
- Stock reduction
- Purchase savings
- Better cash flow management

From a study of twenty heavy construction sites, the following benefits from the introduction of materials management systems were noted (Stukhart and Bell, 1987):

- In one project, a 6% reduction in craft labor costs occurred due to the improved availability of materials as needed on site. On other projects, an 8% savings due to reduced delay for materials estimated.

- A comparison of two projects with and without a materials management system revealed a change in productivity from 1.92 man-hours per unit without a system to 1.14 man-hours per unit with a new system. Again, much of this difference can be attributed to the timely availability of materials.

- Warehouse costs were found to decrease 50% on one project with the introduction of improved inventory management, representing a savings of $ 92,000. Interest charges for inventory also declined, with one project reporting a cash flow savings of $ 85,000 from improved materials management.

Against these various benefits, the costs of acquiring and maintaining a materials management system has to be compared. However, management studies suggest that investment in such systems can be quite beneficial.

2.8 Scope of Materials Management

This section deals mainly with the attributes of material management and the responsibilities of those involved in carrying out the material management functions.

A detailed understanding of each contributing function is required in order to comprehend the interfaces between material management functions. A materials management system includes the major functions of identifying, acquiring, distributing, and disposing of materials on a construction site (Stukhart, 1995).

By definition, material management is the management system for planning and controlling all of the efforts necessary to ensure that the correct quality and quantity of materials are properly specified in a timely manner, are obtained at a reasonable cost, and are available at the point of use when required. Each firm has its particular materials management system where the responsibility for the various activities is spread between engineering, purchasing, and construction. Some assign full responsibility and accountability to a material manager, but for most firms the responsibility is divided and therefore prone to problems (Stukhart, and Bell, 1987).

Figure 2.3 represents the logical steps in the process from identifying material needs to delivering the materials when required at the point of use. Each step is a link in the chain of events and the strength of the chain is only as good the weakest link. From review of these steps it is apparent that the system can break down in numerous places as the result of misdirected effort or lack of effort by the many individuals involved. These steps resulting delays in delivery. It always costs more if things are not done right the first time. Delays and additional effort are costly, reduce efficiency of a construction operation because of reallocation of resources, and therefore negatively impact productivity. The steps shown are only the key element and are part of the whole material management process which by definition includes the planning and controlling of all supporting efforts (Ahuja et al, 1994).

2.9 Material Management Steps

There are several steps within the scope of material management and each of these steps can give rise to potential problems. The more the responsibility is divided, the more potential problems that exist.

Figure 2.3 shows the steps in material management and the pertinent action related to these steps. Some actions are described in terms of the documentation produced, such as receiving report and vendor data. (Ahuja et al, 1994)

Sequence	Contribution action
1-RFQ (Requisition)	Drawings, specifications. Material bills Terms and conditions
2-Bids	Approved bidders list Pre qualification of bidders Bid evaluations
3-P.O. (Purchase Order)	Bid clarification Notice of award
4-Expediting	Vender data Manufacturer inspection Delivery Routings
5-Transport	Carrier and route Ownership en route Custom
6-Receiving	Inspection and acceptance Receiving report Storage
7-Inventory	Dispersal (i.e. material handling) Inventory level

Figure 2.3: Material Management steps (Ahuja et al, 1994)

2.9.1 Request for Quotation (RFQ)

Specifications and drawings are needed to implement the request for quotation process successfully. The specifications and drawings are utilized by a rather diverse group of participants. The specifications and drawings help the contractor to estimate, control, manage and direct the works. Also they help the purchasing department to purchase materials and equipments that described in the drawings and specifications, finally they help the owner to know what to buy and what he is entitled to receive.

There are relations between the specifications and drawings will clear and generally show the following information and items. From drawings we can obtain information about the location of materials, equipment, fixtures, details and overall dimensions, interrelation of materials, equipment and space, sizes of equipment, identification of materials at is locations, and another alternatives. And from specifications we can obtain type and quality of materials, equipment and fixtures, quality of workmanship, methods of fabrication, installation, erecting, test and code requirements, unit, options and alternatives (Ahuja, and Dozzi 1994)

2.9.2 Purchasing

The purchasing function is central to material management. Purchasing has the responsibility and the authority to commit project funds for materials, equipment, and services. This activity may be accomplished by the home office, the field, or a combination of both depending on the size and the scope of the project. The home office must maintain planning, procedural, and policy direction over the field operations in order to ensure consistent purchasing practices. (Stukhart, and Bell, 1987)

Vendor selection follows policy and procedures as a key step in accomplishing the work. In selecting vendor for the project, purchasing is forming the foundation for the success or failure of the project. Vendors must be selected on the basis of their capabilities, geographical location, prior experience, and owner preference. Measurement of capabilities includes such considerations as past performance, financial condition, bargaining agreements, capacity, competitiveness, responsiveness, and schedule adherence. (Stukhart, and Bell, L.C, 1987)

Several methods of contracting are available to the purchasing organization, depending on the commodity or service required. Purchasing orders are the most common form of contract utilized on projects. Although blanked orders and other forms of agreement are used in varying degrees. Under any form the contract it must encourage the on time delivery and completion of the work.

"Standard" or "general" terms and conditions of the order or contract generally address various commercial aspects of transaction; they define the respective rights, duties, and obligations of the contracting parties.

Special terms and condition also must be incorporated into the body of the purchase order or contract. Items such as schedule test information, data submittals, drawing approvals, expediting, and terms of payment are typical of the information, which must be clearly specified.

Purchase orders often require technical service agreements to complete the scope of work when the vendor's technical representative is required at the site to supervise installation and or erection.

2.9.3 Expediting

Several types of expediting exist, each with a different level of intensity and cost. The least intense type of expediting is simple status reporting. Periodic telephone contact

is made with the vendor to determine the status or progress of an order, and the information is reported to the project in some systematic format. This type of expediting provides basic information to the project, but does little to prevent or overcome delays or problems with an order.

Reactive or correction expediting is more intense than the simple status reporting. But it is initiated only in response to some event or action. Vendor contact may be made in response to a problem of delayed or late delivery (Ahuja and Dozzi 1994).

Finally, proactive or preventative expediting is the most intense aggressive type of expediting. Here, vendor and sub vendor contact is initiated as soon as the order is issued and continues through the live of the order. The expeditor will review all elements of the order to ensure that the vendor understand the various submittal, testing, and delivery requirements.

The expeditor will seek to gain a thorough understanding of the vendor's engineering, purchasing, and manufacturing operations as they relate to the particular order. This enables the expeditor to monitor all elements of the vendor's performance with the intent of anticipating and resolving problems before they seriously impact the projects.

Experienced professional expeditors serve as a key bridge between the engineering and purchasing activities that specify and order materials and the field operations that are dependent on those materials for their progress. Accurate and dependable expediting information is essential for informed management of the projects, and facilitates the mobilization of buyer and vendors resources in response to problems or delays (Ahuja and Dozzi 1994)

2.9.4 Transportation

The movement of equipment, materials, and personnel to the job site represents a unique and specialization element of materials management. Experienced traffic personnel can have a positive impact on the execution of the project while minimizing transportation cost (Ahuja and Dozzi 1994)

Significant saving is possible with national agreements or negotiated project transportation, and through various commercial arrangements for the transportation of goods, materials, documentation, or personnel. Special consideration is required in setting terms, thereby determination the proper point for transfer of materials ownership and liability. The prime contract, especially insurance clauses, may have a

direct impact on the purchasing terms and conditions concerning transportation.
Early specialized activities in the project planning phases, such as properly performed route survey and consideration of local traffic conditions, can significantly affect later execution of the work. These front end efforts affect engineering by defining shipping envelopes, weight limits, and schedule limitations, the traffic function or group significant input to purchase documents including packing specifications, shipping instructions, invoicing instructions, and document requirements.
This group's expertise is necessary in developing routing guides, shipments progress reports, and troubleshooting as transportation problems develop.

Transportation or traffic expertise aids the materials management team in handling numerous types of special loads from delicate electronics to massive modules, each requiring transport equipment that is specially designed or of limited availability. Knowledge of requirements, source and availability of this equipment may be critical to successful execution of the work.
Transport permitting requirements also must be considered early in the project. Assigning the above responsibilities to suppliers may present an easy upfront decision, but can later lead to painful lessons if the expertise is not available to the materials management team to ensure that traffic functions are handled properly.

Traffic or logistics for foreign sites present an added dimension to the transportation requirements for a project. Each phase of the transportation effort is more complex, with often-stringent requirements due to ocean shipment and transportation to remote areas of the world. Each country's customs requirements are unique with potentially significant duties, taxes, and delays that must be considered in the planning efforts.

2.9.5 Surplus Materials

All projects can expect a certain amount of surplus, however, the key to successful surplus materials management is a well-conceived and well-executed materials management plan. Various shortcomings in the engineering, materials control, procurement, and field materials management phases of the work may results in surplus materials. Understanding and anticipating these potential problems areas are the first in minimizing surplus (Stukhart and June 1987)
Many causes of surplus can be identified. Surplus can be caused by a poorly

performed materials take off (MTO). Engineering revision and changes are yet another cause of surplus, particularly if the MTO occurs early and systems are not adequately responsive to changes. Inadequate construction materials management practices also may lead to surplus, particularly on fast track projects. Primary causes are:

- Duplicate buying and poor control systems/procedures leading to procurement of unnecessary materials.
- Minimizing surplus on a project requires a proactive and timely system of communication among all functions involved in the materials acquisition and installation cycle.
- Option for disposal include using the surplus in the alternative services, using the surplus materials on other projects, returning them to the vendor, or selling them to a third party. All options require complete records and timely reporting to achieve optimum results. The best option is to do the necessary planning and to implement the necessary materials management system to reduce surplus at the source(Ahuja and Dozzi 1994)

2.10 Responsibilities

The purpose of clearly establishing the responsibilities and authority of the participants is not for attaching blame should something go wrong in the process, but to communicate clearly what is expected and avoid misunderstandings as to who does what and when. The scope of each participant's involvement must be clearly defined. If not, increased effort will be expended to rectify missed expectations in quantity, quality, or cost. Unexpected effort reduces productivity of the operation. A quality effort is required in all parts of the project, otherwise poor quality in the material management process becomes apparent immediately at the point of use. By comparison, poor quality of engineering, for example, may not become apparent at all. (Ahuja and Dozzi, 1994)

Several participants contribute to the material management process and the scope of their involvement should be clearly stipulated in the contractual document. Figure 2.4 shows the contractual relationships (shown with double-ended arrows) and the key document that are used to establish the scope of material management of each participant. An efficient material management system leads to improve productivity

and must necessarily include all participants. The alternative is an inefficient, incomplete plan, which will prove counterproductive.

If an owner purchases a long-lead item and later assigns the purchase order to the contractor, a clear understanding of the purchase order is required, as well as full knowledge of any relevant correspondence, to ensure that nothing is overlooked.

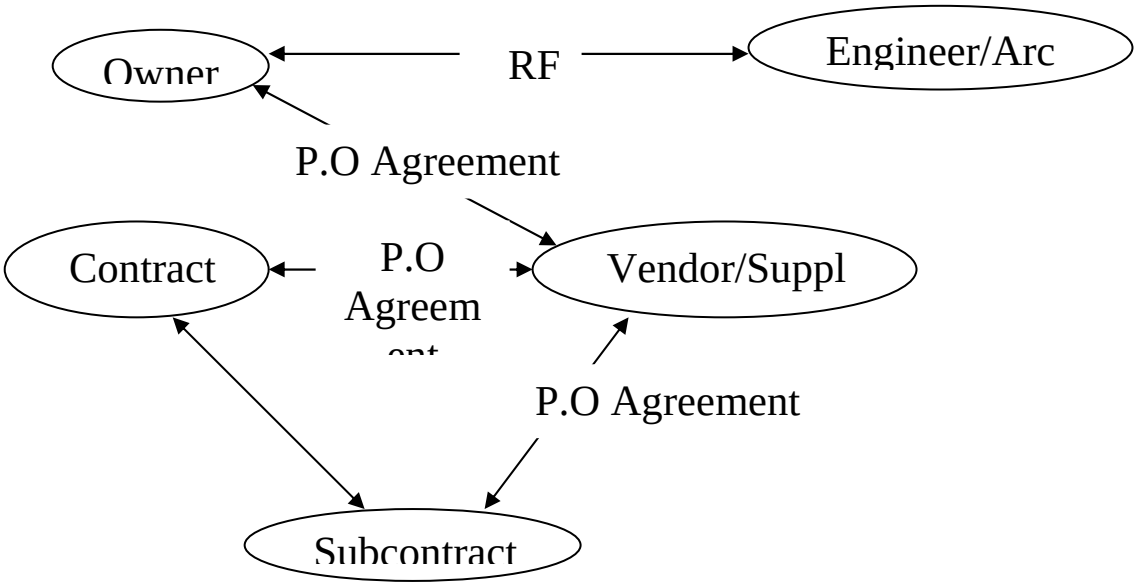


Figure 2.4: Relationships and key documents (Ahuja and Dozzi, 1994)

2.11 Legal Aspects of Document

A purchase order (P.O.) is a contract, which specifies technical, delivery, warranty, and cost details for the goods and services to be provided. Besides providing technical specifications, it is important to clearly state the required delivery date and whether the goods are FOB (free on board) at the supply source or the delivery destination. Vendor information such as engineering data sheets and drawings are often required in order to finalize the engineering drawings, specifications, or both. The P.O. must clearly defined what drawings are required and when. Two examples are the final anchor bolt layout for a piece of machinery or electrical grounding locations. This information is required in order to complete foundation design and construction, and late delivery of vendor information could result in delays and additional costs to overcome the effects of delay.

Leases should be read carefully to understand the limitations respecting insurance coverage. The wording on leases leaves little doubt that the lessee assumes

responsibility for the piece of equipment or vehicle that is being leased from the lesser. The legality of contracts is readily ascertained, but it is not apparent to many involved in procurement of materials that some of the otherwise bothersome paperwork has legal implications. A bill of lading transfers responsibility for the goods from the supplier to the transporter of the goods.

Upon delivery to the receiver of the goods, at both ends of the shipping phase, the bill of lading is signed as being correct by the receiver of the goods. Signed releases by inspectors are another group of documents that allow fabrication or processing to proceed during the manufacture of items. Pressure vessels and piping are examples of fabricated is not allowed until signed approval is received from an authorized inspector. (Ahuja and Dozzi, 1994) It is commonly required to produce mill test reports for materials used in the shop fabrications or field construction. Also, reports for specific testing of materials are required to fulfill the contractual requirements for supply of some goods. In fact, materials should not be unloaded without the proper and complete documentation.

The absence or delay of the required documentation can delay fabrication progress and potentially delay the project. Besides, there are serious longer term legal implications for use of material that has not been properly certified as acceptable for use in a particular application. A dramatic example of such an occurrence is the major fire damage exceeded 100 millions of dollars.

2.12 Just In Time (JIT)

The acronym JIT has been highly visible since the late 1980's, as manufacturing attempted to meet competitive challenges by adopting newly emerging management theories and techniques, referred to by some as Lean Production (Womack and et all, 1991). Manufacturing JIT is a method of pulling work forward from one process to the next "just-in-time"; i.e. when the successor process needs it, ultimately producing throughput. One benefit of manufacturing JIT is reducing work-in-process inventory, and thus working capital. An even greater benefit is reducing production cycle times, since materials spend less time sitting in queues waiting to be processed. However, the greatest benefit of manufacturing JIT is forcing reduction in flow variation, thus contributing to continuous, ongoing improvement.

2.12.1 Construction JIT vs. Manufacturing JIT

JIT is a technique developed by Taichi Ohno and his fellow workers at Toyota (Ohno, Taichi., 1987). Ohno's fundamental purpose was to change production's directives from estimates of demand to actual demand. A purpose originally rooted in the absence of a mass market and the need to produce small lots of many product varieties. In assembly line production systems managed by lean production concepts, the directives for production are provided by means of kanban from downstream processes. This system insures that whatever is produced is throughput, i.e. is needed for the production of an order. Kanban works as a near-term adjusting mechanism within a system of production scheduling that strives for firm and stable aggregate output quantities, and provides all suppliers in the extended process progressively more specific production targets as the plan period approaches, resulting ultimately in a firm 2-6 week production schedule. This system provides sufficient flexibility to adjust to actual demand, while assuring that all resources are applied to the production of throughput. In manufacturing, the need for flexibility comes from a potential difference between forecast and actual demand. Many products are being produced, so it is important to minimize the time required to produce any specific type of product demanded. In construction, there is only one product produced once. And in the case of industrial construction, that product is the facility for producing manufacturing's products. It is consequently important to reduce the time needed to produce the facility, not necessarily the time to produce any component.

The application of JIT to construction differs substantially from its application to manufacturing because construction and manufacturing are different types of production, and because of the greater complexity and uncertainty of construction. The extent and significance of uncertainty in construction has been adequately addressed, but a moment's reflection supports the view that construction is complex. The number of parts, relative lack of standardization, and the multiple participants and constraining factors easily make the construction of an automobile factory more difficult than the production of an automobile in that factory. When this complexity is joined with economic pressures to minimize time and cost, that uncertainty results is not surprising.

2.12.2 Using JIT to reduce variation and waste: Manufacturing vs. construction

By minimizing inventories between processes, Ohno removed the safety stock that allowed a downstream process to continue working when a feeder process failed. He also required that operators stop the production line when they were unable to fix problems. Consequently, it became necessary to solve problems rather than simply passing bad product down the line. Problems also became highly visible since they could result in line stoppages. Forced confrontation with problems together with analysis to root causes produced a progressively more steam lined and smoother running production process, with fewer end-of-the line defects and higher throughput. How might this work in construction? Construction is schedule driven. Given a well-structured schedule, if everyone stays on their part of the schedule, the work flows smoothly and maximum performance is achieved. However, as we all know, it is rare that projects perform precisely to their original schedule. Business conditions change, deliveries slip, a design requires correction, etc. If a schedule has sufficient slack in the impacted activities, changes may not impact end dates. When there is little or no slack, players are pressured to make it up in accelerated production.

2.12.3 Types of Construction Buffers

There are two types of inventories that can serve the function of buffering downstream construction processes from flow variation. The most familiar type is piles of stuff; materials, tools, equipment, manpower, etc. These piles of stuff may originate in decisions to insert certain time intervals between scheduled activities, e.g. between fabrication and installation of pipe spools. Consequently, while they take the form of stuff, they often also represent time added to project duration, so these are called "schedule buffers" (Howell et. all, 1994). Less familiar are inventories of workable assignments, produced by planning processes that make work ready for downstream production (Ballard et. all, 1994). These buffer by enabling a reliable, predictable flow of output from each process. They need not imply the existence of piles of stuff, depending upon the predictability of flow between supplier and customer processes. Ballard et. all called these inventories of workable assignments "plan buffers."

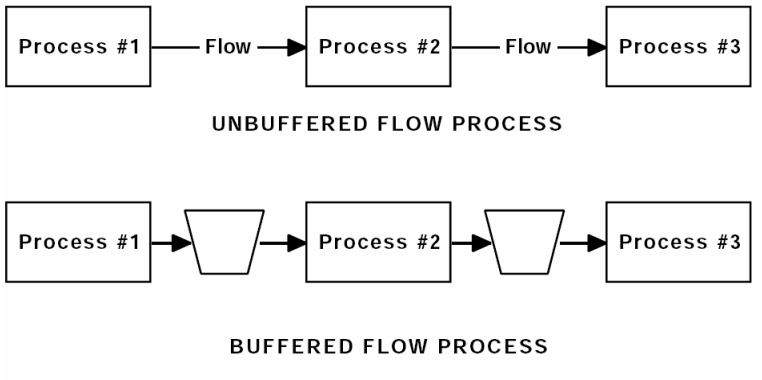


Figure 2.5: Types of construction buffers (Howell et. all, 1994)

2.12.4 Functions of Schedule Buffers

In the construction of process plants (petroleum, chemical, food processing, pulp and paper, etc), projects are frequently fast track; i.e. construction begins before design is completed (Huovila et. all, 1994). Late delivery of drawings and materials has led construction contractors to demand earlier delivery, reducing the time available for engineering to complete design, resulting in more delivery problems and demands for even earlier deliveries. This is clearly a vicious circle. Large schedule buffers between suppliers and construction may shield the contractor from the impact of late deliveries (Howell et. all, 1994), but does nothing to address the root causes of variation. Further, the shielding is expensive, both in time and money. There is a better way. A suggested rule: Place schedule buffers just after processes with variable output. For example, that suggests placing schedule buffers between engineering and fabrication, rather than between fabrication and installation. The fabrication and delivery processes are highly predictable, unless drawings are incorrect or incomplete, or drawings are pulled out of fabrication to be revised. A schedule buffer in front of fabrication would provide more time for engineering to complete its work and do it correctly. It would also provide the fabricator an opportunity to select and bundle work to meet his needs for production efficiency and the contractor's needs for quantities and sequence.

Another suggested rule: Size schedule buffers to the degree of uncertainty and variation to be managed. Research (Howell et. all, 1994) has shown that schedule buffers are sized without regard to the toughness of projects; i.e. their level of uncertainty. This amounts to wasting time and money accumulating piles of stuff not all of which is needed

CHAPTER (3)

METHODOLOGY

3.1 Introduction

This chapter includes the methodology used in this research. It provides the information about the research strategy, research design, population, sample size, various approaches to data collection and data analysis. It also identifies the questionnaire design, pilot study, validity content, and reliability.

3.2 Research strategy

Research strategy can be defined as the way in which the research objectives can be questioned (Naoum, 1998). The explanation of mass behavior often requires mass attitude data that can only be obtained by a survey (Weisberg and Bowen, 1977). The people who provide information to the researchers are referred to as subjects, study participants, or respondents in quantitative research or as study participants or informants in qualitative research (Polit and Hungler, 1999). There are two types of research strategies, namely, 'quantitative research and qualitative research' (Naoum, 1998). Data may take the form of narrative information (qualitative data) or numerical values (quantitative data), (Polit and Hungler, 1999). Quantitative research is 'objective' in nature. It is defined as an inquiry into a social human problem, based on testing a hypothesis or a theory composed of variables, measured with members, and analysis with statistical procedures (Naoum, 1998). Quantitative researchers focus on the relationship between the independent variables and dependant variables (Polit and Hungler, 1999). Quantitative research is an objective measurement of the problem.

In this study, both quantitative and qualitative approaches are used. The questionnaire of this study is designed to get the factual information about local practices of contractors in managing construction materials in building projects as well as the opinions of contractors about these practices.

3.3 Research design

The purpose of this research is to explore the current practices of construction materials management of building projects and develop a computerized materials management system to be used in materials management works.

A structured questionnaire with personal interviews is used together in this research. The structured questionnaire is probably the most widely used data collection technique for conducting surveys. Questionnaires have been widely used for descriptive and analytical surveys in order to find out facts, opinions and views (Naoum, 1998). It enhances confidentially, supports internal and external validity, facilitates analysis, and saves resources. The advantages of interviews as summarized by Naoum (1998) are:

- the response rate is relatively high.
- providing more accurate answers and
- eliminating the tedium and idleness of the responds.

Data collected in a standardized form from samples of population. The standardized form allowed the researcher to carry out statistical inferences on the data, often with the help of computers. Using a questionnaire has some limitations such as: it must contain simple questions, no control over responds and respondents may answer generally (Naoum 1998).

3.4 Limitation of the research

The study is limited to Gaza strip contracting companies that are classified as first, second and third degrees, which have a valid registration in PCU. The subcontractors and contracting companies of fourth and fifth categories were excluded because these companies are too small to have specific arrangements for materials management.

3.5 Data collection and questionnaire design

In this research, few methods of data collection were used including observation, documentations, interviews and questionnaire and documentary analysis.

The good design of the questionnaire is a key to obtain good results and warranting a high rate of return. The questions of the research questionnaire are constructed based on:

- Literature review.

- Several interviews (39 interviews) with contractors to obtain different thoughts, which can be useful for creating questions.
- The experience of the researcher and some engineers in construction management in Gaza strip.

The questionnaire was built mainly using closed questions, and it was divided into five sections as follows:

Section one: company profile, which includes 10 items.

Section tow: Application of construction materials management tools and techniques in construction projects, which includes 17 items

Section three: The effect of closure in Gaza strip on materials availability and cost, which includes 5 items

Section four: Computer applications in materials management systems in construction projects, which includes 11 items

Section five: Implementation of construction materials management systems, which includes 12 items.

The questionnaire was developed in Arabic (Annex 1) to be more understandable by respondents. An English version is prepared (Annex 2) to help in documenting this research.

3.6 Field work research

The problem solving approach accompanied with a field survey was adopted for conducting this research. In the problem-solving approach (also named action research), the researcher reviews the current situation, identifies the problem, gets involved in introducing some changes to improve the situation and, possibly, evaluates the effect of his/her changes. This type of research is more attractive to practitioners, industrialists, and students from the professional background that has identified a problem during the course of work and wish to investigate and propose a change to improve the situation (Naoum 1998).

A questionnaire was designed and constructed to survey the situation and reality of construction materials management practices of Gaza strip contracting companies. The data which is collected by the questionnaire is analyzed and discussed.

Figure 3.1 illustrates the methodology flow chart.

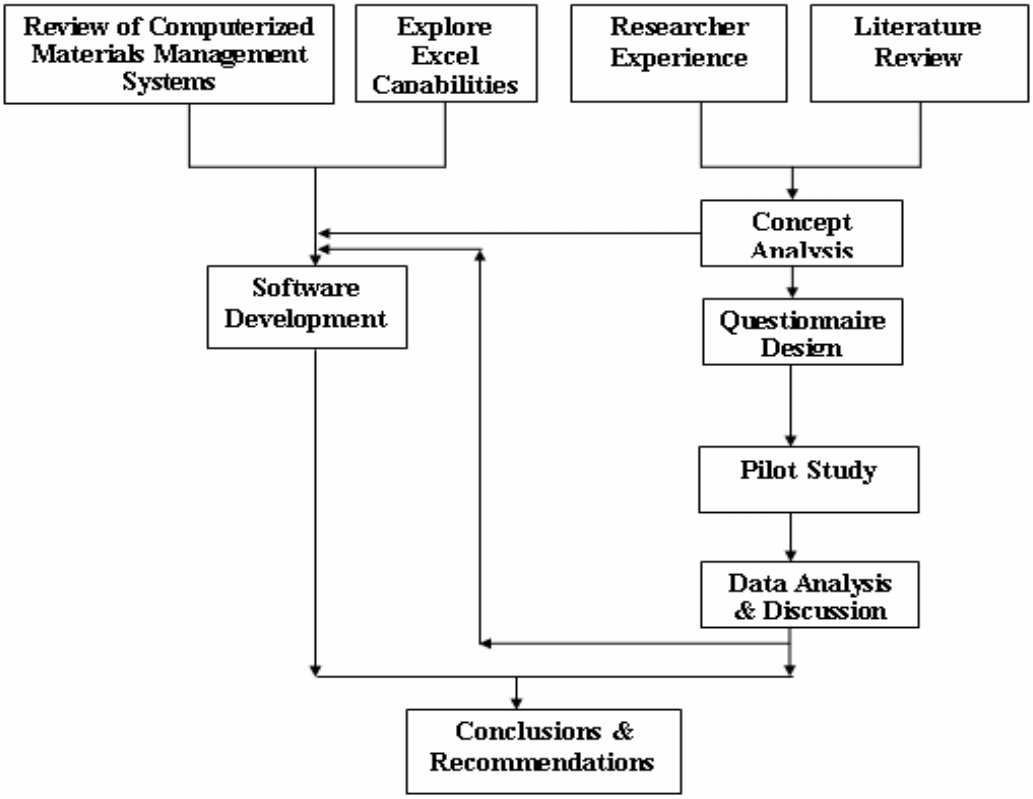


Figure 3.1: Methodology flow chart

3.7 Pilot study

A pilot study provides a trial run for the questionnaire, which involves testing the wording of questions, identifying ambiguous questions, testing the technique that used to collect the data, etc. (Naoum 1998). After the preliminary testing, a pilot study was conducted to evaluate the questionnaire; the researcher distributed the questionnaire to a sample of five different contracting companies to fill them. The purpose of this step is to discover if the questions are well understandable or not, also to find out any problem that may raise in filling the questionnaire. Generally speaking, it appeared that respondents had no difficulty in understanding the items or the instructions to complete the questionnaire.

The validity content of the questionnaire was tested by five contractors. Each of them has full information about the research objectives. Each of them was requested to evaluate validity content for each item based on rating the index of content validity. The contractors were then requested to rate each item based on relevance on the four-point ratings scale. The point scale developed by Yaghmaie (2003) as "1 = not relevant; 2 = item need some revision; 3 = relevant but need minor revision; 4 = very relevant". Based on comments of the contractors some minor changes, modifications, and addition were introduced to the questions.

The relatively of the questionnaire is a major criterion for assessing its quality and adequacy. The value of the reliability coefficient theoretically can range between -1.00 and +1.00. For most purposes, reliability coefficients above 0.7 are considered satisfactory (Polit and Hungler, 1999). Five questionnaires were redistributed. The reliability coefficient was calculated which indicated a high level of reliability. For more accuracy, reliability coefficient was calculated for important parts.

Table 3.1 Reliability coefficient for the questionnaire.

section No.	contents	No. of questions	reliability coefficient
2	Application of construction materials management tools and techniques in construction projects.	43	0.9356
3	The effect of closer in Gaza strip on materials availability and cost.	5	0.7542
4	Computer applications in material management systems in construction projects.	13	0.7327
5	Implementation of construction materials management.	109	0.9626

3.8 Interview

The researcher interviewed 39 contractor company representatives and asked them to fill the questionnaire during the interview. The interview gave to a far extent, accurate and clear answers due to the clarifications which made by the researcher.

Before carrying out the interview, the questionnaire was sent to a company and specific time and date were determined for interview. This provided a chance for the contractors to study the questions before answering them. In the beginning of the interview the researcher introduced himself to the respondent to create a friendly atmosphere, then he thanked the respondent and affirmed that all the data to be collected would be used only for the research and would not be transferred to any other party.

3.9 Population and sample

The studied population includes the contracting companies in Gaza strip who have a contractor's union valid registration in January 2006. As materials management is a somehow sophisticated activity, the researcher addressed his study towards the top contracting companies of the first, second, and third class according to the contracting Union classification. The total number of these companies is 84 companies and they are stratified as follows: the first class has 34 companies; the second class has 21 companies; the third class has 29 companies.

3.10 Data coding and data analysis

The use of computers requires that answers given by the respondents be coded into numbers before the actual data analysis (Weisberg and bowen 1977). The coding process for closed ended questions consists of recording the number of response. The response categories must be mutually exclusive, so no answer can fit more than one of the categories (Weisberg and bowen 1977).

The returned questionnaire was numerically coded to enter the data systematically and efficiently. Data was entered using the statistical package for social sciences (SPSS) software. Double check, manually and by computer, was made to ensure data cleaning.

Statistical analysis for the data was conducted using the SPSS as follows:

- Defining and coding of variables.
- Summarizing the data on raw data sheet.
- Entering data.
- Cleaning data (Double check).

After applying the above-mentioned steps, the descriptive statistic method has been used. The descriptive method is one of analysis method which provides a general overview of results. It gives an idea of what is happening (Naoum 1998). In this study, frequency distribution and percentage were used to describe aspects of data. The researcher uses this method because large amounts of data were gathered. It is often useful to distribute the data into categories and to determine the number of individuals or cases belonging to each category. This is called "category frequency" (Naoum 1998). In this research, the data were presented in forms of tabulation, bar charts, and pie charts.

3.11 Developing and evaluating the computerized system

The researcher has developed a tailored construction materials management software that suits Gaza strip contracting companies. This software was developed depending on survey results, literature review, the experience of the researcher and other experts in construction materials management in Gaza strip, and the relevant computerized packages that the researcher reviewed such as Navon study (2002). He developed and evaluated an automated model for management and control of materials ordering, purchasing, and supply and use. In order to evaluate the model under real conditions,

the model was implemented in a prototype system and used in ongoing construction projects. The software was developed using *Microsoft Excel* platform. This is because contracting companies are familiar with Excel and find it easy to use. To increase the capability and skills of the researcher in Microsoft *Excel* package, he reviewed some books explaining the use of Excel, internet Excel publications, and Excel manual. These skills increased the capability of the researcher to develop the software. The developed software was tested by four contractors asking them to try it on real projects. They were also asked to fill a questionnaire for evaluating the software (See annex 5)

CHAPTER (4)

SYRVEY RESULTS

4.1 Introduction

In this chapter, the results of the field survey are presented and discussed. The chapter illustrates and discusses the characteristics of the study population, application of construction materials management tools and techniques in construction projects, computer applications in material management systems in construction projects, and Implementation of construction materials management systems.

4.2 Study population characteristics

The general characteristics of the study population were investigated. They include the field of work, classification of contractors, number of employees and their qualifications, number of executed projects and their values during the last five years, and the person in-charge-of managing construction materials.

4.2.1 Year of establishment

Table 4.1 shows that only (14.2%) of the contracting companies were established before 1994. (36.9%) of companies were established from 1994 to 1997, while (48.8%) of them were established after 1997. This indicates that most of companies are relatively newly established having less than 13 years of experience.

.

Table 4.1: Year of establishment of contracting companies

Variable		Contractors	
		Frequency	*Percentage%*
Year of establishment	Before 1994	12	14.2
	1994 - 1997	31	36.9
	After 1997	41	48.8

4.2.2 Field of work

Table 4.2 demonstrates that all respondents are involved, in a way or another, in building works, (94.9%) are involved in water and sewerage works, and (95%) are involved in roads works. This show how important is the building construction to the construction industry in Gaza strip.

Table 4.2: Field of company specialization

Company work field		Main	Secondary	Unspecialized
Building work field	*Frequency*	75	6	0
	Percentage%	92.6	7.4	0
Water and sewerage works	*Frequency*	44	30	4
	Percentage%	56.4	38.5	5.1
Roads works	*Frequency*	44	32	4
	Percentage%	55.0	40.0	5.0

4.2.3 Classification of contractors

Table 4.3 illustrates that about half of contractors (43%) are classified as first class in building works. (22.6%) of them are classified in first class in sewage and water works and (19.0%) of the respondents are classified in first class in roads works.

Table 4.3: Degree of classification

Company classification according the contracting union for the following fields		First class	Second class	Third class	Others
Building works	*Frequency*	34	21	29	0
	Percentage%	43.0	26.6	30.4	0.0
Water and sewerage works	*Frequency*	19	20	36	9
	Percentage%	22.6	23.8	42.8	10.7
Roads works	*Frequency*	16	26	35	7
	Percentage%	19.0	30.9	41.7	8.4

4.2.4 Number of employees and their qualifications

From Table 4.4, it has been found that (97.6%) of respondents employ civil engineers, while (76.2%) of them employ architects, (55.9%) of them employ electrical engineers, and (59.5%) of contracting companies employ mechanical engineers.

Table 4.4: Qualification of employees in the contracting companies

Variable	*No.*	*Percentage%*
Civil engineer	82	97.6
Architect	64	76.2
Electrical engineer	47	55.9
Mechanical engineer	50	59.5
other specialist engineer	14	16.5
Technician	75	89.3

Table 4.5 demonstrates that (45.2%) of respondents have 10 employees or less, whilst (3.6%) of contractors have more than 40 employees. The other (51.2%) of contracting companies has from 11 – 40 employees.

Table 4.5: Distribution of respondents' number of employee.

Number of employees	*Frequency*	*Percentage%*
10 and below	38	45.2
11-20	29	34.5
21-30	11	13.1
31-40	3	3.6
More than 40	3	3.6
total	**84**	**100.0**

These results reveal how small the organization size of contracting companies in Gaza strip is generally. This means that most contractors execute their projects mainly using subcontractors. In fact, subcontracting is an essential component of almost any project.

4.2.5 The number and value of executed projects during the last five years

Table 4.6 shows that (42.9%) of contractors executed less than 10 projects during the last five years and only 3 contractors executed more than 40 projects. The majority of contracting companies (53.6%) executed from 20 – 40 projects in the same period.

Table 4.6: Distribution of number of executed projects

Number of executed projects during the last five years	*Frequency*	*Percentage%*
10 and below	36	42.9
11-20	31	36.9
21-30	10	11.9
31-40	4	4.8
More than 40	3	3.6
total	**84**	**100.0**

Table 4.7 shows that (53.5%) of respondents executed projects with a value of less than 3 million dollars, during the last five years. (27.3%) of contracting companies executed projects with a value between 3 and 6 million dollars, and (19%) of contractors executed projects with a value of more than 6 million dollars. This indicates that most of executed projects are of small size.

Table 4.7: Distribution of value of executed projects.

Total amount of executed projects during the last five years (in million dollars)	*Frequency*	*Percentage%*
1.5 and lesser	27	32.1
1.6-3	18	21.4
3.1-4.5	17	20.2
4.6-6	6	7.1
6.1-7.5	6	7.1
More than 7.5	10	11.9
Total	**84**	**100.0**

4.2.6 Distribution of respondent's person in-charge-of managing materials in construction projects

Table 4.8 shows that none of contracting companies has a specific section for managing construction materials. For other companies, the person in-charge-of managing construction materials is the director in (26.2%) of companies and the project manager in (50%) of companies.

Table 4.8: Distribution of respondents' person in charge of managing construction materials

The person in charge of managing construction materials in construction projects	*Frequency*	*Percentage%*
Company Director	22	26.2
Project Manager	42	50
Site Engineer	20	23.8
specific section	0	0.0
Others	0	0.0
Total	**84**	**100.0**

4.3 Application of construction materials management techniques in construction projects

Considering the necessity and degree of using of some techniques in managing materials process in general, Table 4.9 illustrates that (69.5%) of contracting companies believe that updating the database for materials price when change occurs is the most important technique.

The results show general consistency between the necessity and usage degree of establishing database techniques and the necessity and usage degree of corresponding updating database techniques. The results show also consistency between the necessity and usage degree of each of these techniques.

Also Table 4.9 shows that the most important technique in establishing database group is "*creating materials price database*" (72.8%), and the most important technique in updating database group is "*updating the database for materials price when change occur*" (69.5%). It is noticed that the most important tool in establishing database group and updating database group is the tool that related to the prices of materials. This results may referred to the fact that in Gaza strip materials cost has the lion's share of the project cost.

Table 4.9: Technique necessity and usage in managing construction materials

	No.	Techniques	Necessity degree			Usage degree		
			Necessary %	Somehow Necessary %	Unnecessary %	Usually%	Occasionally%	Rarely
Establishing Data base	1	Establishing categorized materials database	61.3	35.0	3.7	50.0	44.4	5.6
	2	Creating local suppliers database.	65.4	32.1	2.5	56.9	40.3	2.8
	3	Creating international suppliers database.	38.5	47.4	14.1	33.8	48.6	17.6
	4	Creating materials price database.	72.8	23.5	3.7	60.3	36.8	2.9
Updating database	5	Updating the database of local suppliers.	60.8	32.9	6.3	57.5	32.9	9.6
	6	Updating the database of international suppliers.	39.2	41.8	19.0	36.0	38.7	25.3
	7	Updating the database for materials price when change occurs.	69.5	22.0	8.5	64.7	29.4	5.9
	8	Using internet for knowing the new materials and their prices.	50.9	35.3	13.8	49.3	29.6	21.1

4.3.1 The necessity, degree of usage, and method of use of some techniques in construction materials management

From the information in Table 4.10, it is clear that most contracting companies (85%) consider that using daily recording for used materials in the project is necessary, (77.8%) of contractors usually use this technique, and (55.6%) of them recording materials by using a form.

Other observation, the relatively least important technique in managing materials is reporting the situation of materials in project's store where (63.3%) of respondents consider it necessary and (56.0%) of them usually use it. This somehow come in line with Al-Ostaz's study (2004) who concluded that (75.6%) of the respondents report the situation of materials in the project's store in managing construction materials in Gaza strip.

The results demonstrate that (21.4%) of companies recording the received materials on site by using a computerized form, but in Al-Ostaz's study (2004), (2.4%) of the companies recording the received materials on site by using a computerized form. In general about half of contracting companies using the techniques shown in table 4.10 by using a form, but Al-Ostaz's study (2004) concluded that less than (10%) of contracting companies using a form to apply some techniques shown in Table 4.10.

Table 4.10: The necessary, degree of usage, and method of use some techniques in construction materials management

No.	Techniques	Necessity degree			Usage degree			Method of use			
		Necessary %	Necessary somehow %	Unnecessary %	Usually %	Occasionally %	Rarely %	By using a computerized form %	Recording by using a form %	Recording without form %	Without recording %
1	Providing a list of materials in project that includes for example (material name, material number unit price).	74.1	22.2	3.7	68.0	24.0	8.0	20.0	50.0	25.7	4.3
2	Daily recording of using materials in the project.	85.0	13.8	1.3	77.8	22.2	0.0	20.8	55.6	22.2	1.4
3	Providing material cards at site store that contain for example (input-output-balance).	68.3	23.2	8.5	52.8	33.3	13.9	17.9	50.7	14.7	16.4
4	Providing materials purchase order including for example (order number-material description-required quantity –price).	76.9	17.9	5.2	60.8	28.4	10.8	21.2	62.1	10.6	6.1
5	Recording the received materials on site, the record shows for example (delivery number-supplier name-material description- quantity).	82.7	16.0	1.3	75.3	23.3	1.4	21.4	58.6	17.1	2.9
6	Reporting the situation of materials in the projects' store, the report shows (supplier name-order number-quantity input-quantity output-balance).	63.3	25.3	11.4	56.0	32.0	12.0	16.9	52.1	18.3	12.7
7	Reporting the problems for examples (wastage and breakage-thief and loss-shortage in delivery).	73.2	24.4	2.4	58.7	36.0	5.3	8.3	51.4	27.8	12.5
8	Following up the prices in the market and recording the variation of prices.	83.1	13.3	3.6	74.7	18.7	6.7	14.3	55.7	20.0	10.0
9	Following up the closure variations in the `market	80.0	8.2	11.8	68.1	23.6	8.3	10.0	50.0	22.9	17.1

4.4 The effect of closure of Gaza strip on materials availability and price

Table 4.11 represents the effect of closure on materials availability and price as expressed by respondents. These results show that all respondents (100%) agree that the closure causes a delay of a project completion. (98.9%) of them agree that the closure has big effect on the prices of basic materials such as cement, aggregate and reinforcement steel. On the other hand, the results show that (54.2%) of contracting companies believe that the closure increase subcontractor rates. The researcher expected all of these results. He was expected, in general, that the closure causes a noticeable increase in the main material prices, an increase of other material prices, a delay of a project completion, and causes an increase of total project cost.

Table 4.11: The effect of closure of Gaza strip on materials availability and price

No.	Factor	Very high degree effect %	High degree effect %	∑ Very high+ High degree%	Mid degree effect %	Little degree effect %	Very little degree effect %
1	The closure causes a noticeable increase in the main material prices specially (cement, aggregate, and steel).	81.0	17.9	98.9	1.2	0.0	0.0
2	The closure causes an increase of other material prices (painting, electrical, sewage material).	51.2	35.7	86.9	8.3	4.8	0.0
3	The closure increases the subcontractors' rates.	28.9	25.3	54.2	12.0	10.8	22.9
4	The closure causes a delay of a project completion.	69.0	31.0	100	0.0	0.0	0.0
5	The closure causes an increase of total project cost.	59.5	35.7	95.2	4.8	0.0	0.0

4.5 Using software for supporting the construction materials management

Table 4.12 shows that (28.6%) of the respondents do not use computer applications in material management systems in construction projects and (61.9%) use spreadsheet-based software like (Ms Excel) because it is a familiar application for all construction companies. On the other hand (9.5%) of them Use specialized software and this is somehow strange as the researcher did not get any evidence from interviewees of these software that they claimed they had used.

Table 4.12: Using software for supporting the construction materials management

Using software for supporting the construction materials management	*Frequency*	*Percentage%*
Not use	24	28.6
Use spreadsheet-based software (Ms Excel)	52	61.9
Use specialized software.	8	9.5
total	84	100.0

4.5.1 Respondent's efficiency of using popular computer software

Table 4.13 shows the respondents efficiency of using popular computer software. These results illustrate that most of respondents (93.9%) have very good capabilities in using MS-Excel spreadsheets, where (60.3%) of contractors have very good in using Ms-Project. Only (24.1%) of them have the same capabilities in using Ms-Access. The distinguished place of Excel may refer to its advantages, which are stated by christofferson (1999) as the following:

- It is easy to use.
- It can be customized to the company style of doing business.
- It is powerful.

Table 4.13: Efficiency of respondents in using popular computer software

No.	software	V. Good %	Good %	Acceptable %	Low %	V. Low %
1	Excel	93.9	4.9	1.2	0.0	0.0
2	Word	91.6	7.2	1.2	0.0	0.0
4	Ms-Project	60.3	30.8	0.000	0.0	9.0
3	Access	24.1	17.7	12.7	11.4	34.2

4.5.2 Obstacles that are facing the local companies in using a construction materials management software

Table 4.14 represents the obstacles, which are facing the contractors in using construction materials management software. These results show that the majority of respondents (80%) consider absence of understanding of construction materials management software is the most important obstacle that affects the using of computerized materials management packages. (79.2%) of the respondents think that non-realization of importance of construction materials management system by the contractor has big effect on using computerized materials management packages. Another observation noted from Table 4.14, (49.5%) of the contractors believe that implementing the system wastes the time of project supervisors. The researcher notices that the most important obstacles are the technical ones (obstacle Nos. 1, 2, 3, 4, and 5), while the least important obstacles are the cost related obstacles (obstacle Nos. 7 and 8).

The importance of technical obstacles has been supported by Navon study (2002); he concluded that the main reason for non-using computer in materials management is the lack of suitable software for managing construction materials.

Table 4.14: The obstacles which are facing contractors in using construction materials management systems .

No.	Obstacle	Very high degree effect %	High degree effect %	∑ Very high+ High degree%	Mid degree effect %	Little degree effect %	Very little degree effect %
1	Non- realization of importance of construction materials management system by the contractor.	32.9	55.3	79.2	4.7	7.1	0.0
2	Absence of understanding of construction materials management system.	25.9	54.1	80.0	16.5	3.5	0.0
3	Inability implementation of the system.	23.8	53.8	77.6	8.1	14.3	8.3
4	Shortage of user friendly of construction materials management system.	27.1	36.5	63.6	20.0	15.3	1.2
5	Shortage of qualified persons in using a construction materials management system.	44.7	32.9	77.6	15.3	7.1	0.0
6	Simplicity of manual managing a construction material.	24.1	34.9	62.0	28.9	7.2	4.8
7	The high cost of a construction materials management system.	25.0	32.1	57.1	17.9	16.7	8.3
8	The thinking that implementing the system wastes the time of project supervisors.	22.4	27.1	49.5	23.5	17.6	9.4

4.5.3 Contractors` opinions regarding willingness to get materials management packages

In general, most of contractors surveyed (87%) are willing to get and use user friendly and low cost construction materials management software in managing materials. Table 4.15 shows that (70.2%) and (16.8%) of contractors surveyed are strongly agree and agree, respectively, to get and use a user friendly and inexpensive construction materials management software in managing construction materials.

Table 4.15: Contractors` willingness to get materials management packages.

I am ready to get and use user friendly and inexpensive cost construction material management system	*Frequency*	*Percentage%*
strongly agree	59	70.2
Agree	14	16.8
Neutral	5	5.90
Disagree	1	1.2
strongly disagree	5	5.9
total	84	100.0

4.6 Implementation of construction materials management systems

Implementation of construction materials management systems on construction projects provides the contracting company with many benefits and it can solve many problems that may face the contracting company.

4.6.1 Benefits of implementation of materials management on construction projects

Table 4.16 outlines the benefits of construction materials management systems according to contractors' opinions. The most important benefits are listed below:

- Materials are timely available on site with the right quantity (95.3%).
- Reducing duplication of materials orders (90.5%).
- Improving cash flow (86.6%).
- Complying to time schedule (85.1%).

On the other hand the benefits, which have lesser effect, are:

- Better relationships with suppliers (66.5%).
- Complying to enhancement of quality control. (74.7%).
- Reducing the space for materials on site (74.7%)

Table 4.16: Benefits of implementation of materials management software on construction projects

No.	Benefit	Very high degree effect %	High degree effect %	∑ Very high+ High degree%	Mid degree effect %	Little degree effect %	Very little degree effect %
1	Reducing the costs of project materials.	40.0	38.8	78.5	17.6	3.5	0.0
2	Better handling of materials.	40.5	40.5	81	17.9	0.0	1.2
3	Reducing duplication of materials orders.	41.7	48.8	90.5	8.3	1.2	0.0
4	Materials are timely available on site with the right quantity.	54.8	40.5	95.3	4.7	0.0	0.0
5	Improving labour productivity.	37.3	47.0	84.3	10.8	3.6	1.2
6	Complying to time schedule.	44.4	40.7	85.1	14.8	0.0	0.0
7	Complying to enhancement of quality control.	28.9	45.8	74.7	21.7	3.6	0.0
8	Improving follow up and monitoring of construction materials.	31.0	44.0	75	23.8	1.2	0.0
9	Better relationships with suppliers.	32.5	33.7	66.5	31.3	2.4	0.0
10	Waste reduction.	42.7	35.4	78.1	19.5	2.4	0.0
11	Reducing the space for materials on site.	32.5	42.2	74.7	19.3	6.0	0.0
12	Obtaining better price for the construction materials.	44.0	33.3	77..3	19.0	2.4	1.2
13	Improving cash flow.	50.0	36.6	86.6	8.5	3.7	1.2

4.6.2 Importance of materials management systems to solve some problems

Table 4.17 lists the contractors` opinion about the extent of effect of implementing materials management system to reduce material problems on construction site. The results show that the majority of contracting companies believe that its important to implement a construction materials management system to overcome most of material management problems. The results also show that the problems which have more conscious on its importance are "*Materials are not available with required quantity*" (92.9%), " *Slow response from the consultant engineer about submittals*" (91.5%), and " *Materials are not available*" (90.6%)

Table 4.17: The importance of implementing a materials management system

No.	Problem	Very important %	Important %	∑ Very important+ Important %	No difference%	Absolutely not important %	Absolutely never Important %
1	Materials are not available.	43.5	47.1	90.6	3.5	3.5	2.4
2	Materials are not available with required quantity.	35.3	57.6	92.9	5.9	0.0	1.2
3	Late delivery to the site.	38.8	49.4	88.2	11.8	0.0	0.0
4	Slow response from the consultant engineer about submittals.	32.5	59.0	91.5	8.4	0.0	0.0
5	Deliver wrong materials.	42.2	47.0	89.2	9.6	1.2	0.0
6	Deliver materials with wrong dimensions.	31.0	52.4	83.4	14.3	2.4	0.0
7	Deliver materials with wrong quantities.	38.1	47.6	85.7	13.1	1.2	0.0
8	Increase materials quantity in storages.	36.5	51.8	88.3	7.1	4.7	0.0
9	Burglary, theft and vandalism	39.3	44.0	83.3	14.3	2.4	0.0
10	Destroyed materials when deliver.	33.3	50.0	83.3	14.3	1.2	1.2

4.6.3 The responsibility of ordering construction materials

Table 4.18 shows that (30.9%) of the respondents have the company manager responsible for ordering materials, and (48.8%) of them have the site engineer responsible for this duty. Another observation noted from Table 4.18, none of contracting companies has a specific section for ordering materials process.

Table 4.18: The responsible about ordering construction materials

The person who responsible about Ordering materials	*Frequency*	*Percentage%*
Company manager	26	30.9
site engineer	41	48.8
procurement department	17	20.2
Persons worked in a specific section	0	0

4.6.4 The techniques used for ordering materials from suppliers

From Table 4.19, it has been found that most of contractors (97.7%) use the telephone for ordering materials from suppliers, (92.9%) of them prefer to use the fax for ordering materials, while (47%) of respondents use the E-Mail, and (44.7%) of them use internet for ordering materials from suppliers. It is noticed that the telephone is the most important tool for ordering materials. This result may refer to the fact that in

Gaza strip construction materials are ordered from local suppliers. It is noticed that the modern techniques for ordering materials such as websites are not use in Gaza strip.

Table 4.19: Techniques for ordering construction materials from suppliers.

No.	Technique	Very important %	Important %	∑ Very important+ important %	I don't know	Not important %	Not Important at all %
1	Internet.	11.8	32.9	44.7	10.6	35.3	9.4
2	E-mail.	12.9	34.1	47	8.2	38.8	5.9
3	Fax.	55.3	37.6	92.9	4.7	2.4	0.0
4	Telephone.	71.8	25.9	97.7	2.3	0.0	0.0
5	Personal meeting.	54.1	31.8	85.9	4.7	4.7	4.7

4.6.5 Available covered and open storages

As illustrated in Table 4.20, most of respondents (52.4%) have an area of 200m2 and below of covered storages, and (53.6%) of the contractors have an area of 1,000 m2 and below of opened storages. It is noted that none of the contractors have an area more than 2,000 m2 of covered storages, and only one of them have an area more than 10,000 m2 of opened storages.

Table 4.20: Available covered and open storages.

Available area of covered storages	*Frequency*	*Percentage%*	Available area of opened storages	*Frequency*	*Percentage%*
200m2and below	44	52.4	1,000m2and below	45	53.6
201-500m2	26	30.9	1,001-3,000 m2	22	26.2
501-1,000m2	9	10.7	3,001-6,000 m2	13	15.5
1,001-2,000m2	5	6	6,001-10,000 m2	3	3.6
more than 2,000m2	0	0	more than 10,000m2	1	1.1
total	84	100	total	84	100

4.6.6 Materials that are stored in the company's storages

Table 4.21 shows how often the construction materials are stored in the contractor's storages. The most important materials that often stored in the contractor's storages are (shuttering timber, cement, sanitary materials, electrical materials, and pipes). On the other hand, materials that are rarely stored in the contractor's storages are (curbstone, stone, blocks, terrazzo tiles, and sand)

Table 4.21: How often contracting companies store construction materials

No.	Material	Always %	Often %	∑ Always+ Often%	Sometimes %	Seldom %	Never %	∑ Seldom+ Never %
1	Reinforcement steel.	6.0	14.3	20.3	39.3	27.4	13.1	40.5
2	Shuttering timber.	28.6	13.1	41.7	20.2	33.3	4.8	38.1
3	Cement.	11.9	22.6	34.5	23.8	35.7	6.0	41.7
4	Sand.	7.1	4.8	11.9	29.8	35.7	22.6	58.3
5	Aggregate.	4.9	4.9	9.8	42.7	35.4	12.2	47.6
6	Blocks.	4.8	3.6	8.4	27.7	44.6	19.3	63.9
7	Tiles.	4.8	7.1	11.9	29.8	48.8	9.5	58.3
8	Painting.	8.4	3.6	12	31.3	44.6	12.0	56.6
9	Stone.	6.1	4.9	11	22.0	35.4	31.7	67.1
10	Pipes.	13.1	11.9	25	31.0	32.1	11.9	44.0
11	Terrazzo tiles.	1.2	6.0	7.2	32.1	39.3	21.4	60.7
12	Curb stone.	0.0	6.0	6.0	26.2	46.4	21.4	67.8
13	Base course.	3.6	19.0	22.6	23.8	36.9	16.7	53.6
14	Electrical materials.	11.9	19.0	30.9	28.6	31.0	9.5	40.5
15	Sanitary materials.	14.3	16.7	31	33.3	28.6	7.1	35.7

4.6.7 The importance of some factors in qualifying suppliers

Table 4.22 shows that (98.8%) of the respondents believe that *"price competitiveness"* is the main important factor in qualifying suppliers, and the least important factor is *"having many branches in different geographical areas"*.

Table 4.22: The factors which are affecting qualifying suppliers.

No.	Factor	Very high degree effect %	High degree effect %	∑ Very high+ High degree%	Mid degree effect %	Little degree effect %	Very little degree effect %
1	Price competitiveness.	57.6	41.2	98.8	0.0	1.2	0.0
2	Short period to deliver materials to the contractor	56.5	41.2	97.7	2.4	0.0	0.0
3	Quality of materials	45.9	50.6	96.5	2.4	1.2	0.0
4	Increase payment period	60.0	31.8	91.8	3.5	4.7	0.0
5	The capability of supplier in the market	61.2	29.4	90.6	5.9	3.5	0.0
6	Having many branches in different geographical areas.	46.4	35.7	82.1	6.0	8.3	3.6

4.6.8 Frequency of contractor problems at qualifying suppliers

Table 4.23 shows that the most frequent problems that are facing contractors in the process of qualifying suppliers are the prevailing political condition, the sole supplier and lack of penalty measures against defaulted suppliers, respectively.

From the information in Table 4.23, it has been found that only (1.1%) of the contracting companies never face the problems shown in Table 4.23.

Table 4.23: Problems which are facing the companies when qualifying suppliers.

No.	problem	Always %	Often %	Sometimes %	Seldom %	Never %
1	Sole supplier.	29.8	50.0	15.5	4.8	0.0
2	Lack of required information about suppliers.	13.4	62.2	17.1	7.3	0.0
3	Wrong information about suppliers.	16.7	39.3	36.9	6.0	1.1
4	Lack of penalty measures against defaulted suppliers.	31.0	41.7	22.6	4.8	0.0
5	Inability to enforce contract condition on suppliers.	28.6	41.7	17.9	11.9	0.0
6	Prevailing political conditions.	54.8	36.9	8.3	0.0	0.0

4.6.9 The importance of knowing waste percentage for different building materials

As Table 4.24 indicates, most contractors think that knowing waste for different building materials helps them to determine the exact quantities required for a project, to price tenders more accurately and to prepare accurate bill of quantities

Table 4.24: The importance of knowing materials waste percentage.

No.	Importance	Strongly agree %	Agree %	∑ Strongly agree+ Agree %	Neutral %	Disagree %	Strongly disagree %
1	Help to determine the exact required quantities.	50.0	47.6	97.6	2.4	0.0	0.0
2	Increase the chance for obtaining the project finance.	22.6	52.4	75	19.0	6.0	0.0
3	Help for preparing accurate bill of quantities.	38.1	59.5	97.6	2.4	0.0	0.0
4	Help contractors to price tenders more accurately.	50.0	44.0	94	6.0	0.0	0.0
5	Help the contractor to have a better chance to win the tender.	39.3	47.6	86.9	8.63	3.6	1.2
6	Knowing the real requirements for the project (materials-time-	34.5	51.2	85.7	13.1	1.2	0.0

No.	Importance	Strongly agree %	Agree %	∑ Strongly agree+ Agree %	Neutral %	Disagree %	Strongly disagree %
	cost)						
7	Help to finish the project successfully and have profits.	40.5	51.2	91.7	7.1	1.2	0.0
8	Help in preparing a good schedule program including project resources.	33.7	44.6	78.3	15.7	6.0	0.0
9	Help contractor to prepare a good materials schedule program.	34.5	45.2	79.7	14.3	6.0	0.0

4.6.10 Material waste on site

In this section, the researcher divides the factors that are causing increase in material waste on construction site into five groups. They are: on site practice; material handling; transportation; site management and supervision on site. The total numbers of factors are 35 factors.

a. On site practice

Table 4.25 represents the factors related to on site practice which cause increase waste on construction site. The results show that the majority of contracting companies believe that most of the factors, which are shown in Table 4.25, cause waste increase on construction site. They believe that the factors which have bigger effect on causing waste increase on construction site are poor quality of materials (89.1%), materials damage on site (88.2), and improper cutting of materials (84.7%).

On the other hand, the factor which they believe has the lowest effect on causing waste increase on construction site, is the existence of unnecessary materials on site (64.3%). This comes in line with Al-Mogany study (2006), who concluded that more than 80% of contractors consider that which factors causes waste on construction sites.

Table 4.25: Factors that increase waste on the construction site (Group a)

	No.	Factors causes increase waste on site	Very high degree effect %	High degree effect %	∑ Very high degree effect + High degree effect %	Mid degree effect %	Little degree effect %	Very little degree effect %
(A): On site practice	1	Materials damage on site.	50.6	37.6	88.2	10.6	0.0	1.2
	2	Improper cutting of materials.	40.0	44.7	84.7	15.3	0.0	0.0
	3	Existence of unnecessary materials on site.	23.8	40.5	64.3	28.6	6.0	1.1
	4	Overproduction/Production of a quantity greater than required or earlier than necessary.	23.5	45.9	69.4	18.8	9.4	2.4
	5	Manufacturing defects.	29.8	48.8	78.6	16.7	4.8	0.0
	6	Burglary, theft and vandalism.	36.9	46.4	83.3	14.3	0.0	2.4
	7	Poor quality of materials.	38.1	51.2	89.3	9.5	0.0	1.2
	8	Lack of materials (due to closure).	49.4	32.5	81.9	3.6	7.2	7.2
	9	Lack of on site materials control.	41.7	34.5	76.2	19.0	4.8	0.0
	10	Poor storage of materials.	37.3	42.2	79.5	20.3	0.0	0.0
	11	Over sizing structural elements during execution.	29.8	44.0	73.8	20.2	3.6	2.4
	12	Using excessive quantities of materials.	30.6	40.0	70.6	21.2	8.2	0.0

b. Materials handling

Table 4.26 represents the factors related to materials handling group which cause material waste increase on construction site. (75.8%) of the contracting companies think that *"duplication of transporting material on site"* causes waste increase, (69.1%) of them believe that "*insufficient instructions about handling materials on site"* causes waste increase, and (67.2%) of the respondents believe that *"improper handling of materials on site"* causes waste increase**.**

Table 4.26: Factors that increase waste on the construction site (Group b)

	No.	Factors causes waste increase on site	Very high degree effect %	High degree effect %	∑ Very high degree effect + High degree effect %	Mid degree effect %	Little degree effect %	Very little degree effect %
(B):Materials handling:	13	Improper handling of materials on site.	32.1	35.1	67.2	29.8	2.4	0.0
	14	Duplication of transporting material on site.	30.5	45.1	75.8	18.3	6.1	0.0
	15	Insufficient instructions about handling materials on site.	26.2	42.9	69.1	23.8	7.1	0.0

c. Material transportation

Table 4.27 represents the factors related to transportation group which cause material waste increase on construction site. (81.2%) of the contracting companies believe that *"improper material transportation"* causes waste increase, and (69.5%) of them think that "*storing materials in far away stores"* causes waste increase.

Table 4.27: Factors that increase waste on the construction site(Group c)

	No.	Factors causes increase waste on site	Very high degree effect %	High degree effect %	∑ Very high degree effect + High degree effect %	Mid degree effect %	Little degree effect %	Very little degree effect %
(C): Transportation	16	Improper materials.	36.5	44.7	81.2	16.5	2.4	0.0
	17	storing materials in far away stores	22.4	47.1	69.5	24.7	5.9	0.0

d. Site management

Table 4.28 represents the factors related to Site management which cause waste increase on construction site. The results show that the majority of contracting companies believe that the factors which have bigger effect on causing material waste increase on construction site are "L*ack of material and time waste management plan*" (83.8%), "*Ineffective control of the project progress by the contractor*" (80%), and "*delay in project commencement*" (79.7%). On the other hand, the factors, which have lower effect on causing waste increase on construction site, are "*providing project team with insufficient information*" (64.7%), "*poor site layout*" (70.6%), and "*lack of a quality management system*" (71.5%).

Table 4.28: Factors that increase waste on the construction site (Group d)

	No.	Factors causes increase waste on site	Very high degree effect %	High degree effect %	∑ Very high degree effect + High degree effect %	Mid degree effect %	Little degree effect %	Very little degree effect %
(D): Site management	18	Lack of material and time waste management plan.	31.8	52.9	83.8	14.1	2.1	0.0
	19	Lack of a quality management system aimed at waste minimization.	17.9	53.6	71.5	26.2	2.4	0.0
	20	Poor site layout.	31.8	38.8	70.6	24.7	4.7	0.0
	21	Poor qualification of the contractor's technical staff assigned to the project.	34.1	42.4	76.5	22.4	1.2	0.0
	22	Providing project team with insufficient information.	22.4	42.3	64.7	32.9	2.4	0.0
	23	Ineffective control of the project progress by the contractor.	36.5	43.5	80	18.8	0.0	1.2
	24	Shortage of technical professionals in the contractor's organization.	31.0	44	75	23.8	0.0	1.2
	25	contractors slowness in taking decisions.	27.4	48.8	76.2	20.2	2.4	1.2
	26	Delay in project commencement.	39.3	40.4	79.7	15.5	2.4	2.4

e. Site supervision

Table 4.29 represents the factors related to site supervision group, which causes material waste increase on construction site. The results show that the majority of contracting companies believe all factors shown in Table 4.29, have a high degree effect on waste increase on construction site. This result shows the adversely relationship between the contractor and the consultant.

Table 4.29: Factors that increase waste on the construction site (Group e)

	No.	Factors causes increase waste on site	Very high degree effect %	High degree effect %	∑ Very high degree effect + High degree effect %	Mid degree effect %	Little degree effect %	Very little degree effect %
(E): Site supervisor:	27	Poor control of supervision and delay in giving instructions.	50.6	32.9	83.5	15.3	1.2	0.0
	28	Poor qualification of consultant engineer's staff assigned to the project.	56.5	24.7	81.2	17.6	1.2	0.0
	29	Slow response from the consultant team to contractor inquiries.	51.2	33.3	84.5	13.1	1.2	1.2
	30	Delay in performing inspection and testing by the consultant team.	54.5	29.9	84.4	13.0	2.6	0.0
	31	Poor coordination and communication among the consultant, the owner and the contractor.	47.1	37.6	84.7	9.4	5.9	0.0
	32	Owner's delay in handing over the site to the contractor.	34.1	48.2	82.3	10.6	4.7	2.4
	33	Suspension of work by the owner.	43.5	36.5	80	14.1	3.5	2.4
	34	Change orders.	41.2	45.8	87	11.8	0.0	1.2
	35	Poor cooperation of the owner towards settling contractors payments and claims	48.2	36.5	84.7	14.1	0.0	1.2

4.7 Conclusions

From the results obtained, analyzed, and discussed, the researcher concludes that:

- The contracting companies in Gaza strip are:
  - Relatively newly established.
  - Involved mainly in building works.
  - Small size organizations.
  - Depending heavily on subcontractors.
- Most contractors are interested in using some techniques in construction materials management such as:
  - Providing a list of materials in project that includes for example (material name, material number unit price).
  - Daily recording of using materials in the project.
  - Providing material cards at site store that contain for example (input-output-balance).
  - Reporting the situation of materials in the projects' store, the report shows (supplier name-order number-quantity input-quantity output-balance).
  - Following up the prices in the market and recording the variation of prices.
- The Israeli closure has big effect on materials availability and cost.
- Some obstacles that face the contractors in using computerized materials management systems are:
  - Non- realization of importance of construction materials management system by the contractor.
  - Absence of understanding of construction materials management system.
  - Inability of implementing of the system.
  - Shortage of user friendly of construction materials management system.
  - The high cost of a construction materials management system.
  - The belief that implementing the system wastes the time of project supervisors.
- Many benefits can be obtained from using a user friendly and inexpensive computerized materials management systems such as:
  - Improving cash flow.
  - Reduce duplication of materials order .
  - Materials are on site with required time and quantity.
  - Complying with time schedule.

- Complying with enhancement of quality control.
- Reduce the space for materials on site.

- Many problems can be reduced when contractors implement construction materials management systems such as:
  - Materials not available.
  - Materials not available with required quantity.
  - Late delivery to the site.
  - Deliver wrong materials
  - Slow response from the consultant engineer about submittals.
  - Destroyed materials when deliver.
- Many benefits can be obtained from knowing waste percentage for different building materials such as:
  - Help to determine the exact required quantities.
  - Help for preparing accurate bill of quantities.
  - Help contractors to price tenders more accurately.
  - Help to finish the project successfully and have profits.
- There are many factors that cause increase to material waste on site they can be categorized as the following:

a. On site practice
   - Poor quality of materials.
   - Materials damage on site.
   - Improper cutting of materials.
   - Burglary, theft and vandalism.
   - Lack of materials (due to closure).

b. Materials handling
   - Duplication of transporting material on site.
   - Insufficient instructions about handling materials on site.
   - Improper handling of materials on site.

c. Material transportation
   - Improper materials.
   - storing materials in far away stores

d. Site management
   - Lack of material and time waste management plan.
   - Ineffective control of the project progress by the contractor.

- Delay in project commencement.
- Poor qualification of the contractor's technical staff assigned to the project

e. Site supervision

- Change orders.
- Poor cooperation of the owner in settling contractors payments and claims.
- Slow response from the consultant team to contractor inquiries.
- Delay in performing inspection and testing by the consultant team.

CHAPTER 5

Construction Materials Management Software (CMMS)

5.1 Introduction

This Chapter presents the computerized system which the researcher developed to help the Gaze strip contractors to improve their practice in construction materials management. The author named this software Construction Materials Management Software (CMMS). It also discusses the general concepts on which the development of software was based. The chapter describes the software components, and the method of use. The software evaluation and limitations are also discussed.

5.2 Concepts

The researcher reviewed the current situation of construction materials management in Gaza strip by interviewing eighty-four contractors. He found out that the construction materials management practices are generally inadequate and in the first stages. In addition, he concluded that construction materials management practices are not done in a systematic way. The researcher aims, by introducing CMMS, at improving the common practices of local contractors.

Ahuja et al. (1994) summarize the criteria for selection a software system as follows:

1. The software must be relatively easy to install and operate. The input data must be easy to prepare, and the output reports must be understandable.
2. Data sorting is one of the base uses of computers.
3. It must be a fully tested system and should have a proven record.
4. The program should be flexible and have capacity for handling many types of application.
5. The database must contain all the necessary elements so it can be managed to generate the desired information reports.
6. The program should be compatible with other programs and systems in use in the company.
7. The system must be economical in terms of installation, operation, and maintenance.

The author tries his best to accommodate, as much as possible, the above mentioned criteria in development of CMMS.

5.2.1 Computerized system

Figure 5.1 illustrates a schematic diagram for CMMS. The software consists of four parts. Part one (input data and basic calculations), part two (materials purchase decisions), part three (materials cards), and part four (waste control).

They are detailed as follows:

Part 1 (Input data and basic calculations): The input data and basic calculations can be classified into company and project information; materials pool; activity pool; project activities; activities materials quantities; materials needed; "2 dates materials to order"; materials spaces and cash requirements; earned value calculations and earned value S-curve.

Part 2 (Materials purchase decisions): The materials purchase decisions can be classified into lead time for delivery and ordering; "materials must be purchased at"; materials spaces at (purchase order) P.O. date; materials prices at P.O. date; cumulative prices and spaces; "purchase order and materials must be on the site at".

Part 3 (Materials card): It has one sheet called materials card.

Part 4 (waste control): It has one sheet called waste control.

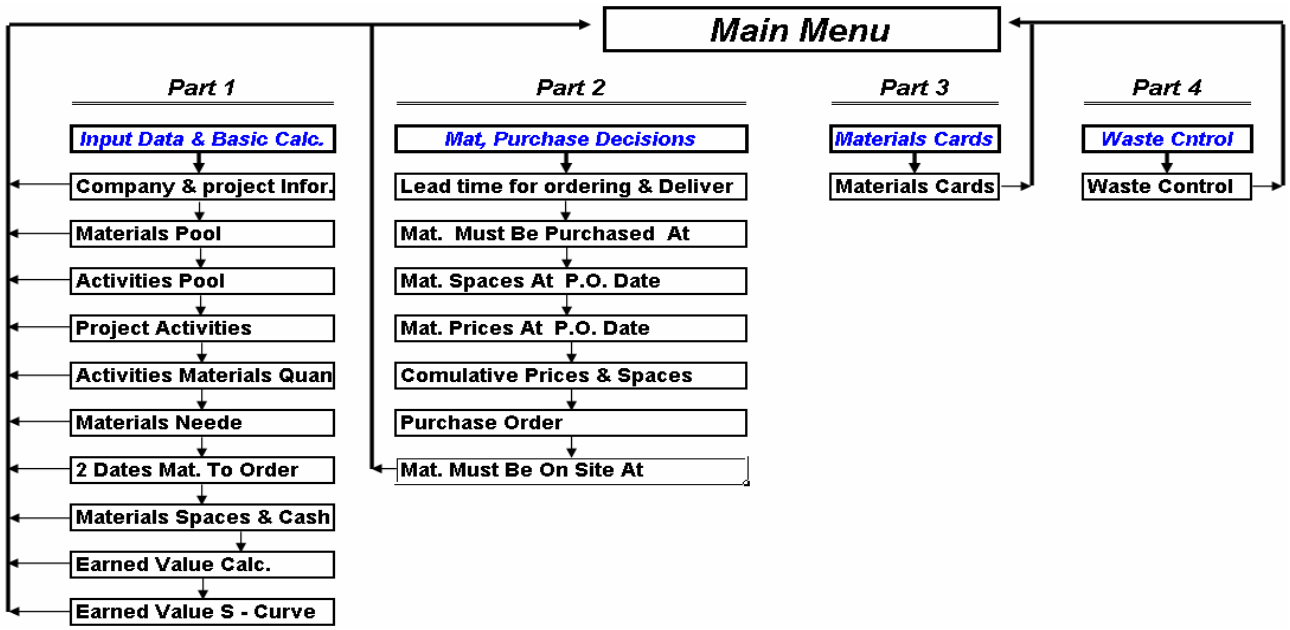


Figure 5.1: Construction Materials Management System (CMMS)

5.2.2 Excel environment

The software is built within Excel environment. It includes spreadsheets processed by number of functions which automate repetitive steps. Spreadsheets have many advantages such as:

- They are versatile.

- They are inexpensive.
- They are easy to use.
- They can customize to your style of doing business.
- They are powerful.
- They provide a clear and complete picture of inputs and outputs (Christofferson 1999).

The field survey illustrated that most companies use Excel more than other programs such as MS word, MS project, and Access. For this reason and for the previous mentioned advantages, the researcher has chosen Excel environment for developing CMMS. This will make the user more comfortable and confident in using CMMS.

5.3 Software description and components

CMMS basically consists of number of spreadsheets processed by functions. Template sheets with embedded formulas are also utilized to make CMMS more user friendly. The following is a general description of CMMS components:

5.3.1 Start sheet

Figure 5.2 illustrates the start sheet. It provides a summarized identification of the software. The user can open the main menu sheet by clicking on "*Enter" icon* of the bottom at this sheet.

Figure 5.2: Start sheet

5.3.2 Main menu

This sheet contains many icons which represent the sheets and components of the software. By clicking on any icon, the sheet related to this icon opens automatically. The basic topics of the main menu are:

- Part 1 (Input data and basic calculations).
- Part 2 (Materials purchase decision).
- Part 3 (Material card).
- Part 4 (Waste control).
- Help and method of use.

The followings are more detailed description of these icons of the menu:

5.3.2.1 Part one (Input data and basic calculations)

It includes basic input data about the company and the project, activities pool, materials pool, project activates, activities materials quantities, materials needed, "2 dates materials to order", materials spaces and cash requirements, earned value S-curve calculations, and earned value S-curve diagram. Basic input data can be either directly entered or electronically transferred, especially the project activities sheet, which can be transferred from the *Microsoft project.* The followings are details of the basic input data and calculations sheets:

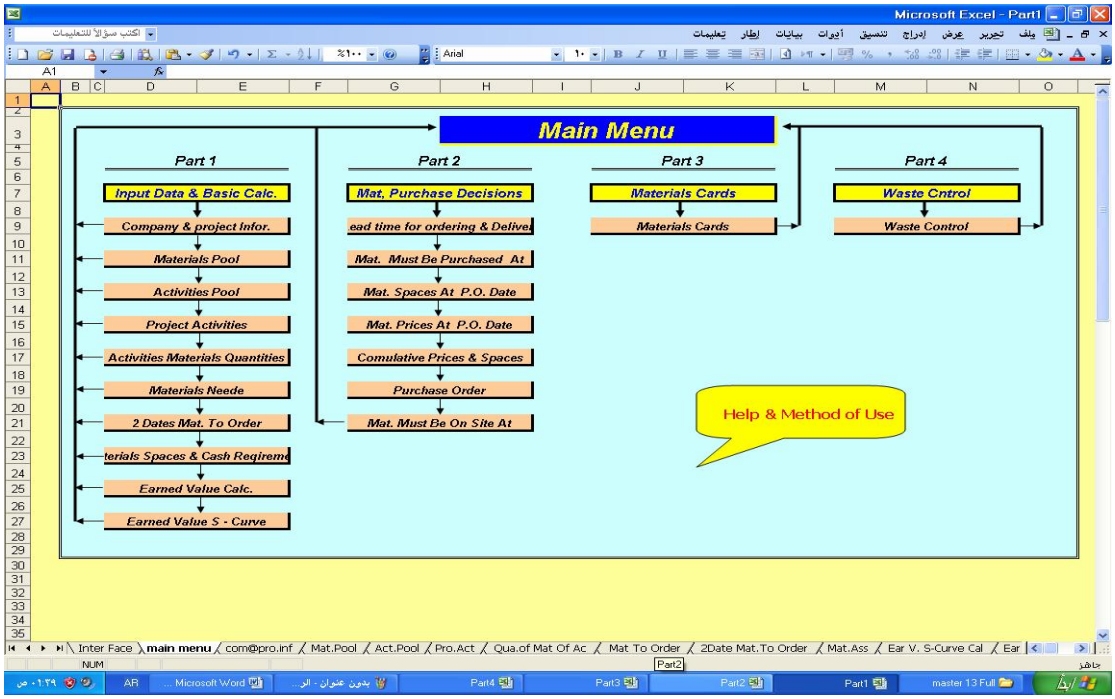


Figure 5.3: "Main Menu" sheet.

A. "Company and project information" sheet

"Company and project information" sheet involves data about the company like the company name, address, city, phone number, location, and fax number. It also includes data about the project like the project name, number, location, total cost, start date, and finish date. This sheet can be opened by clicking on the company and project information icon in the main menu. The data of the company and project can be entered by typing or electronic transmission. Once this is entered it automatically appears on the other sheets. The user can turn back to the main menu by clicking on *"Back to Main Menu*" icon at the bottom of this sheet. Figure 5.4 illustrates the company and project information sheet.

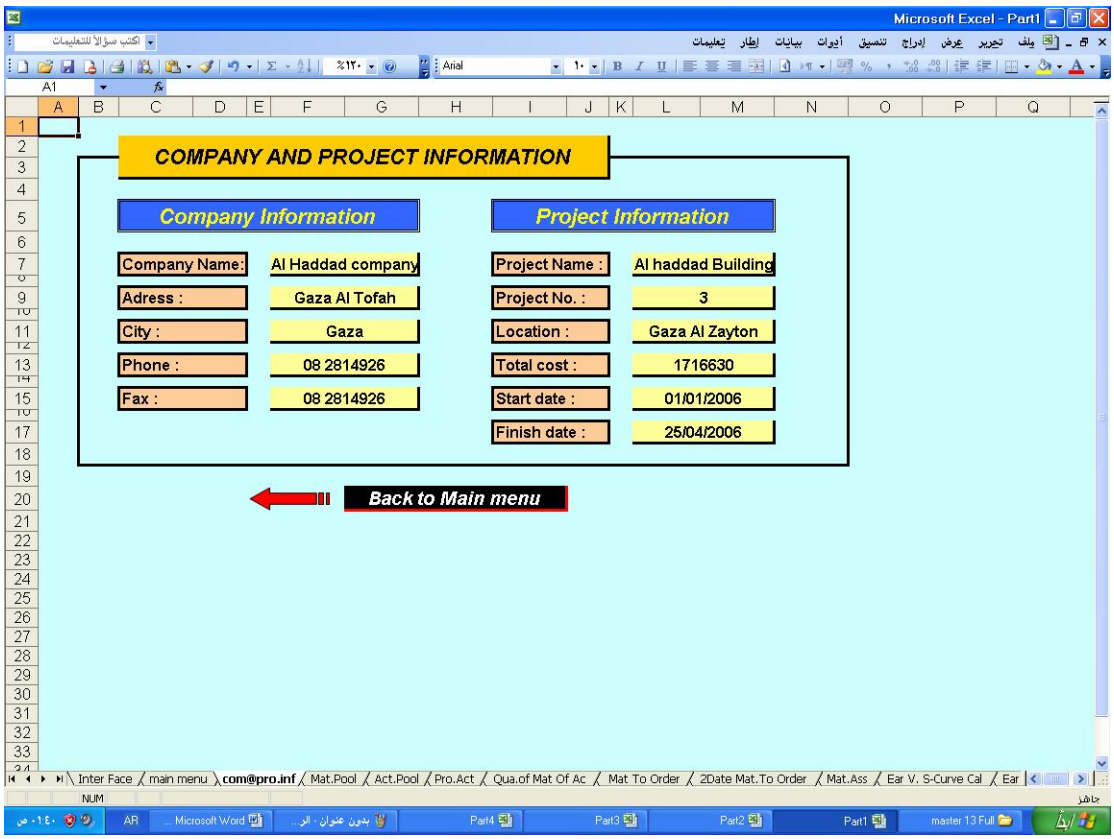


Figure 5.4: "Company and project information" sheet

B. "Activity pool" sheet

"Activity pool" sheet can be opened by clicking on the activities pool icon in the main menu. This sheet includes data about activity description, activity unit; activity pool code, materials name and its quantity, which is required for achieving one unit of an activity. These materials and quantities are entered for one time for all building projects. An activity code has four digits, the first two digits are reserved to main

work type classification, the researcher assigned for example 01 for general works, 02 for earth works, 03 for concrete works, 04 for block works, 05 for plaster works, 06 for tiling works, 07 for painting works, 08 for carpentry works, 09 for metal and aluminum works, 10 for electrical works, 11 for mechanical works, 12 for isolation works, 13 for special works and 14 for finishing works. The other two digits is reserved to different work types such as building blocks works 10, 15 and 20 cm thick. The materials and its quantities which are used for one unit of activity are transferred into project activates sheet automatically and these quantities are multiplied by total quantities of each activity. (See annex 4)

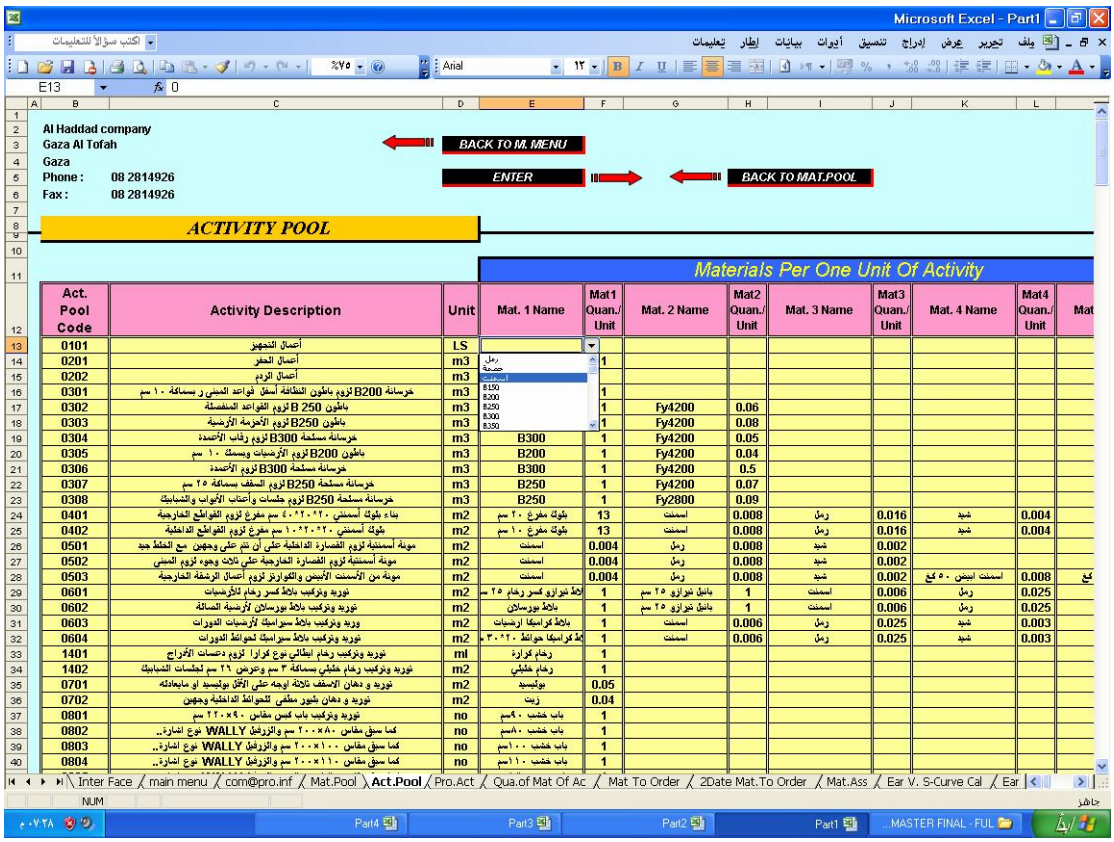


Figure 5.5: "Activity Pool" sheet

C. "Materials Pool" sheet

Materials pool sheet contains materials code, material name, material unit, the space needed to store one unit of the material and unit price. This data can be typed manually or transferred electronically from another sheet. Most of materials used in building works entered in the sheet for one time. Material unit can be typed or chosen from a list as shown in Figure 5.6.

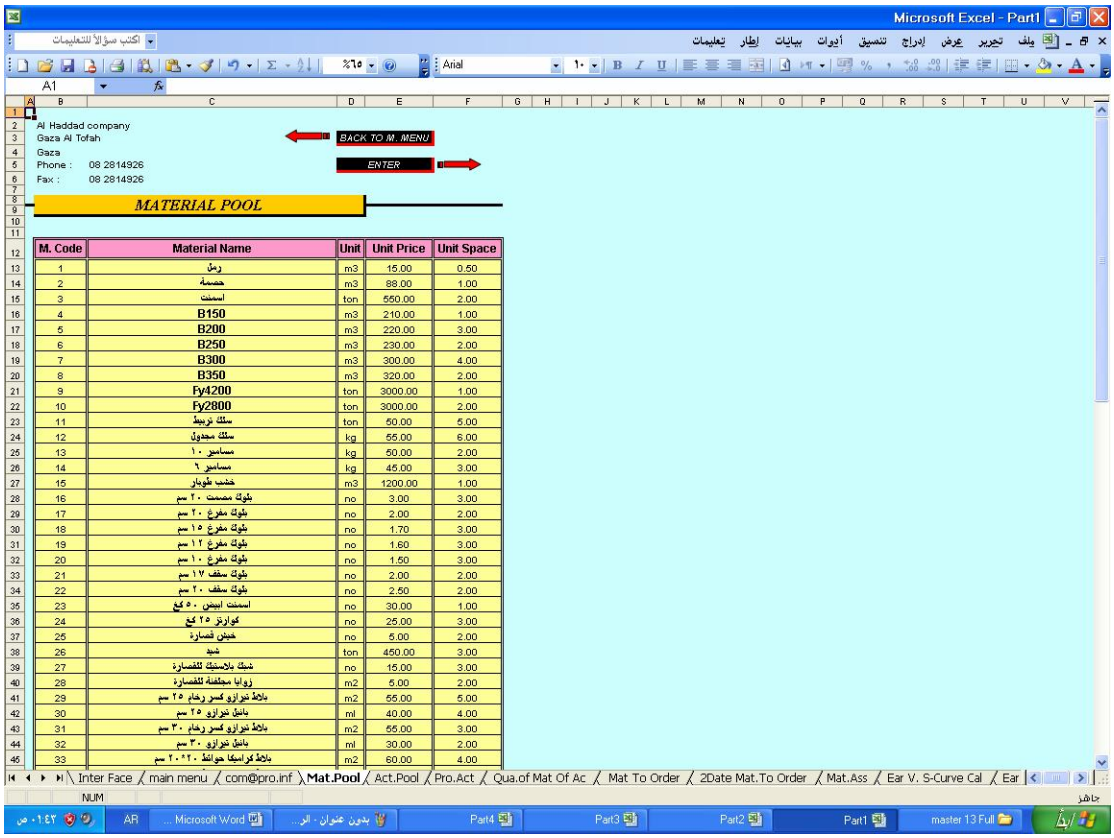


Figure 5.6: "Materials Pool" sheet

D. "Project Activities" sheet

"Project activities" sheet contains story number, activity pool code, activity description, unit, duration, start and finish dates, quantity, unit price and total price. This data can be obtained from Ms. Project by copying and pasting or typing manually. Activity code in this sheet must match the activity code in activity pool sheet. For example, B300 for column works in activity pool sheet have the code number 0360. This activity in the project sheet must have the same code even if this activity used in any storey (The activity code of B300 for the ground floor column works is 0360, and the activity code of B300 for the tenth floor column works is the same code 0360). Figure 5.7 shows a sample of project activities. Uniqueness of activity code is achieved by combining the storey No. and activity code.

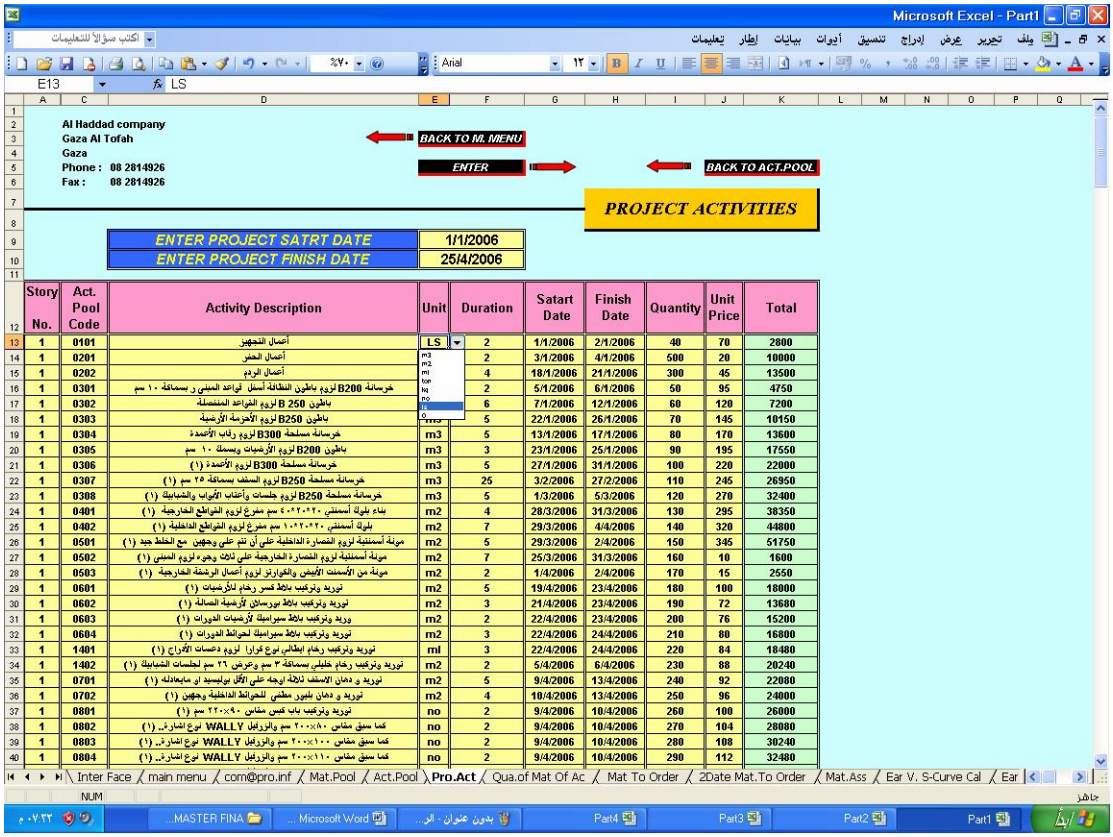


Figure 5.7: "Project Activities" sheet

E. "Activities Materials Quantities" sheet

Figure 5.8 shows a sample of "Activities Materials Quantities" sheet. This sheet consists of story number, activity pool code, activity description, unit, total quantity, materials name, and its quantity, which is required for constructing the whole quantity for each activity. Materials names and materials quantity can be obtained automatically from activity pool sheet, but after the quantities be multiplied with total quantity for each activity. The user can turn back to the main menu sheet by clicking on *Back to Main Menu* icon at the top of this sheet. Also the user can open the "materials to order" sheet by clicking on *Enter* icon at the top of the sheet.

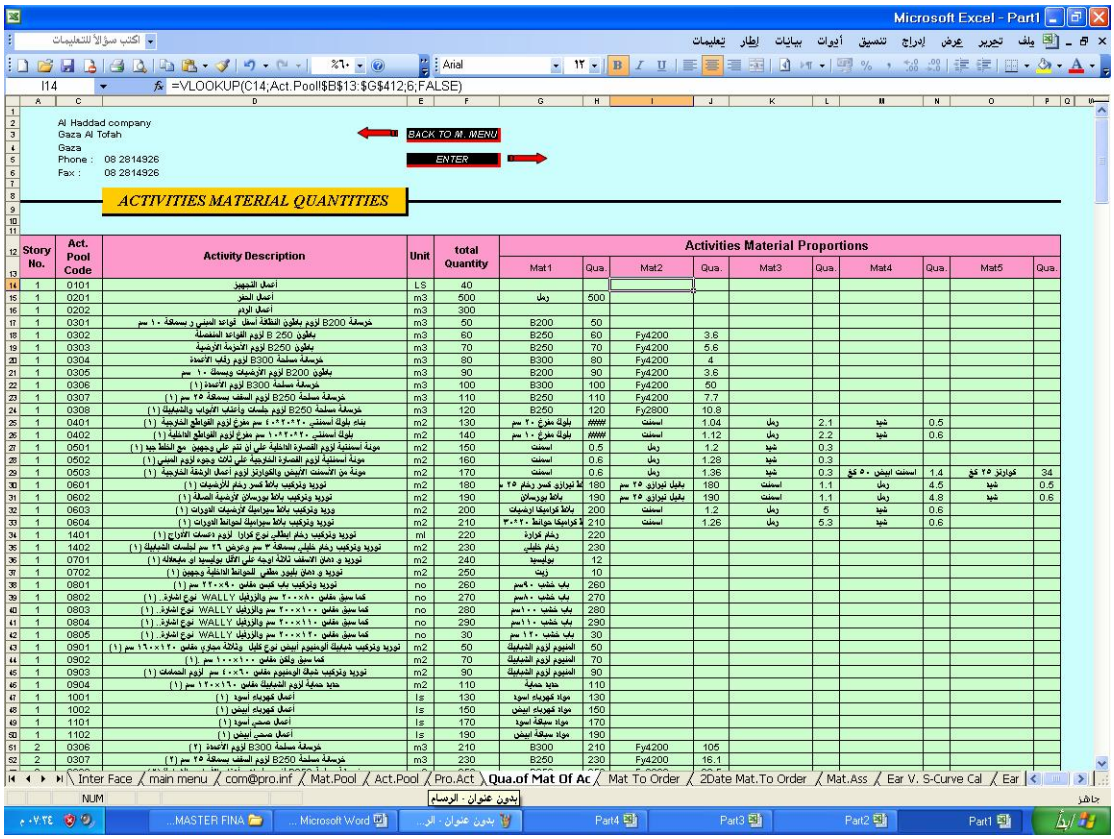
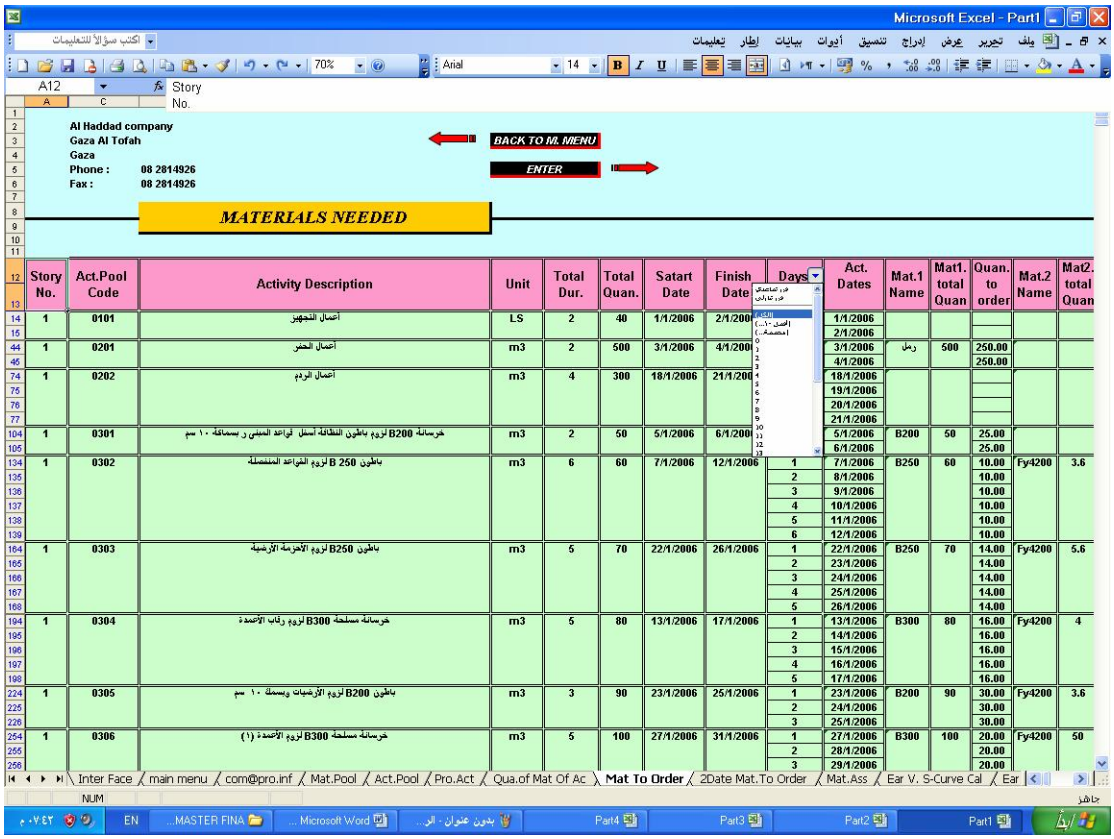


Figure 5.8: "Activities Materials Quantities' sheet.

F. "Materials Needed" sheet

Figure 5.9 shows a sample of "Materials Needed" sheet. This sheet contains story number, activity pool code, activity description, unit, total duration and total quantity, start and finish dates, the period of executing the activity and the distribution of materials according to the duration of the activity. This data can be obtained automatically from project activities sheet. Materials are equally distributed along the duration days of an activity. The user can turn back to the main menu sheet by clicking on *Back to Main Menu* icon at the top of this sheet, and he or she can open the "2 days materials to order" sheet by clicking on *Enter* icon at the top of this sheet.



Story No.	Act.Pool Code	Activity Description	Unit	Total Dur.	Total Quan.	Satart Date	Finish Date	Days	Act. Dates	Mat.1 Name	Mat1. total Quan	Quan. to order	Mat.2 Name	Mat2. total Quan
1	0101	أعمال التجهيز	LS	2	40	1/1/2006	2/1/2006		1/1/2006					
									2/1/2006					
1	0201	أعمال الحفر	m3	2	500	3/1/2006	4/1/2006		3/1/2006	رمل	500	250.00		
									4/1/2006			250.00		
1	0202	أعمال الردم	m3	4	300	18/1/2006	21/1/2006		18/1/2006					
									19/1/2006					
									20/1/2006					
									21/1/2006					
1	0301	خرسانة B200 لزوم باطون النظافة أسفل قواعد المبنى و بسماكة ١٠ سم	m3	2	50	5/1/2006	6/1/2006		5/1/2006	B200	50	25.00		
									6/1/2006			25.00		
1	0302	باطون B 250 لزوم القواعد المنفصلة	m3	6	60	7/1/2006	12/1/2006	1	7/1/2006	B250	60	10.00	Fy4200	3.6
								2	8/1/2006			10.00		
								3	9/1/2006			10.00		
								4	10/1/2006			10.00		
								5	11/1/2006			10.00		
								6	12/1/2006			10.00		
1	0303	باطون B250 لزوم الأحزمة الأرضية	m3	5	70	22/1/2006	26/1/2006	1	22/1/2006	B250	70	14.00	Fy4200	5.6
								2	23/1/2006			14.00		
								3	24/1/2006			14.00		
								4	25/1/2006			14.00		
								5	26/1/2006			14.00		
1	0304	خرسانة مسلحة B300 لزوم رقاب الأعمدة	m3	5	80	13/1/2006	17/1/2006	1	13/1/2006	B300	80	16.00	Fy4200	4
								2	14/1/2006			16.00		
								3	15/1/2006			16.00		
								4	16/1/2006			16.00		
								5	17/1/2006			16.00		
1	0305	باطون B200 لزوم الأرضيات وبسمك ١٠ سم	m3	3	90	23/1/2006	25/1/2006	1	23/1/2006	B200	90	30.00	Fy4200	3.6
								2	24/1/2006			30.00		
								3	25/1/2006			30.00		
1	0306	خرسانة مسلحة B300 لزوم الأعمدة (١)	m3	5	100	27/1/2006	31/1/2006	1	27/1/2006	B300	100	20.00	Fy4200	50
								2	28/1/2006			20.00		
								3	29/1/2006			20.00		

Figure 5.9: "Materials needed" sheet

G. "Materials to Order between two Dates" sheet

"Materials to order between two dates" sheet contains material code, material description, and quantity of material. Figure 5.10 shows a sample of "2 dates materials to order" sheet. The data can be obtained by entering two dates at the top of this sheet. The user can return to the main menu sheet by clicking on *Back to Main Menu* icon, and he or she can open the "Materials spaces and cash requirements" sheet by clicking on *Enter* icon at the top of this sheet.

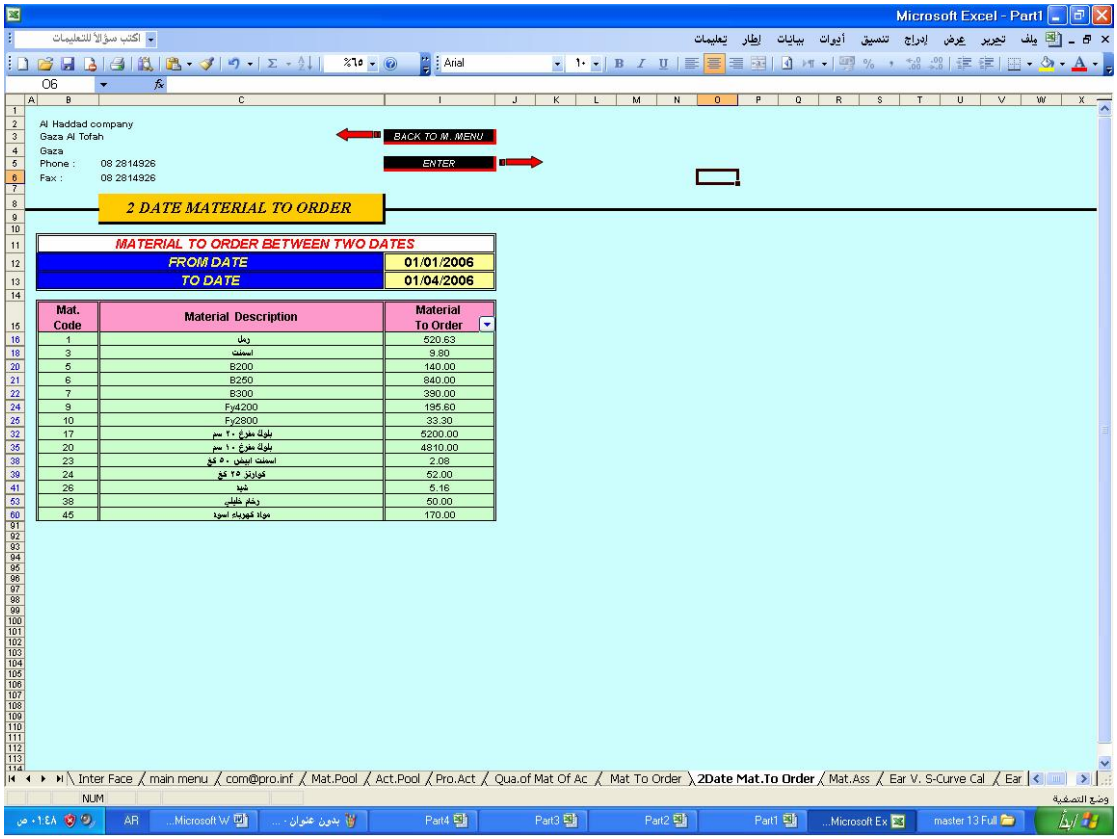


Figure 5.10: "Materials to Order between two Dates" sheet

H. "Materials Spaces and Cash Requirements" sheet

Figure 5.11 illustrates "Materials Spaces and Cash Requirements" sheet. This sheet consists of story number, activity pool code, activity description, all materials and their quantities required for each activity, unit space, unit price, total space, and total price. From this sheet the user knows total material quantities, prices, and spaces required for each project activity. The user can return to the main menu by clicking on the *Back to Main Menu* icon at the top of this sheet, and he or she can open the "earned value S-curve calculations" sheet by clicking on *Enter* icon at the top of this sheet.

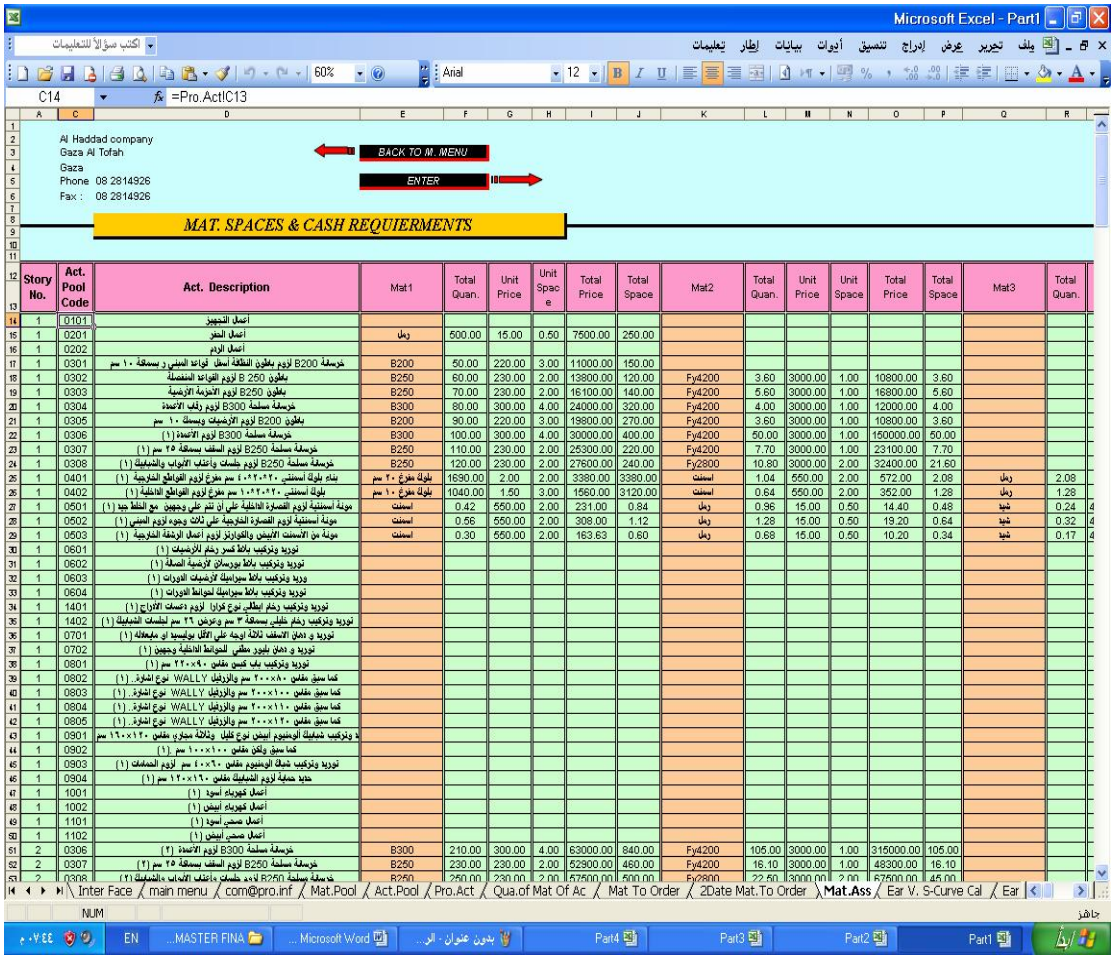


Figure 5.11: "Materials Spaces and Cash Requirements" sheet

I. Earned value S-curve calculations sheet

Figure 5.12 shows a sample of "Earned value S-curve calculations" sheet. It contains activity code, activity description, unit, start and finish dates, quantity, duration, unit price and total price. In this sheet, the user must enter the project start date and project finish date at the top of the sheet to obtain the total earned value for each activity. From this output information earned value S-curve is drawn and it can be used as a guideline for making a decision.

J. Earned value S-curve Sheet

It is a graph, which shows the cumulative earned value of the project against the time, (see Figure 5.13)

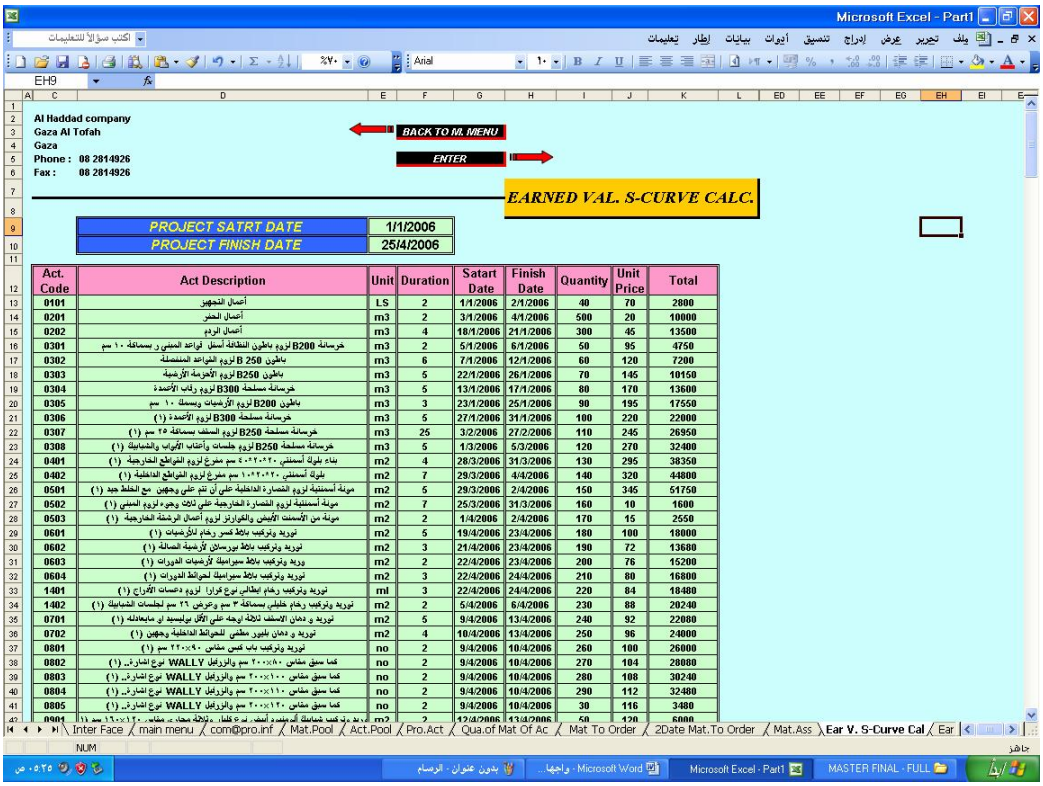


Figure 5.12: "Earned value S-curve calculation" sheet

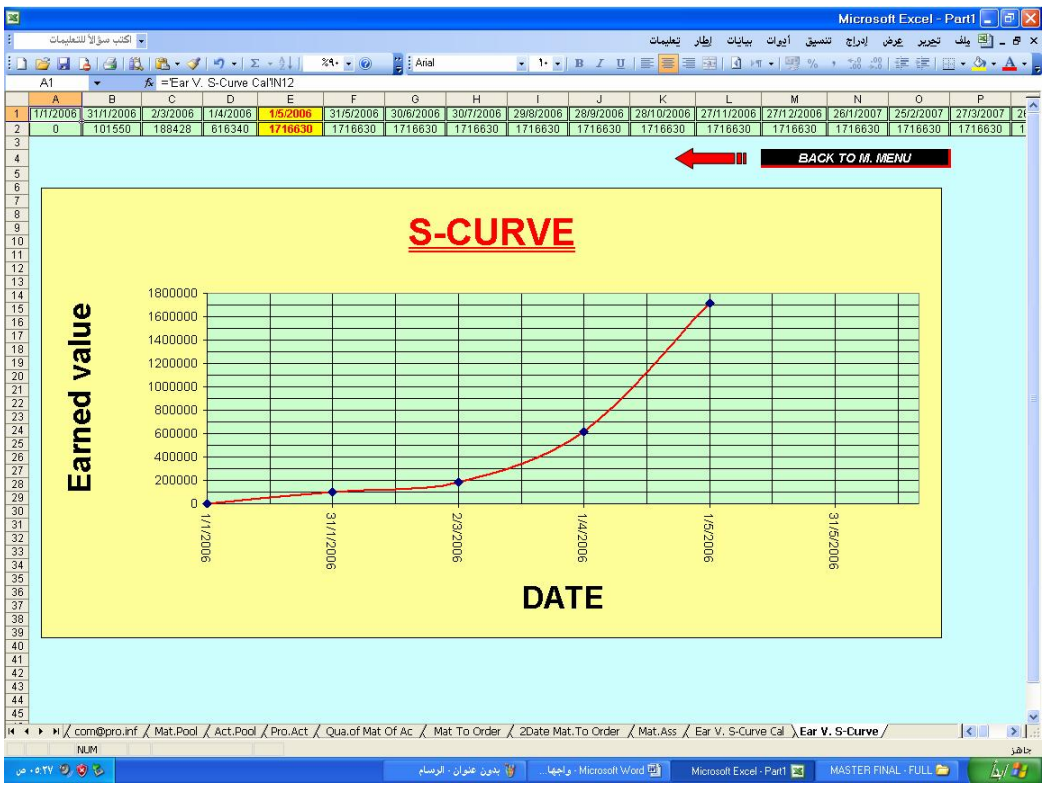


Figure 5.13: "Earned value S-curve" sheet

5.3.2.2 Part two (Materials purchase decision)

It includes the following sheets: "Materials to order and deliver on site" sheet; "materials must be purchased at" sheet; "materials spaces assignment" sheet; "materials prices assignment" sheet; "materials cumulative spaces sheet & prices at purchase order" sheet; "purchase order" sheet; and "materials must be purchased at" sheet. The followings are details of part two sheets:

A. "Materials to order and deliver on site" sheet

Figure 5.14 shows a sample of "materials to order and deliver on site" sheet. This sheet consists of material name, lead-time to order, and lead-time for delivery. In this sheet, in the column of "lead time for orders", the user should enter the number of days before which construction materials are to be ordered to have it available for delivery on time. The same thing he has to do for "lead time for delivery". The user can open "materials must be purchase at" sheet by clicking on *Enter* icon at the top of this sheet.

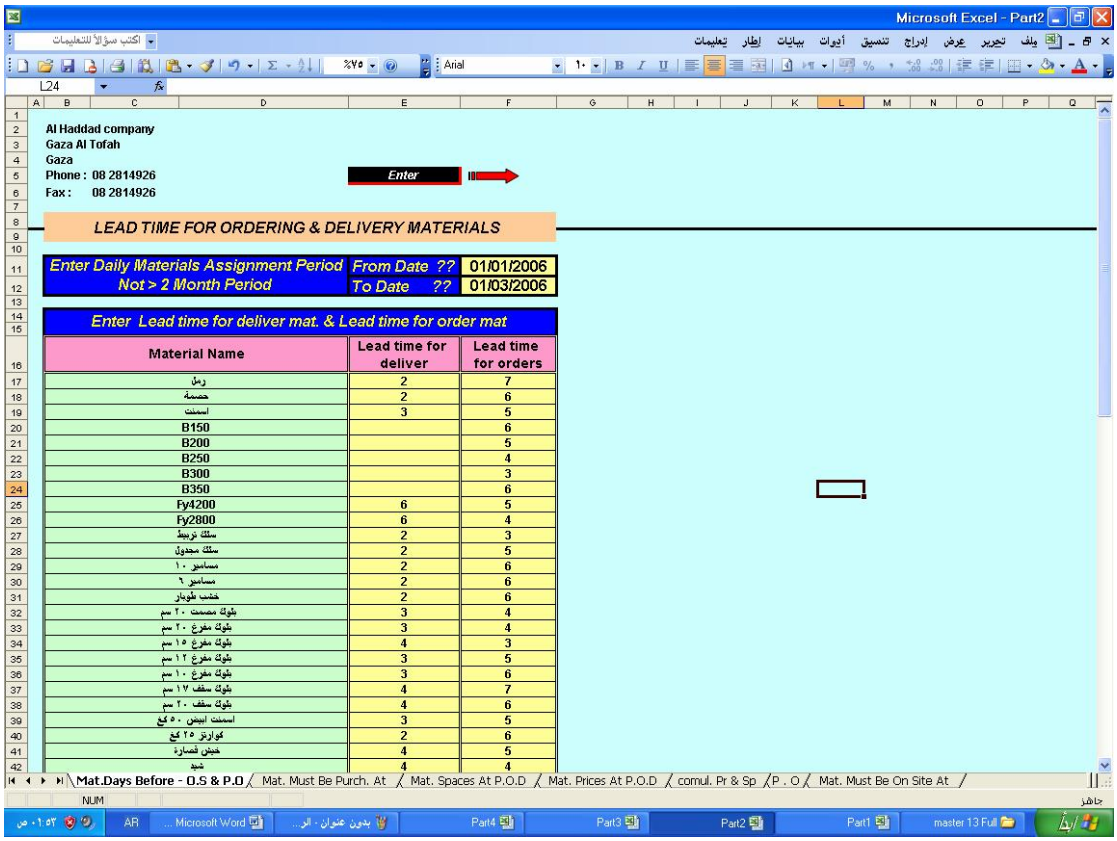


Figure 5.14: "Materials to order and deliver on site" sheet

B. "Materials must be purchased at "sheet

Figure 5.15 shows a sample of "Materials must be purchased at" sheet. Data in this sheet is obtained automatically; this sheet shows materials assignment quantities against the time for two months only. From this sheet the user will know the total quantities of construction materials needed for project activities which required to be purchased. The user can open "materials spaces assignment" sheet by clicking on *Enter* icon at the top of this sheet.

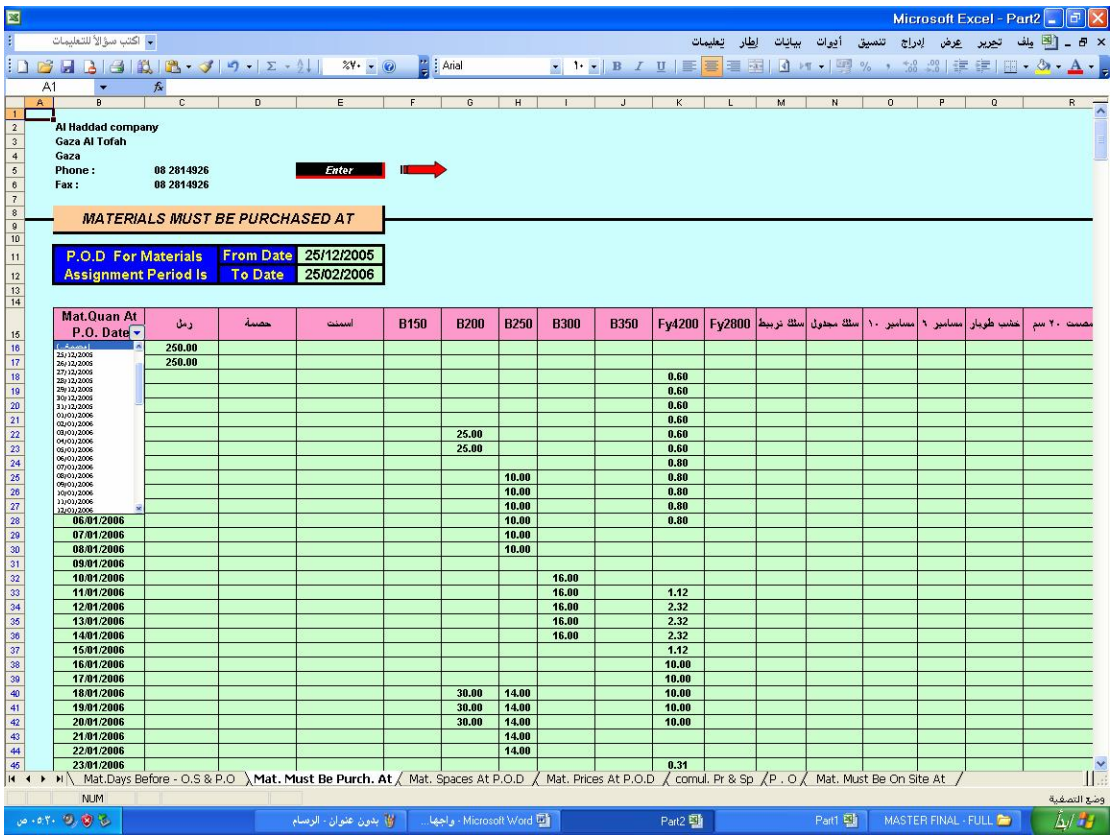


Figure 5.15: "Materials must be purchased at" sheet

C. "Materials Spaces Assignment" sheet

Figure 5.16 shows a sample of "Materials spaces assignment" sheet. This sheet consists of material name and material spaces in m2 to be purchased. Data in this sheet is obtained automatically. From this sheet, the user knows the spaces required for storing construction materials daily and for two months only. Data in this sheet is used for calculations used in "materials cumulative spaces & prices at purchase order" sheet in order to calculate materials cumulative spaces. He or she can open "materials prices assignment" sheet by clicking on *Enter* icon at the top of this sheet.

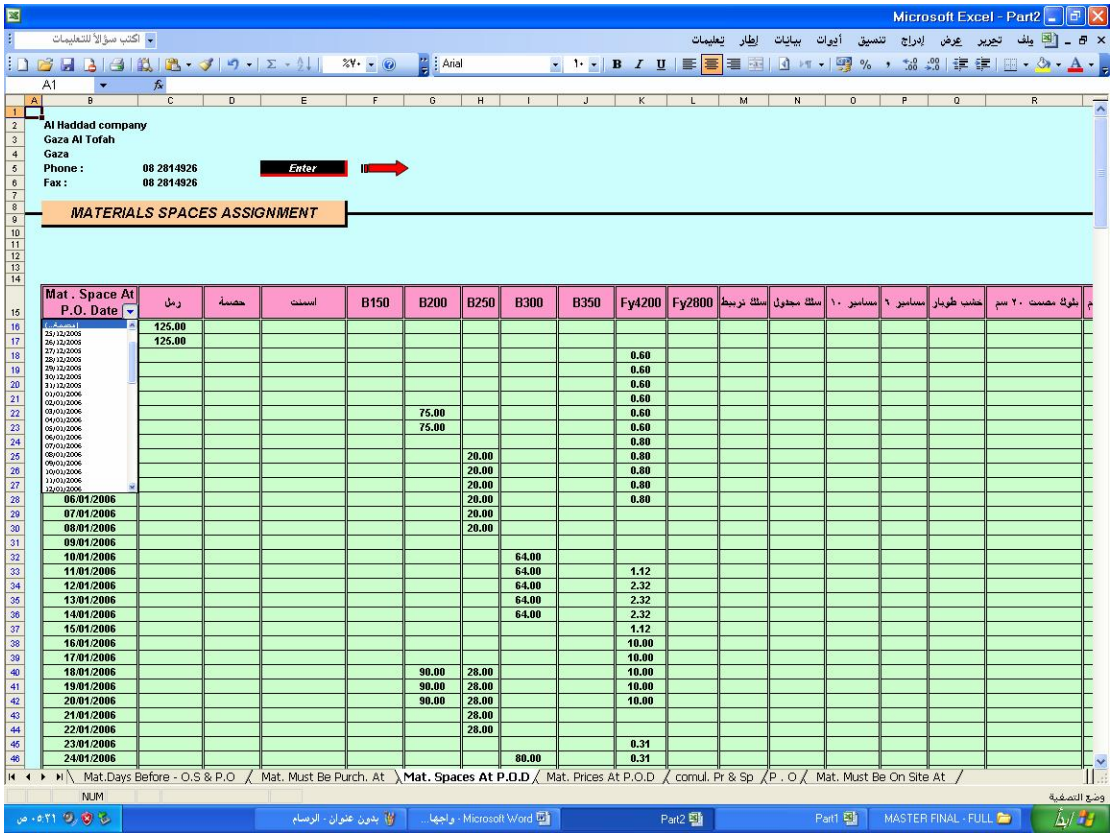


Figure 5.16: "Materials Spaces Assignment" sheet

D. "Materials Prices Assignment" sheet

Figure 5.17 shows a sample of "Materials Prices Assignment" sheet. Data in this sheet can be obtained electronically, such as dates between start, and finish dates for the two months, which entered in "materials to order and deliver on site" sheet, materials and prices required. Data in this sheet is used for calculations used in "materials cumulative spaces & prices at purchase order" sheet to calculate materials cumulative prices. The user can open" Materials Cumulative Spaces & Prices at Purchase Order" sheet by clicking on *Enter* icon at the top of this sheet.

E. "Materials Cumulative Spaces & Prices at Purchase Order" sheet

Figure 5.18 shows a sample of "materials Cumulative Spaces & Prices at Purchase Order" sheet. It contains purchase order dates, materials total space, materials total price, and materials cumulative space and price. The program provides data in this sheet automatically. The purpose of this sheet is to help the user for determining a period of time to buy construction materials for this period according to the available space and the available cash money. So the user can release a purchase order for this period by typing the start and finish dates of this period in purchase order sheet. He or she can open "Purchase Order "sheet by clicking on *Enter* icon at the top of this sheet.

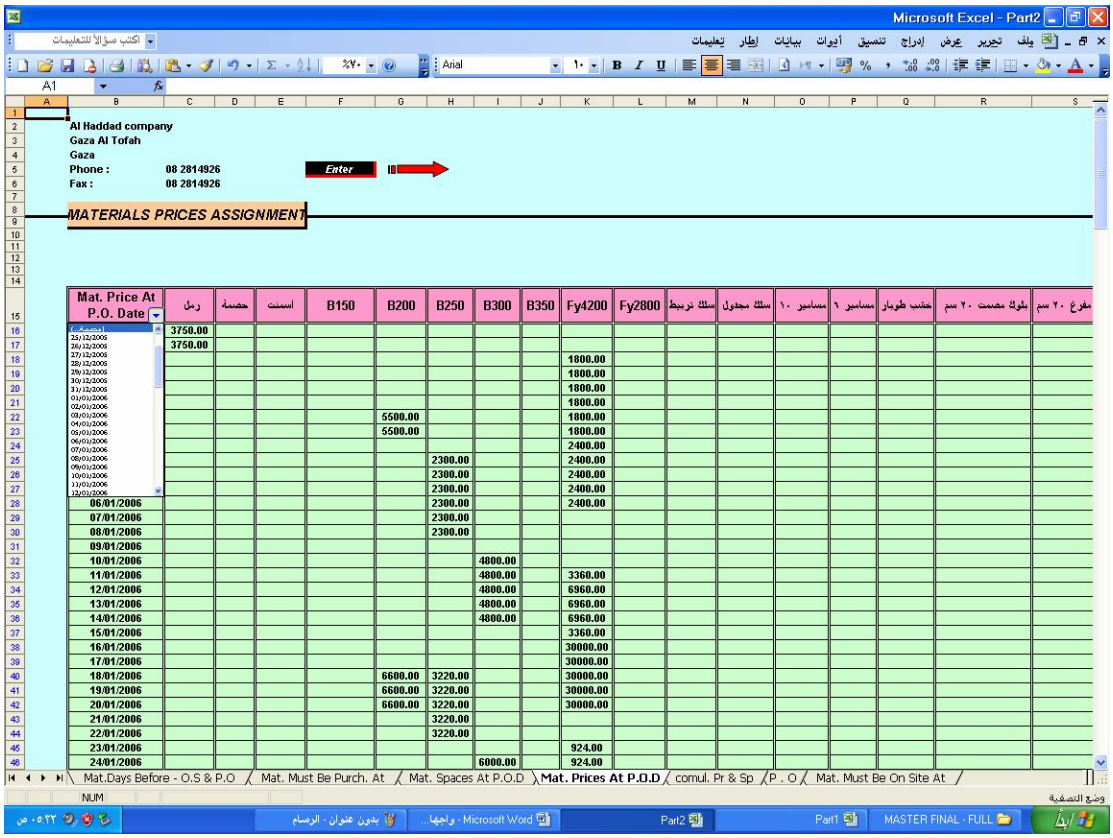


Figure 5.17: "Materials Prices Assignment" sheet

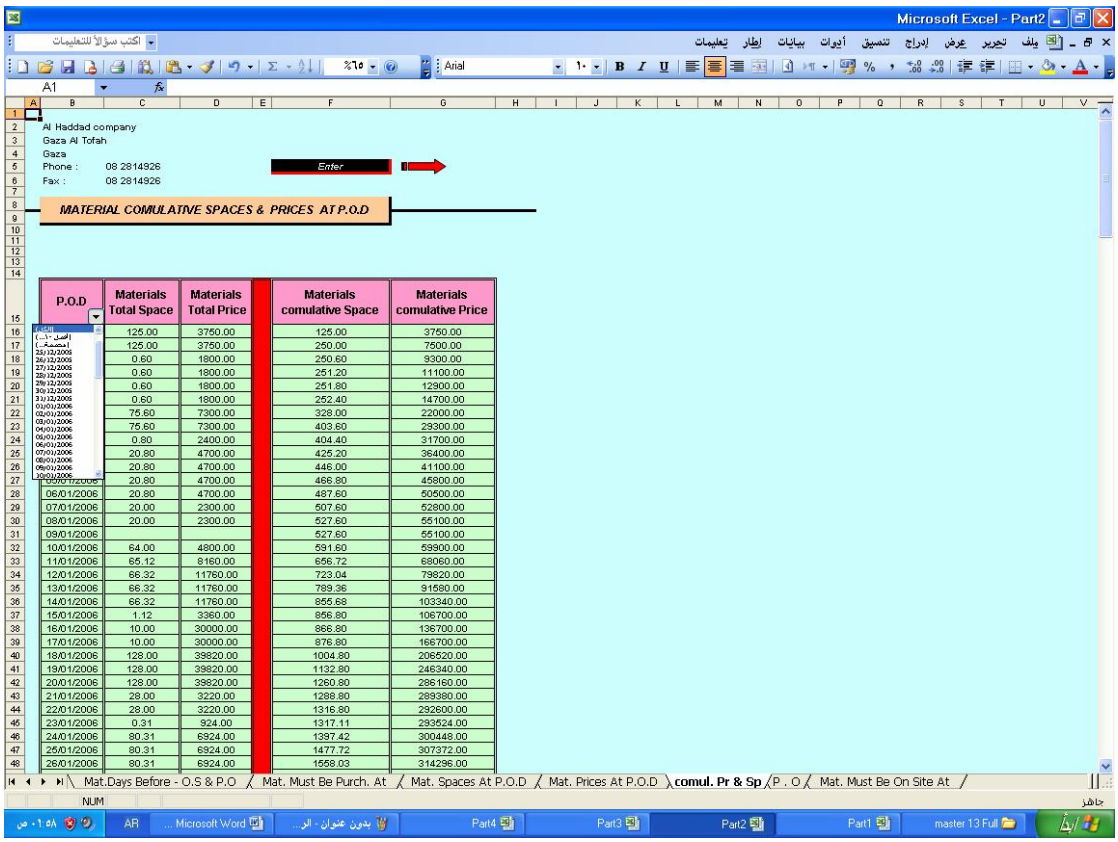


Figure 5.18: "Materials Cumulative Spaces & Prices at Purchase Order" sheet

F. "Purchase Order" sheet

Figure 5.19 shows a sample of "purchase order " sheet. This sheet consists of start and finish dates for purchase order, materials name, materials quantities, and unit. In this sheet, the user can obtain a purchase order for any period of the construction project by typing the start and finish dates in yellow colored cells. The user can open "Materials Must Be Purchased at" sheet by clicking on *Enter* icon at the top of this sheet.

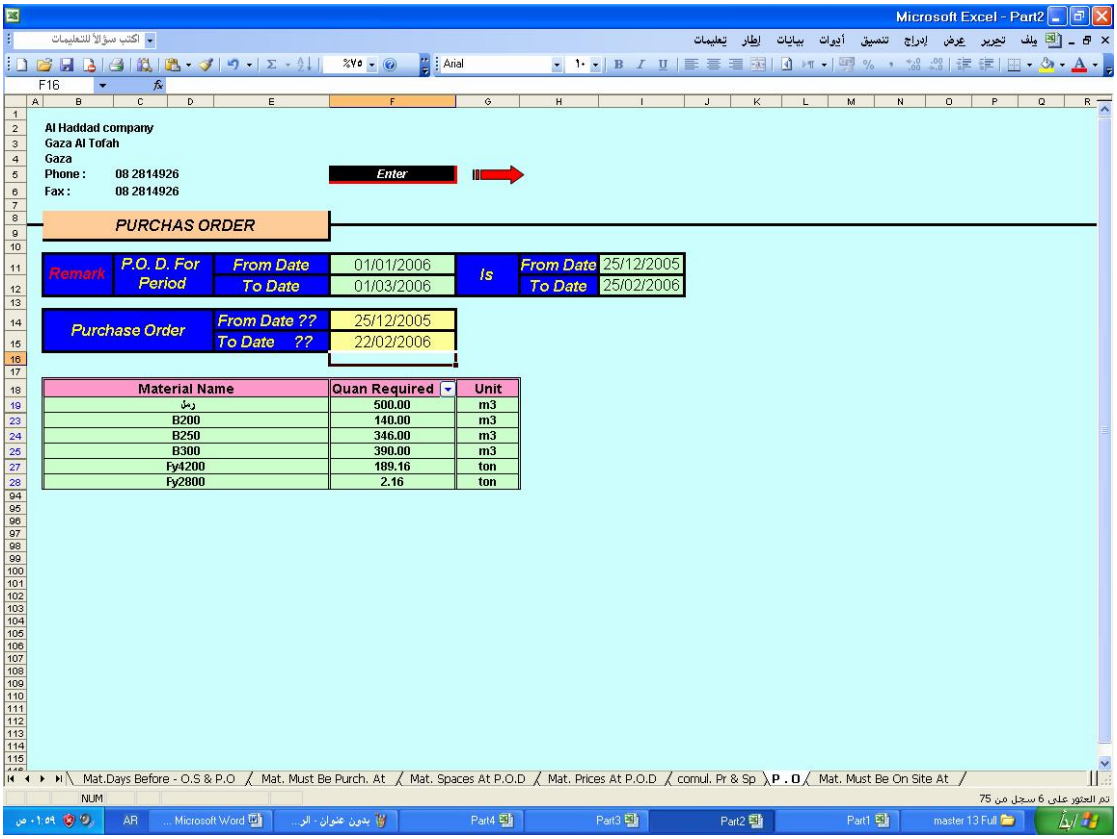


Figure 5.19: "Purchase Order" sheet

G. "Materials must be on the site at" Sheet

Figure 5.20 shows a sample of "Materials must be on the site at" sheet. CMMS provides data in this sheet automatically. This sheet consist of materials name, materials quantities. The purpose of this sheet is to help the user in controlling and managing construction materials. The user can return to main menu sheet by clicking on *Back to Main Menu* icon at the top of this sheet.

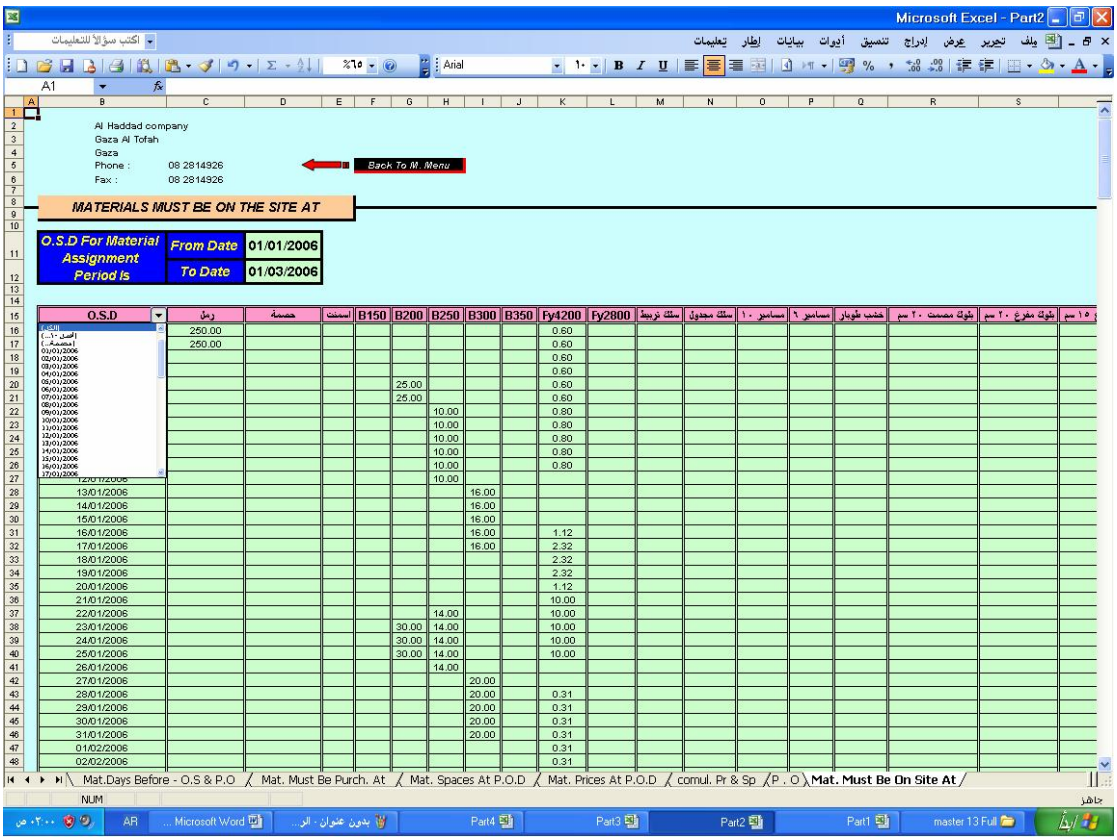


Figure 5.20: "Materials must be on the site at" sheet

5.3.2.3 Part Three (Materials Card)

Part 3 has one sheet called "materials card" sheet. Figure 5.21 shows a sample of this sheet. It shows the distribution of a construction material on project activities. The user can choose the name of construction material from a list, and then the software will show the distribution of this construction material and its quantities. The user can return to main menu sheet by clicking on *Back to Main Menu* icon at the top of this sheet.

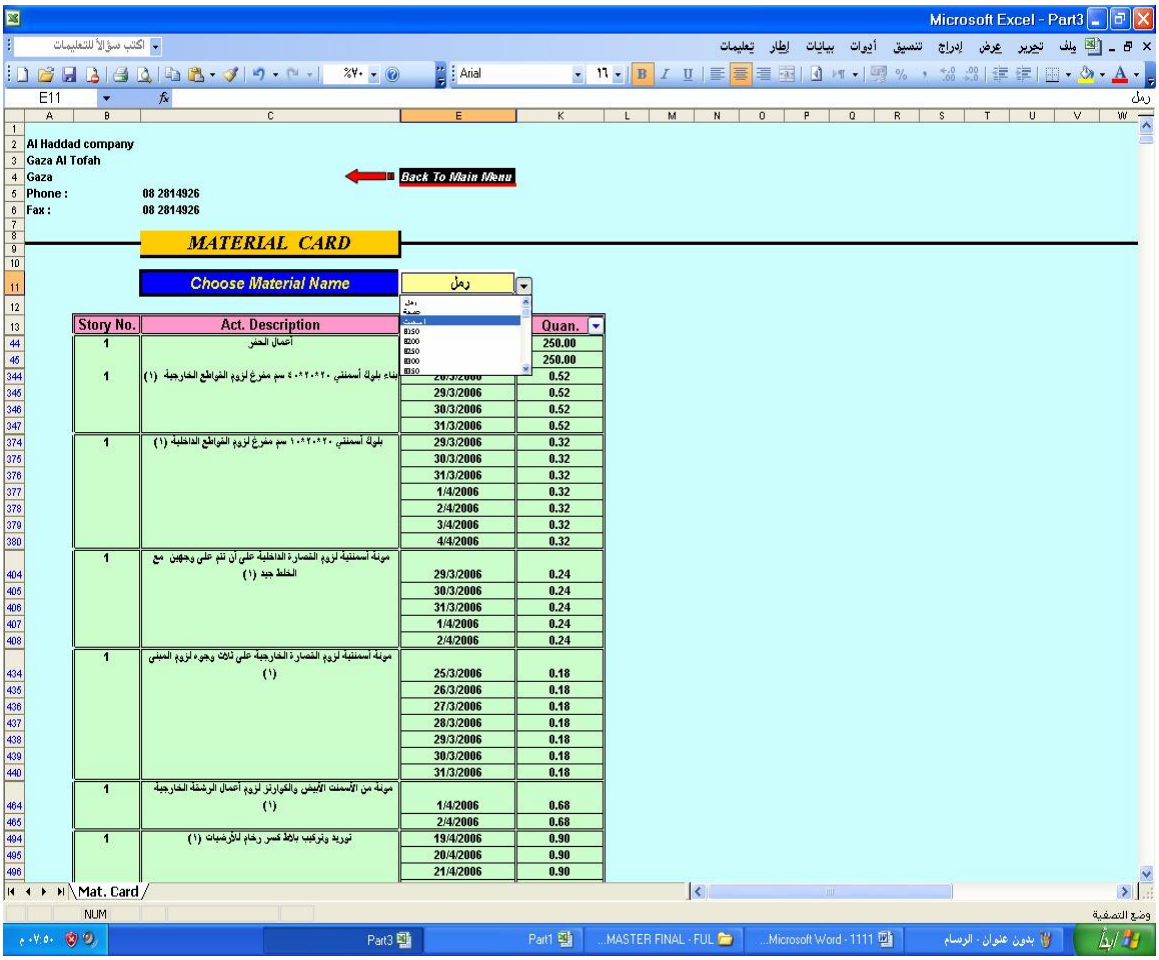


Figure 5.21: "Materials Card" sheet

5.3.2.4 Part 4 (Waste Control)

Part four has one sheet called "waste control" sheet. It consists of story number, activity pool code, activity description, unit, total duration and total quantity, start and finish dates, the stipulated activity duration in days, distribution of materials according to the duration of activities, earned quantity, consumed quantity, and percentage of waste. In this sheet, the user should fill earned and consumed quantities in earned and consumed columns day by day, and then the program calculates waste percentage for all materials as follows:

Waste percentage % = (consumed quantity - earned quantity)*100 / earned quantity.

The user should calculate earned and consumed quantities before filling it in the program as follows:

Earned quantity = quantity achieved to date. – Previous achieved quantity.

Consumed quantity = quantity on site (Q) + IN quantity – Left quantity

Quantity on site (Q): Quantity available before.

IN quantity: New quantity brought to the construction site this day.

Left quantity: The quantity left at the end of the day.

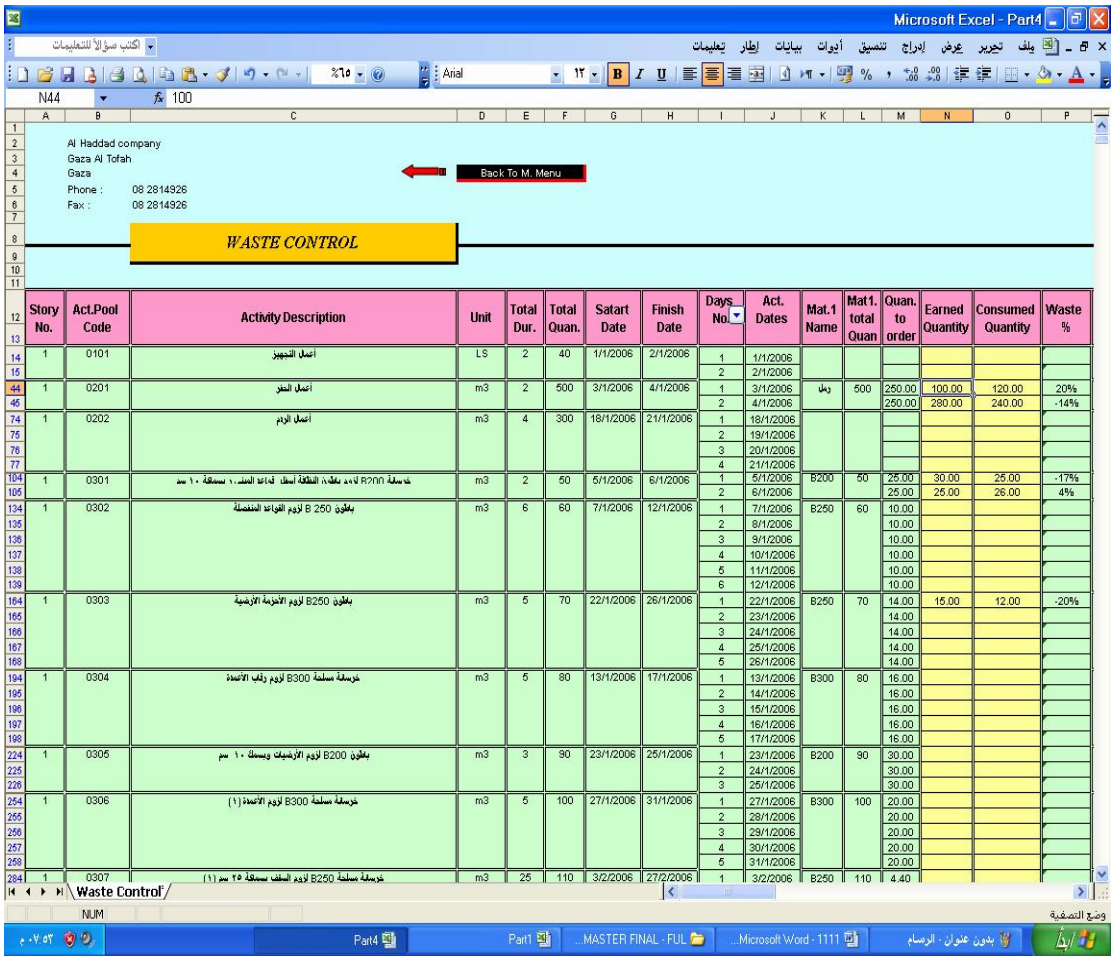


Figure 5.22: "Waste control" sheet

5.3.2.5 Help and Method of Use

Figure 5.23 shows a sample of "help and method of use" sheet. CMMS consists of four files, input data and basic calculations, materials purchase decisions, material cards, and waste control. The purpose of "help and method of use" sheet is to guide the user in using CMMS efficiently. It is written in Arabic to be more helpful and to suit Gaza strip building contractors. (See Annex 8)

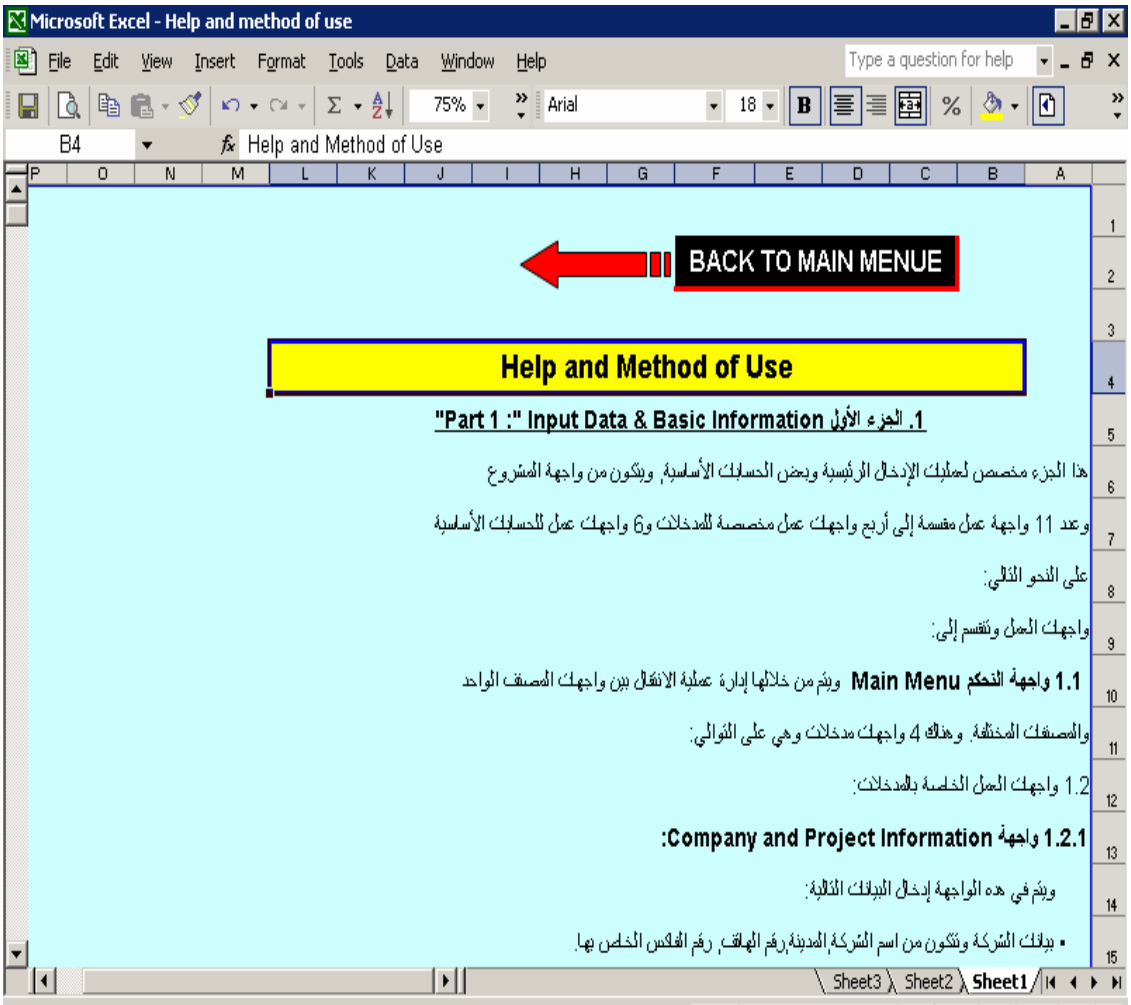


Figure 5.23: "Help and method of use" sheet

5.4 CMMS Evaluation

5.4.1 Evaluation objectives

Face validity is used as a test for model evaluation. Face validity is asking well-experienced people about the system whether the model and or its behavior are reasonable (Sargent 2000). CMMS was evaluated by this method, where four contractors were approached to apply CMMS in four different on going projects. Then they were asked to fill a questionnaire to evaluate the performance of CMMS.

The objectives of CMMS evaluation are: (1) to assess the performance of construction materials management CMMS tools and techniques; (2) to check the suitability of CMMS design and structure; (3) to know the difficulties that faced the users during applying CMMS; (4) to recognize the contractors` criticisms or comments on the software and (5) to explore CMMS advantages.

5.4.2 Evaluation methodology

CMMS was tested in four under-construction projects belonging to four different contractors. All the four projects were in Gaza. The first project is a two-story building for the ministry of health (surgery department). The second project is a five floor building in Al- Remal area. The third and fourth buildings are for transportation department in security forces complex (Al- Saraya).

5.4.3 Evaluation result and discussions

Table 5.1 illustrates the contractors` responses to performance of CMMS tools and techniques. It is clear that all respondents have positive attitudes towards CMMS regarding the performance of many techniques especially *"Actual cost report for project activities at any date", " Needed storage area report for project materials at any date", "Earned value S-Curve", and "Provide a card for any material and its assignment on projects` activities"*.

Table 5.2 illustrates the contractors` responses to the features of CMMS design and structure. The results illustrate that all contractors companies agreed that the reports and outputs are clear, and easy to read and understand.

Also it is noted that three of contractors companies strongly agreed that the software is flexible, the data can be updated easily, text and numbers shown are concise, and their sizes are suitable and readable, and the method of use is understandable. Not that some of the respondents did not answer some questions.

Table 5.1: The contractors` responses to performance of CMMS tools and techniques

.

No	Techniques	Strongly agree	Agree	Intermediately agree	Weakly agree	Very weakly agree
1	Needed storage area report for project materials at any date.	3	1			
2	Required quantities of materials report project activities at any date.	2	1			
3	Actual cost report for project activities at any date.	4				
4	Required materials report to be purchased at any date.	2	1			
5	Required materials, to be available on site.	1	2			
6	Earned value S-Curve.	3	1			
7	Waste monitoring report for activity materials.	1	2			
8	Provide a card for any material and its assignment on projects` activities.	2	2			

Table 5.2: The contractors` responses to the features of CMMS design and structure.

No	Techniques	Strongly agree	Agree	Intermediately agree	Weakly agree	Very weakly agree
1	The software is flexible, and the data can be updated easily.	3	1			
2	In general, it is easy to use.	4				
3	It saves time and effort.	1	2			
4	Method of entering data is easy and clear.		3			
5	The reports and outputs are clear, and easy to read and understand.		4			
6	Method of sorting data is easy.	1	3			
7	Text and numbers shown are concise, and their sizes are suitable and readable.	3	1			
8	The information can be inquired easily.	2	2			
9	The method of use is understandable.	3	1			
10	It is easy to handle as it is developed within Excel environment.	2	1			
11	Training to use the CMMS is easy and it does not need much time. In addition, it does not need a professional user to deal with it.		2			
12	It can be applied for most of Gaza strip projects. (It is suitable for Gaza strip contractors).	3	1			
13	It contributes in improving the construction materials management practice in Gaza strip.	1	2			

Regarding the difficulties that the contractors were facing during the use of CMMS, almost all contractors said that they had not faced real difficulties.

As for the criticisms or comments of the contractors, there are two main comments. The first is that materials quantities per one unit in the "materials pool" sheet have to

be determined by experience. The second comment is the difficulty in determining the consumed and earned quantities for any materials used in the construction site day by day in the "waste control" sheet to determine waste percentage.

On the other hand, the main advantages expressed by contractors are:
CMMS is easy to use and flexible; it helps the management staff in managing the construction materials in future projects; also, it helps the management staff to decide when and how much of materials quantities to be bought; and CMMS input-output relationships are reasonable.

Overall, the results of evaluation indicate that CMMS tools and techniques are encouraging. Also, the contractors are generally satisfied with the design and structure of CMMS. Moreover, the contractors mention that a CMMS suite the Gaza strip contracting companies and has the potential to contribute in improving the construction materials management practice in Gaza strip.
The researcher suppose that this edition of CMMS must use by contractors in the construction site, and another edition of this software after testing and evaluating will be used on home office and attached them together with website.

5.5 Software Limitations

Some tools and functions are used in developing CMMS such as "macro" tool and "v-lookup" function. The security level in MS Excel should be low to make full use of CMMS.
The researcher tried to make use of the full capacity of Ms Excel 2003. However, the following are the limits, which directly, affect the function of CMMS:

- Maximum number of project activities in Project activity sheet is 65,536 (affected by the capacity of Excel 2003).
- Maximum number of materials in materials pool sheet is 65,536 (affected by the capacity of Excel 2003).
- The number of materials that the user can enter in activity pool for each activity is five materials.
- Maximum duration for one activity is 30 units (days, weeks, months).

To use CMMS for a new project all yellow cells must be deleted by determining them and press "0" then presses Ctrl and Enter

CHAPTER 6
CONCLOUSION AND RECOMMENDATIONS

6.1 Introduction

Construction Materials Management Software (CMMS) was developed to satisfy some needs of Gaza strip contracting companies in managing construction materials. This chapter introduces the research conclusions and recommendations for many parties involved in the construction process to improve the local practices in construction materials management. Recommendations for further studies are also included.

6.2 Conclusions

- The survey results show that contactors, in general, are interested in using many tools of managing construction materials. However, Most contractors did not actually apply some tools and techniques of construction materials management such as:
  - Creating database for materials categories, local suppliers, international suppliers, and materials cost.
  - Updating database for local suppliers, international suppliers, materials cost when change, and using internet for knowing the new materials and its prices.
  - Providing a list of materials in project, providing material cards at site store, and recording the received materials on site.

  Even the few contractors who used the above-mentioned tools and techniques, they applied these tools either without recording at all, or with recording in an unsystematic way without using manual or computerized forms.

- All surveyed contractors believe that the Israeli closure on Gaza strip is the main element that affects construction materials availability and cost. In addition, the Israeli closure affects clearly the prices of main materials such as cement, aggregates, and reinforcement steel.

- Most contracting companies manage construction materials using non computerized forms. Shortage of suitable construction materials management software is considered the main obstacle to computerize materials management processes. Another important factor is lack of qualified persons in using computerized construction materials management packages.

- There is a consensus amongst contractors on the importance of using a computerized construction materials management system. The main advantages that can be obtained from using materials management software are:

    - Reducing the cost of materials needed in the project.
    - Better handling of materials.
    - Materials be on the construction site in time and with required quantities.
    - More effective waste control.
    - Improving follow up and monitoring construction materials.

- Gaza strip contractors did not use any software to support project materials management. This gave the researcher a thrust to develop a computerized construction materials management system that supports and improves this practice. The researcher names this software "construction materials management software" (CMMS). It was designed within Ms Excel environment where the results show that Ms Excel is the most used software by the contracting companies in Gaza strip.

- CMMS suits Gaza strip contracting companies and has the potential to contribute in improving the construction materials management practice in Gaza strip. It has a good performance and adequate accuracy.

- CMMS provides many reports such as materials to order between two dates, materials assignments, waste control, when to purchase construction materials, when materials must be on the site, and purchase order between two dates.

- CMMS provides the mechanism to decide when to buy construction materials and what quantities of construction materials the contractor need in the project.

6.3 Recommendations to the parties involved in construction

Top management of contracting companies is invited to encourage development and using construction materials management systems. They can make incentives for their staff members to attend training courses in construction materials management and its applications. They should be encouraged to actually use computerized construction materials management systems to save effort and time, and to achieve more accurate results.

Public employers can contribute in improving the current construction materials management practices of the contractors by requesting them to implement construction materials management systems during construction. This could be done by adding relevant clauses in the project conditions of contract.

Universities, contractors union, and engineering association have to do more efforts to improve the existing construction materials management practices, which may include:

- Encouraging the contractors to use construction materials management systems by addressing the importance of these systems.
- Helping the contractors to understand the system by initiating training courses, lectures, seminars, and workshops.
- Transferring of technology and experiences of other countries in the construction materials management field and adapting them to suit Gaza strip contractors

6.4 Recommendations for further studies

CMMS is a step along the way to establish a systematic construction materials management practice amongst Gaza strip contractors. Of course, it needs continuous modification and enhancement. The followings are some points, which need further research efforts:

- CMMS does not deal specifically with materials waste on the construction site. So, researchers are invited to put more effort to handle this aspect.
- The user can obtain the list of activities and all information involved in the project activities sheet by typing or copying and pasting these information from Microsoft Project software. This is a manual way to obtain data. So, researchers are invited to fully integrate Microsoft Project with CMMS to obtain data automatically.
- Different construction processes need more attention for study and research in order to determine more realistic waste percentage for construction materials. The resulting information will be helpful in determining required quantities for each activity.
- CMMS divides all construction materials required for each activity equally at the duration of the activity on "materials quantities of activities" sheet. This is not realistic in all cases, and the user may want to modify these quantities. Therefore, researchers are invited to handle this case.
- Researchers are invited to develop integrated packages that include CMMS. Integration can be approached at various levels such as:
    - Integrating materials management, materials control and monitoring functions.
    - Integration with a scheduling application packages such as MS-Project.
    - Integration with other software programs such as the software which is used in the construction storages.
- CMMS can be improved by adding to it some communications features that enable it to be used on-line between the site and the head office (See annex 7).
- There is a chance to alter the method of gathering site data such as materials delivered to the construction site. The proposed method is collection the data by using an electronic device instead of filling a paper form. Now there are global research studies to automate monitoring process to calculate the in-progress quantities. Researchers use cameras, electronic sensors, and other devices to capture the data of progress and transfer them to computer electronically (See annex 7).

Researchers are invited to develop a new version of construction materials management software (CMMS) with probabilistic capabilities

References

Ammer, Dean S. (1974) Materials Management, Richard D. Irwin, Inc. Homewood, Illinois

Ammer, Dean S. (1980) Materials Management and Purchasing, Richard D. Irwin, Inc. Homewood, Illinois

Arnold, J.R. (1991) Introduction to Materials Management, Prentice-Hall, Englewood Cliffs, New Jersey

Ahuja, Hira, N. and S, P, Dozzi (1994) Project management techniques in planning and controlling construction projects, Second Edition, John Wiley& Sons Inc., New York.

Al Mogany, S., (2006). Managing and Minimizing Construction Waste in Gaza Strip, pp 242. Unpublished Msc Thesis. The Islamic university of Gaza (IUG).

Al Ostaz, M., (2004). A cost Monitoring System for Gaza Strip Contracting, Unpublished Msc Thesis. The Islamic University of Gaza (IUG).

Bailey Peter and Farmer, David (1982) Materials Management Handbook, Gower Publishing Company Limited, Aldershot, Hants, England.

Ballot, Robert B. (1971) Materials Management: A Results Approach, American Management Association Inc., United States of America.

Ballard, Glenn and Gregory Howell, (1994) "Implementing Lean Construction: Stabilizing Work Flow." Conference on Lean Construction, Santiago, Chile.

Beekman-Love, G.K. (1978) Materials Management, Martinus Nijhoff Social Sciences Division, Boston.

Bernold, Leonhard E.,and Treseler, John F., (1991) Vendor Analysis for Best Buy in Construction, Journal of Construction Engineering and Management, Vol.117, No. 4, December 1991, pp. 645-658.

Cavinato, Joseph, L. (1984) Purchasing and Materials Management, West Publishing Company, Minnesota.

Chandler, Ian E. (1978) Materials Management on Building Sites, The Construction Press Ltd, Lancaster, England.

christofferson , J. (1999) . Using Powerful Spreadsheet Application Tools to Increase the Efficiency and Effectiveness of Estimating , ASC Proceeding of the 35th Annual conference , California Polytechnic Stat University San Luis Obispo , California .

Chen, Z., Li, H., and Wong, C.T.C., (2002). An Application of Bar-Code System for Reducing Construction Wastes. Elsevier Science, Automation in Construction 11, pp 512-535.

Construction Industry Institute (1988) Project Materials Management Primer, Publication 7-2, Bureau of Engineering Research, The University of Texas at Austin.

Construction Industry Institute (1999) Procurement and Materials Management: A Guide to Effective Project Execution, Implementation Resource 7-3, Bureau of Engineering Research, The University of Texas at Austin.

Damodara, K., (1999) Materials Management: The Key to Successful Project Management, Journal of Management in Engineering, Vol.15, No.l, January/February 1999, pp. 30-34.

Dahman, M., Abo Modalala, M., Al Shabban; A. and Mohmad, O., (2004) Construction Waste Minimization. Bachelor researcher, Islamic University-Gaza.

Dobler, Donald W., and Burt, David N., (1996) Purchasing and Supply Management: Text and Cases, McGraw-Hill Series in Management, The McGraw-Hill Companies Inc, USA.

Dos Santos, A., Formoso, C.T. and Hinks, J. (1996) Method of intervention on the flow of materials in building processes, in: Proceedings of the Fourth Annual Conference of the International Group for Lean Construction, University of Birmingham, Birmingham, UK. Also at: http:/web.bham.ac.uk/d.j.crook/lean.

Ericsson, Dag (1974) Materials Administration, McGraw Hill Book Company (UK) Limited, England.

Enshassi, A., (1996). Materials Control and Waste on building sites, Building research and Information, vol. 24, No. 1, pp 31-34.

Ekanaglce, l., l. and Ofer. , G., (2004). Building waste assessment design-based tool. Elsevier science, Building and Environ meet 39, pp 351-861.

Gossom, W.J. (1983) Control of Projects, Purchasing, and Materials, PennWell Publishing Company, Tulsa, Oklahoma.

Howell, Gregory, Alexander Laufer and Glenn Ballard, (1993) "Uncertainty and Project Objectives" in Project Appraisal. Guildford, England: March..

Howell, Gregory and Glenn Ballard, (1994) "Lean Production Theory: Moving Beyond 'Can-Do'." Conference on Lean Construction, Santiago, Chile. September.

Huovila, Pekka, Lauri Koskela and Mika Lautanala, (1994) "Fast or Concurrent-The Art of Getting Construction Improved." Conference on Lean Construction. Santiago, Chile.

Naoum , S .(1998) . Dissertation Research and Writing for Cons traction students ,Oxford : Butterworth – Heinemann .

Navon, R., and Berkovoich, O., (2005). Development and On Site Evaluation of Automated Materials Management and Control Model. Haifa, Israel.

Plemmons, James K., and Bell, Lansford C. (1995) Measuring Effectiveness of Materials Management Systems, Journal of Management in Engineering, Vol. 11, No.6, November/December 1995, pp. 26-32.

Palestinian Contractors Union (PCU), (2006). Contracting Companies and Classifications sheet. Received (15/5/2006).

Polit , D.F., Hunger , B.P., (1999) . Nursing Research Principles and method . 6th edition. Lippincott Williams and Wilkins . Philadelphia .

Stukhart, G., (1995) Construction Materials Management, Marcel Dekker Inc. New York.

Stukhart, G. and Bell, L.C. "Costs and Benefits of Materials Management Systems,", ASCE Journal of Construction Engineering and Management, Vol. 113, No. 2, June 1987, pp. 222-234.

Thabet, W. (2001), A Framework for an Integrated Materials Management System, Research Proposal Submitted to the Electrical Contracting Foundation, Inc.

Tersing, Richard J., and Campbell, John H. (1977) Modern Materials Management, North-Holland Publishing Company, Amsterdam, The Netherlands.

Thomas, H. Randolph, and Sanvido, Victor E. (2000) Role of the Fabricator in Labor Productivity, Journal of Construction Engineering and Management, Vol.126, No.5, September/October 2000, pp. 358-365.

Willis, E. (1986) Scheduling Construction Projects, John Wiley and Sons.

Womack, James P., Daniel T. Jones and Daniel Roos (1991). The Machine That Changed The World: The Story Of Lean Production. New York. 1st Harper Perennial Edition.

Weisberg ,H.F., and Bowen ,B.D.,(1997) . An introduction to survey research and data analysis . W.H. Freeman company . New York USA .

Koskela, Lauri. (1992), "Application of the New Production Theory to Construction." Technical Report #72, Center for Integrated Facilities Engineering, Stanford University. May.

Ohno, Taichi. (1987) Toyota Production System. Productivity Press.

Yaghmaie, F., (2003). Content Validity and Its Estimation. Journal of Medical Education.

LIST OF ANNEXES

Annex 1

The Questionnaire (In Arabic)

The Islamic University - Gaza
Faculty of Engineering
Deanery of Graduate Studies

الجامعة الإسلامية – غزة
كلية الهندسة
عمادة الدراسات العليا

استبيان عن

ممارسة إدارة مواد البناء في مشاريع التشييد بواسطة مقاولي قطاع غزة

السادة المقاولون المحترمون /

نشكر تعاونكم ومساهماتكم في تعبئة هذا الاستبيان الذي يعتبر جزء من البحث التكميلي لنيل درجة الماجستير في إدارة المشاريع. من خلال الاستبيان نرجو التعرف على الواقع المحلي في إدارة مواد البناء في مشاريع التشييد لدى مقاولي قطاع غزة ومن ثم محاولة حل مشاكل هذا النظام من خلال تطوير برنامج حاسوب متخصص بعمل إدارة مواد البناء لمشاريع التشييد بقطاع غزة.

يتكون الاستبيان من الأجزاء التالية:

الجزء الأول: السيرة الذاتية للشركة.

الجزء الثاني: استخدام أدوات وتقنيات نظام إدارة مواد البناء في مشاريع التشييد.

الجزء الثالث: تأثير الإغلاقات الأمنية علي وفرة المواد وأسعارها.

الجزء الرابع: استخدام الحاسوب في نظام إدارة مواد البناء في مشاريع التشييد.

الجزء الخامس: تطبيق نظام إدارة مواد البناء علي مشاريع التشييد.

جميع البيانات والمعلومات الواردة في الاستبيان ستستخدم فقط لتقيم ودراسة نظام إدارة مواد البناء في المتبع في المشاريع، والمعلومات الشخصية والخاصة الواردة لن تنقل إلى أي جهات أخرى.

سوف نطلعكم بإذن الله علي نتائج البحث للاستفادة منها.

إشراف
د.م كمالين شعث

الباحث
م. إياد عبد القادر الحداد

<u>الجزء الأول/ السيرة الذاتية للشركة:</u>

1- اسم الشركة: _____ سنة تأسيس الشركة: _____

2- مجال عمل الشركة:

- أعمال أبنية: □ رئيسي □ فرعي □ لا يوجد

- أعمال مياه وصرف صحي: □ رئيسي □ فرعي □ لا يوجد
- أعمال طرق: □ رئيسي □ فرعي □ لا يوجد

3- درجة تصنيف الشركة حسب تصنيف اتحاد المقاولين لمجالات العمل التالية:
- أعمال أبنية: □ درجة أولى □ درجة ثانية □ درجة ثالثة
- أعمال مياه وصرف صحي: □ درجة أولى □ درجة ثانية □ درجة ثالثة
- أعمال طرق: □ درجة أولى □ درجة ثانية □ درجة ثالثة

4- المركز الإداري لمن يقوم بتعبئة الاستبيان:
□ مدير/ نائب مدير □ مدير مشروع أو مشاريع □ مهندس موقع
□ غير ذلك_____

5- متوسط عدد الموظفين خلال الخمس سنوات الماضية: _____

6- متوسط عدد الموظفين حسب الشهادات العلمية خلال الخمس سنوات الماضية:
- ماجستير فأعلى: □ لا يوجد □ يوجد عدد _____
- بكالوريوس: □ لا يوجد □ يوجد عدد _____
- معهد متوسط: □ لا يوجد □ يوجد عدد _____
- ثانوية عامة: □ لا يوجد □ يوجد عدد _____
- دون الثانوية العامة: □ لا يوجد □ يوجد عدد _____

7- متوسط عدد الموظفين الفنيين حسب مجالات التخصص الهندسي خلال الخمس سنوات الماضية:
- مهندس مدني □ لا يوجد □ يوجد عدد _____
- مهندس معماري □ لا يوجد □ يوجد عدد _____
- مهندس كهرباء □ لا يوجد □ يوجد عدد _____
- مهندس مكانيك □ لا يوجد □ يوجد عدد _____
- مهندس متخصص بغير ما ذكر □ لا يوجد □ يوجد عدد _____
- فني □ لا يوجد □ يوجد عدد _____

8- عدد المشاريع المنفذة خلال الخمس سنوات الماضية:
□ **50-41** □ **40-31** □ **30-21** □ **20-11** □ **10 فأقل**
□ **أكثر من 50**

9.- إجمالي قيمة المشاريع المنفذة خلال الخمس سنوات الماضية (بالمليون دولار):
□ **7.5-6.1** □ **6-4.6** □ **4.5-3.1** □ **3-1.6** □ **1.5 فأقل**
□ **أكبر من 7.5**

10. الشخص المخول بعملية إدارة المواد في مشاريع التشييد لديكم:
□ مدير/ نائب مدير □ مدير مشروع أو مشاريع □ مهندس موقع
□ قسم خاص بذلك □ غير ذلك_____

الجزء الثانى/استخدام أدوات وتقنيات نظام إدارة مواد البناء فى مشاريع التشيد:

11- يرجى إبداء رأيكم في درجة ضرورة ومدى استخدامكم للتقنيات التالية في إدارة مواد البناء لمشاريع التشييد:

مسلسل	الطريقة	درجة الضرورة			مدى الاستخدام		
		ضروري	ضروري نوعا ما	غير ضروري	تستخدم عادة	تستخدم أحيانا	تستخدم نادرا
	إنشاء قواعد بيانات:						
1	إنشاء قاعدة بيانات لتصنيف المواد.						
2	إنشاء قاعدة بيانات للموردين المحليين.						
3	إنشاء قاعدة بيانات للموردين الخارجيين.						
4	إنشاء قاعدة بيانات للمواد وأسعارها.						
	تحديث قواعد البيانات:						
5	تحديث قواعد البيانات للموردين المحليين.						
6	تحديث قواعد البيانات للموردين الخارجيين.						
7	تحديث قواعد البيانات لأسعار المواد عند حدوث تغير في الأسعار.						
8	استخدام الإنترنت للتعرف علي المواد الجديدة والأسعار الجديدة.						

12- يرجي إبداء رأيكم في درجة ضرورة ومدي استخدام تقنيات إدارة مواد البناء وكذلك طرق الاستخدام:
(ملاحظة/:يرجي إرفاق أي نماذج تستخدمونها في عملية إدارة مواد البناء لمشاريع التشييد)

مسلسل	الطريقة	درجة الضرورة			مدى الاستخدام			طريقة الاستخدام			
		ضروري	ضروري نوعا ما	غير ضروري	تستخدم عادة	تستخدم أحيانا	تستخدم نادرا	باستخدام نموذج محوسب	تسجيل باستخدام نموذج	تسجيل بدون استخدام نموذج	بدون تسجيل
1	توفر قائمة بالمواد الموجودة في موقع المشروع تحتوي مثلا علي (اسم المادة-رقم المادة-الوحدة-السعر).										
2	التسجيل اليومي للمواد المستخدمة في المشروع .										
3	وجود بطاقات لكل مادة لاستخدام مخزن المشروع يشمل (الرصيد-المصروف-المتبقي).										
4	وجود نموذج طلبية مواد لموقع المشروع يوضح مثلا(رقم الطلبية-وصف المادة-الكمية المطلوبة-السعر).										
5	تسجيل المواد المستلمة في المشروع يوضح مثلا (رقم الإرسالية-اسم المورد-وصف المادة-كمية المادة).										

6	تسجيل حالة المواد في مخزن الموقع يوضح مثلا(اسم المورد-رقم الطلبية-الكمية الداخلة-المصروفة).									
7	تسجيل الإشكاليات مثلا(الفاقد-السرقة أو الضياع –نقص في التوريد عند الاستلام).									
8	متابعة الأسعار في السوق وتسجيل تغيرات الأسعار.									
9	متابعة تذبذب حالات الإغلاقات الأمنية في السوق.									

الجزء الثالث / تأثير الإغلاقات الأمنية على وفرة المواد وأسعارها في قطاع غزة:

13- يرجى إبداء رأيكم في مدي تأثير الإغلاقات على العوامل التالية:

مسلسل	العامل	يؤثر بدرجة كبيرة جدا	يؤثر بدرجة كبيرة	يؤثر بدرجة متوسطة	يؤثر بدرجة قليلة	يؤثر بدرجة قليلة جدا
1	يؤثر الإغلاق الأمني للقطاع علي زيادة أسعار بعض المواد الأساسية مثل (أسمنت+حصمة+حديد).					
2	يؤثر الإغلاق الأمني للقطاع علي زيادة في أسعار بعض المواد الأخرى مثل (مواد الدهان+مواد الكهرباء+مواد صحية).					
3	يؤثر الإغلاق الأمني للقطاع علي زيادة أسعار مقاولي الباطن.					
4	يؤثر الإغلاق الأمني للقطاع علي تأخير تنفيذ المشروع عن الوقت المحدد له.					
5	يؤثر الإغلاق الأمني للقطاع علي زيادة في تكلفة المشروع بشكل عام.					

الجزء الرابع / استخدام الحاسوب في نظام إدارة مواد البناء في مشاريع التشييد

14- بين مدي استخدام شركتكم لبرامج حاسوب في دعم إدارة مواد البناء في مشاريع التشييد:

تستخدم برامج متخصصة □ **Excel تستخدم برامج جداول إلكترونية مثل الأكسل** □ **لا تستخدم** □

15- بين مدي كفاءة استخدام شركتكم لبرامج الحاسوب التالية:

Word □ **جيد جدا** □ **جيد** □ **مقبول** □ **ضعيف** □ **ضعيف جدا**

Excel □ **جيد جدا** □ **جيد** □ **مقبول** □ **ضعيف** □ **ضعيف جدا**

Access □ **جيد جدا** □ **جيد** □ **مقبول** □ **ضعيف** □ **ضعيف جدا**

Ms-Project □ **جيد جدا** □ **جيد** □ **مقبول** □ **ضعيف** □ **ضعيف جدا**

16- بين مدى تأثير المعوقات التالية علي استخدام برامج الحاسوب المتخصصة في إدارة مواد البناء في مشاريع التشييد:

مسلسل	المعوقات	يؤثر بدرجة كبيرة جدا	يؤثر بدرجة كبيرة	يؤثر بدرجة متوسطة	يؤثر بدرجة قليلة	يؤثر بدرجة قليلة جدا
1	عدم إدراك أهمية نظام إدارة مواد البناء للمقاول.					
2	عدم فهم نظام إدارة مواد البناء.					
3	عدم القدرة على تطبيق نظام إدارة مواد البناء.					
4	عدم توفر برامج حاسوب سهلة و متخصصة في إدارة مواد البناء.					
5	عدم وجود أشخاص مؤهلين لاستخدام برامج الحاسوب المتخصصة.					
6	إمكانية و سهولة الإدارة يدويا عن استخدام الحاسوب.					
7	التكلفة المالية للبرنامج المرتفعة نسبيا.					
8	الاعتقاد بأن تطبيق النظام يضيع وقت المشرفين على تنفيذ المشروع.					

17- سأكون مستعدا لاقتناء واستخدام برنامج متخصص في إدارة مواد البناء في حال كونه سهل الاستخدام وقليل التكاليف.

□ **موافق جدا** □ **موافق** □ **لا أدري** □ **غير موافق** □ **غير موافق جدا**

الجزء الخامس / تطبيق نظام إدارة مواد البناء على مشاريع التشييد

5-1 أهمية تطبيق نظام إدارة المواد

18- بين مدى تأثير الفوائد التالية عند تطبيق نظام إدارة مواد البناء:

مسلسل	الفائدة	يؤثر بدرجة كبيرة جدا	يؤثر بدرجة كبيرة	يؤثر بدرجة متوسطة	يؤثر بدرجة قليلة	يؤثر بدرجة قليلة جدا
1	تقليل تكاليف مواد البناء اللازمة للمشروع.					
2	تحسين طرق مناولة المواد Better handling of (material).					
3	التقليل من تكرار طلبات المواد.					
4	توفر المواد في موقع العمل في الوقت المناسب والكمية المناسبة.					
5	تحسين في إنتاجية العمال.					
6	الالتزام بالجدول الزمني للمشروع.					
7	التحكم في الجودة.					
8	تحسين متابعة المواد والسيطرة عليها.					
9	العلاقات الجيدة مع الموردين.					
10	التقليل من الفاقد.					
11	التقليل من ساحات تخزين المواد في موقع العمل.					
12	الحصول علي أسعار أفضل للمواد.					
13	التحسين في توفر السيولة النقدية(cash flow).					

19- بين مدى أهمية تطبيق نظام إدارة المواد علي التقليل من المشاكل التالية:

مسلسل	المشكلة	مهمة جدا	مهمة	لا يوجد فرق	غير مهم	غير مهمة بتاتا
1	عدم توفر المواد كليا.					
2	عدم توفر المواد بالكميات المطلوبة.					
3	وصول المواد بشكل متأخر.					
4	تأخر الموافقة علي العينات المقدمة.					
5	استلام مواد غير صحيحة.					
6	استلام المواد و بمقاسات مختلفة عن المطلوب.					
7	استلام المواد بالكميات الغير مطلوبة.					
8	تكدس المواد في المخازن.					
9	سرقة المواد.					
10	تلف المواد أثناء الاستلام.					

2-5 طلب المواد Ordering materials

20- قيم العوامل التالية من حيث تأثيرها علي زيادة نسبة الكمية المطلوبة من المواد بشكل مبكر:

مسلسل	العامل	تأثير إيجابي واضح	تأثير إيجابي	لا يؤثر	تأثير سلبي	تأثير سلبي واضح
1	البرمجة الدقيقة للمشروع.					
2	طول فترة السماح للدفع من قبل المورد.					
3	إمكانية فقدان المواد أو تلفها.					
4	توفر القدرة المالية لدى المقاول.					
5	توفر ساحات تخزين كافية لدي المقاول.					

21-المسئول عن طلب المواد في الشركة هو.

□ مدير الشركة □ مهندس المشروع □ قسم المشتريات □ قسم خاص بذلك

□غير ذلك----------

22-بين مدى أهمية استخدام التقنيات التالية في طلب المواد من الموردين.

مسلسل	الطريقة	مهم جدا	مهم	لا أدري	غير مهم	غير مهم جدا
1	الإنترنت.					
2	البريد الإليكترونيe-mail.					
3	الفاكس.					
4	الاتصال بالهاتف.					
5	الذهاب شخصيا.					

3-5 تخزين المواد(Storage) :

23- ما هي المساحة المتوفرة لديكم من المخازن المغطاة:

□ 200 م2 فأقل □ 500-201 م2 □ 1000-501 م2 □ 2000-1001 م2

□ أكبر من 2000 م2

24- ما هي المساحة المتوفرة لديكم من المخازن غير المغطاة:

□ 1000م2 فأقل □ 3000-1001 م2 □ 6000-3001 م2 □ 10000-6001 م2

□ أكبر من 10000 م2

25- يتم الاحتفاظ بالمواد المختلفة في مخازن الشركة علي النحو التالي:

مسلسل	المادة	دائما	غالبا	أحيانا	نادرا	مطلقا
1	حديد التسليح.					
2	خشب الطوبار.					
3	إسمنت.					
4	رمل.					
5	حصمة.					
6	حجارة البلوك.					
7	بلاط.					
8	دهان.					
9	حجر صخر للواجهات.					
10	مواسير (صرف صحي+مياه).					
11	بلاط إسمنتي.					
12	حجر جبهة.					
13	مادة طبقة الأساس(Base course).					
14	مستلزمات كهربائية.					
15	مستلزمات صحية.					

26- بين مدى تأثير العوامل التالية علي زيادة الفاقد في المخازن:

مسلسل	العامل	يؤثر بدرجة كبيرة جدا	يؤثر بدرجة كبيرة	يؤثر بدرجة متوسطة	يؤثر بدرجة قليلة	يؤثر بدرجة قليلة جدا
1	تخزين خاطئ للمواد (عدم ترتيبها حسب النوع).					
2	تكدس المواد وعدم كفاية مخزن الموقع.					
3	التعليمات غير كافية عن كيفية التخزين.					
4	استخدام أماكن غير مناسبة للتخزين (رطبة- معتمة).					
5	عدم وجود أشخاص مؤهلين في إدارة المخازن .					

4-5 كيفية اعتماد الموردين How to qualify suppliers

27- حدد درجة أهمية العوامل التالية في تقييم واعتماد الموردين:

مسلسل	العامل	مهم جدا	مهم	لا أدري	غير مهم	غير مهم جدا
1	منافسة الأسعار المقدمة منهم.					
2	قصر الفترة الزمنية لتسليم المواد .					
3	جودة المواد المقدمة.					
4	الامتيازات وزيادة فترة السماح للدفع.					
5	سمعة المورد في السوق.					
6	توفر شبكة فروع جيدة للموردين في المناطق المختلفة.					

28- تتم مواجهة المشاكل التالية أثناء تقيم الموردين على النحو التالي:

مسلسل	المادة	دائما	غالبا	أحيانا	نادرا	مطلقا
1	وجود مورد وحيد للمادة المطلوبة.					
2	عدم توفر المعلومات المطلوبة عن الموردين.					
3	عدم صدق المعلومات المتوفرة.					
4	عدم وجود عقوبات تفرض ضد الموردين في حالة الخلل بالاتفاق.					
5	عدم القدرة علي إلزام المورد بتنفيذ العقد.					
6	الظروف السياسية السائدة.					

5-5الفاقد في مواد البناء

29- حدد مدى أهمية معرفة الفاقد في المواد للعوامل التالية:

مسلسل	الأهمية	موافق بشدة	موافق	محايد	غير موافق	غير موافق بشدة
1	يساعد في معرفة الكميات المطلوبة بالضبط لتنفيذ المشروع.					
2	يزيد في فرصة الحصول على تمويل للمشروع.					
3	يساعد على إعداد جدول كميات دقيق.					
4	يساعد المقاولين على تسعير العطاءات بشكل دقيق.					
5	تحسين فرصة الفوز بالعطاء.					
6	معرفة المتطلبات الحقيقية للمشروع المراد تنفيذه والمتمثلة في المواد والزمن والتكاليف.					
7	يساهم في نجاح المشروع وتحقيق الأرباح.					
8	يساهم في تحضير جدول زمني دقيق يشمل موارد المشروع.					
9	يساعد المقاول في إعداد جداول زمنية دقيقة لتوريد المواد.					

6-5 العناصر التي تسبب زيادة الفاقد في الموقع

30- بين مدي تأثير العناصر التالية علي زيادة الفاقد:

مسلسل	العناصر التي تسبب زيادة الفاقد في الموقع	الفاقد في مواد البناء				
		يؤثر بدرجة كبيرة جدا	يؤثر بدرجة كبيرة	يؤثر بدرجة متوسطة	يؤثر بدرجة قليلة	يؤثر بدرجة قليلة جدا
	(أ) في الموقع:					
1	تلف مواد البناء في الموقع.					
2	القص الغير مناسب لمواد البناء.					
3	وجود مواد غير ضرورية في الموقع.					
4	إنتاج كميات أكثر مما هو مطلوب أو قبل الحاجة إليها.					
5	المواد بها عيوب من التصنيع.					
6	السرقة أو التخريب.					
7	رداءة مواد البناء.					
8	نقص المواد المطلوبة بسبب الإغلاق والطلب المتزايد عليها.					
9	نقص الرقابة على المواد في الموقع.					
10	عدم تخزين المواد بشكل صحيح .					
11	زيادة في حجم العناصر الإنشائية أثناء التنفيذ.					
12	استخدام كميات أو أطوال أو أقطار زائدة من المواد دون الحاجة					

مسلسل	العناصر التي تسبب زيادة الفاقد في الموقع	الفاقد في مواد البناء				
		يؤثر بدرجة كبيرة جدا	يؤثر بدرجة كبيرة	يؤثر بدرجة متوسطة	يؤثر بدرجة قليلة	يؤثر بدرجة قليلة جدا
	لذلك.					
	(ب) مناولة المواد:					
13	سوء مناولة المواد داخل الموقع.					
14	النقل المتكرر لمواد البناء داخل الموقع.					
15	التعليمات غير كافية عن كيفية مناولة المواد داخل الموقع.					
	(ج) النقل:					
16	نقل المواد بطريقة غير صحيحة مما يؤدى إلى تلفها.					
17	عدم تخزين المواد في مكان قريب من موقع الإنشاء .					
	(د) إدارة الموقع:					
18	الافتقار إلى خطة لإدارة المواد والوقت.					
19	الافتقار إلى نظام لضبط الجودة.					
20	سوء تخطيط موقع العمل (إهمال الموقع- صعوبة التنقل).					
21	عدم كفاءة طاقم المقاول في التنفيذ.					
22	تزويد فريق العمل في المشروع بمعلومات ضئيلة.					
23	عدم كفاءة المقاول في الرقابة على سير عمل المشروع.					
24	نقص المهنيين والمشرفين في طاقم المقاول.					
25	البطء في اتخاذ القرار من قبل المقاول .					
26	التأخير عن بدء العمل بالمشروع.					
	(و) الإشراف على الموقع:					
27	ضعف المراقبة و الإشراف وتأخر تعليمات المشرف.					
28	طاقم الاستشاري الذي تم تعيينه في المشروع غير مؤهل.					
29	تأخر مهندس الاستشاري في الرد علي تساؤلات المقاول .					
30	تأخر مهندس الاستشاري في الموافقة على تنفيذ أو تفتيش أو فحص أعمال المقاول.					
31	سوء الاتصال والتنسيق بين المالك و مهندس الاستشاري و المقاول.					
32	تأخر المالك في تسليم المشروع للمقاول.					
33	إيقاف العمل من طرف المالك.					
34	الأوامر التغييرية.					
35	عدم تعاون المالك مع المقاول والتأخر في الدفعات وحل مطالباته.					

Annex 2

The Questionnaire (English Version)

Section one: Company Profile:

1- Year of company establishment _____

2- Company work field:

- Building work : □ Main □ Secondary □ Unspecialized
- Water and sewerage works: □ Main □ Secondary □ Unspecialized
- Roads works: □ Main □ Secondary □ Unspecialized

3- Company classification according the contracting union for the following fields:

- Building works: □ First class □ Second class □ Third class
- Water and sewerage works: □ First class □ Second class □ Third class
- Roads works □ First class □ Second class □ Third class

4- Managerial position of the respondent:

□ Director/Deputy director □ Project manager □ Site engineer □ Other way

5- Average of employees' number during the last five years_____

6- Average of employees' number (in the year) during the last five years according to their scientific certificates:

- MSc. And higher □ Existing Number_____
- BSc.: □ Existing Number_____
- Community Collage: □ Existing Number_____
- Baccalaureate-Tawjihi □ Existing Number_____
- Under baccalaureate: □ Existing Number_____

7- Average of technical employees' number during the last five years according to the engineering specialization:

Civil engineer_____ Architect engineer_____ Electrical engineer_____Mechanical engineer_____ other specialist engineer_____ Technical_____

8- Number of executed projects during the last five years:

- □ 10 and below □ 11-20 □ 21-30 □ 31-40 □ 41-50 □ More than 50

9- Total amount of executed projects during the last five years (in million dollars):

- □ 1.5 and lesser □ 1.6-3 □ 3.1-4.5 □ 4.6-60 □ 6.1-7.5 □ More than 7.5

10- The person in charge of managing construction materials in construction projects:

□ Company Director □ Project Manager □ Site Engineer
□ specific section □ Others. Determine ____

Section tow: Application of construction materials management tools and techniques in construction projects:

11. To which extent you evaluate the necessary and degree of usage of the next techniques in construction materials management:

No.	Techniques	Necessity degree			Usage degree		
		Necessary	Somehow necessary	Unnecessary	Usually	Occasionally	Rarely
	Establishing Data base						
1	Establishing categorized materials database						
2	Creating local suppliers database.						
3	Creating international suppliers database.						
4	Creating materials price database.						
	Updating database						
1	Updating the database of local suppliers.						
2	Updating the database of international suppliers.						
3	Updating the database for materials price when change occurs.						
4	Using internet for knowing the new materials and their prices.						

12. To which extent you evaluate the necessary, degree of usage, and method of use of the next techniques in construction materials management:

No	Techniques	Necessity degree			Usage degree			Method of use			
		Necessary	Somehow necessary	Unnecessary	Usually	Occasionally	Rarely	By using a computerized form	Recording by using a form	Recording without form	Without recording
1	Providing a list of materials in project that includes for example (material name, material number unit price).										
2	Daily recording of using materials in the project.										
3	Providing material cards at site store that contain for example (input-output-balance).										
4	Providing materials purchase order including for example (order number-material description-required quantity –price).										
5	Recording the received materials on site, the record										

No	Techniques	Necessity degree			Usage degree			Method of use			
		Necessary	Somehow necessary	Unnecessary	Usually	Occasionally	Rarely	By using a computerized form	Recording by using a form	Recording without form	Without recording
	shows for example (delivery number-supplier name-material description-quantity).										
6	Reporting the situation of materials in the projects' store, the report shows (supplier name-order number-quantity input-quantity output-balance).										
7	Reporting the problems for examples (wastage and breakage-thief and loss-shortage in delivery).										
8	Following up the prices in the market and recording the variation of prices.										
9	Following up the closure variations in the `market										

Section three: The effect of closure in Gaza strip on materials availability and cost:

13. To which extent you evaluate the effect of closure on the following factors:

No	Factor	Very high degree affect	High degree affect	Mid degree affect	Little degree affect	Very little degree affect
1	The closure causes a noticeable increase in the main material prices specially (cement, aggregate, and steel).					
2	The closure causes an increase of other material prices (painting, electrical, sewage material).					
3	The closure increases the subcontractors' rates.					
4	The closure causes a delay of a project completion.					
5	The closure causes an increase of total project cost.					

Section four: Computer applications in material management systems in construction projects:

14. using of your company of software for supporting the construction materials management.

☐ Not use. ☐ Use spreadsheet-based software (Ms Excel) ☐ Use special software

15. Rank the following software according your extent of handling them in the job:

Word	□ V. Good	□ Good	□ Acceptable	□ Low	□ V. Low
Excel	□ V. Good	□ Good	□ Acceptable	□ Low	□ V. Low
Access	□ V. Good	□ Good	□ Acceptable	□ Low	□ V. Low
Ms-project	□ V. Good	□ Good	□ Acceptable	□ Low	□ V. Low

16. To which extent you evaluate the next obstacles effect on the usage of construction materials management:

No.	Obstacle	Very high degree effect	High degree effect	Mid degree effect	Little degree effect	Very little degree effect
1	Non- realization of importance of construction materials management system by the contractor.					
2	Absence of understanding of construction materials management system.					
3	Inability implementation of the system.					
4	Shortage of user friendly of construction materials management system.					
5	Shortage of qualified persons in using a construction materials management system.					
6	Simplicity of manual managing a construction material.					
7	The high cost of a construction materials management system.					
8	The thinking that implementing the system wastes the time of project supervisors.					

17. I am ready to get and use user friendly and inexpensive cost of construction material management system.

□ strongly agree □ Agree □ Neutral □ Disagree □ strongly disagree.

Section five: Implementation of construction materials management systems on construction projects

1-5 Important of implementation a construction materials management system

18. To which extent you evaluate the effect of the following benefits when implement a construction materials management system:

No	Benefit	Very high degree effect	High degree effect	Mid degree effect	Little degree effect	Very little degree effect
1	Reducing the costs of project materials.					
2	Better handling of materials.					
3	Reducing duplication of materials orders.					
4	Materials are timely available on site with the right quantity.					
5	Improving labour productivity.					
6	Complying to time schedule.					
7	Complying to enhancement of quality control.					
8	Improving follow up and monitoring of construction materials.					
9	Better relationships with suppliers.					
10	Waste reduction.					
11	Reducing the space for materials on site.					
12	Obtaining better price for the construction materials.					
13	Improving cash flow.					

19. To which extent you evaluate the importance of implementing materials management to reduce the following problems:

No	Problem	Very important	important	No defense	Not important	Never Important
1	Materials are not available.					
2	Materials are not available with required quantity.					
3	Late delivery to the site.					
4	Slow response from the consultant engineer about submittals.					
5	Deliver wrong materials.					
6	Deliver materials with wrong dimensions.					
7	Deliver materials with wrong quantities.					
8	Increase materials quantity in storages.					
9	Burglary, theft and vandalism					
10	Destroyed materials when deliver.					

2-5 Ordering materials

20-To which extent you evaluate effect of the following factors on increasing quantity of materials early:

No	Factor	Clear positive effect	Positive effect	Don't affect	Negative affect	Clear negative affect
1	Good project schedule.					
2	Long of supplier period for contractor payment.					
3	Damage or waste of materials.					
4	Contractors cash capability.					
5	Sufficient storages available.					

21-The person who responsible about ordering materials:

□ Company manager □ site engineer □ procurement department

□ specific section □ others. Determine

22. Determine the importance degree of the following techniques to order materials from suppliers:

No	Problem	Very important	important	I don't Know	Not important	Never Important
1	Internet.					
2	E-mail.					
3	Fax.					
4	Telephone.					
5	Personal meeting.					

3-5 Storage materials:

23- Available area of covered storages:

□ 200m2and below □ 201-500m2 □ 501-1000m2 □ 1,001-2,000m2

□ more than 2,000m2

24- Available area of no covered storages:

□ 1,000m2and below □ 1,001-3,000m2 □ 3,001-6000m2 □6,001-10000m2

□ more than 10,000m2

25- The company stores the next materials as follow:

No	Material	Always	Often	Sometimes	Seldom	Never
1	Reinforcement steel.					
2	Shuttering timber.					
3	Cement.					
4	Sand.					
5	Aggregate.					
6	Blocks.					
7	Tiles.					
8	Painting.					
9	Stone.					
10	Pipes.					
11	Terrazzo tiles.					
12	Curb stone.					
13	Base course.					
14	Electrical materials.					
15	Sanitary materials.					

NO.	Factor	Very high degree affect	High degree affect	Mid degree affect	Little degree affect	Very little degree affect
1	In proper materials storage.					
2	Inadequate stacking and insufficient storage on site					
3	Insufficient instructions about storage and stacking					
4	Using unsuitable places for store materials					
5	Inappropriate storage leading to damage or deterioration					

26. To which extent these factors affect increasing waste in storage:

4-5.How to qualify suppliers:

27. To which extent you evaluate the important degree of the following factors in qualifying suppliers:

NO.	Factor	very important	important	Don't know	Not important	Little important
1	Price competitiveness.					
2	Short period to deliver materials to the contractor					
3	Quality of materials					
4	Increase payment period					
5	The capability of supplier in the market					
6	Having many branches in different geographical areas.					

28. To which extent you are facing the following problems when qualifying suppliers:

No.	problem	Always	Often	Sometimes	Seldom	Never
1	Sole supplier.					
2	Lack of required information about suppliers.					
3	Wrong information about suppliers.					
4	Lack of penalty measures against defaulted suppliers.					
5	Inability to enforce contract condition on suppliers.					
6	Prevailing political conditions.					

5-5 materials waste:

29- To which extent you evaluate the important degree on knowing materials waste for the following factors:

No.	Importance	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	Help to determine the exact required quantities.					
2	Increase the chance for obtaining the project finance.					
3	Help for preparing accurate bill of quantities.					
4	Help contractors to price tenders more accurately.					
5	Help the contractor to have a better chance to win the tender.					
6	Knowing the real requirements for the project (materials-time-cost)					
7	Help to finish the project successfully and have profits.					
8	Help in preparing a good schedule program including project resources.					

5-6. Factors increase waste on the construction site:

30. Explain the degree of effect for the following factors which increase waste on the construction site:

(1) Very high degree affect (2)High degree affect (3)Mid degree affect (4)Little degree affect (5)Very little degree affect

No.	Factors causes crease waste on site	Effects' Degree				
		1	2	3	4	5
(A): On site:						
1	Materials damage on site.					
2	Improper cutting of materials.					
3	Existence of unnecessary materials on site.					
4	Overproduction/Production of a quantity greater than required or earlier than necessary.					
5	Manufacturing defects.					
6	Burglary, theft and vandalism.					
7	Poor quality of materials.					
8	Lack of materials (due to closure).					
9	Lack of on site materials control.					
10	Poor storage of materials.					
11	Over sizing structural elements during execution.					
12	Using excessive quantities of materials.					
(B): Handling:						
13	Improper handling of materials on site.					
14	Duplication of transporting material on site.					
15	Insufficient instructions about handling materials on site.					
(C): Transportation:						
16	Improper materials.					
17	storing materials in far away stores					
(D): Site management and practices:						
18	Lack of material and time waste management plan.					
19	Lack of a quality management system aimed at waste minimization.					
20	Poor site layout.					
21	Poor qualification of the contractor’s technical staff assigned to the project.					
22	Providing project team with insufficient information.					
23	Ineffective control of the project progress by the contractor.					
24	Shortage of technical professionals in the contractor’s organization.					
25	contractors slowness in taking decisions.					
26	Delay in project commencement.					
(E): Site supervisor:						
27	Poor control of supervision and delay in giving instructions.					
28	Poor qualification of consultant engineer’s staff assigned to the project.					
29	Slow response from the consultant team to contractor inquiries.					
30	Delay in performing inspection and testing by the consultant team.					
31	Poor coordination and communication among the consultant, the owner and the contractor.					
32	Owner's delay in handing over the site to the contractor.					
33	Suspension of work by the owner.					
34	Change orders.					
35	Poor cooperation of the owner towards settling contractors payments and claims					

Annex 3

Review of Construction Materials Management Software Packages

(CMMS)

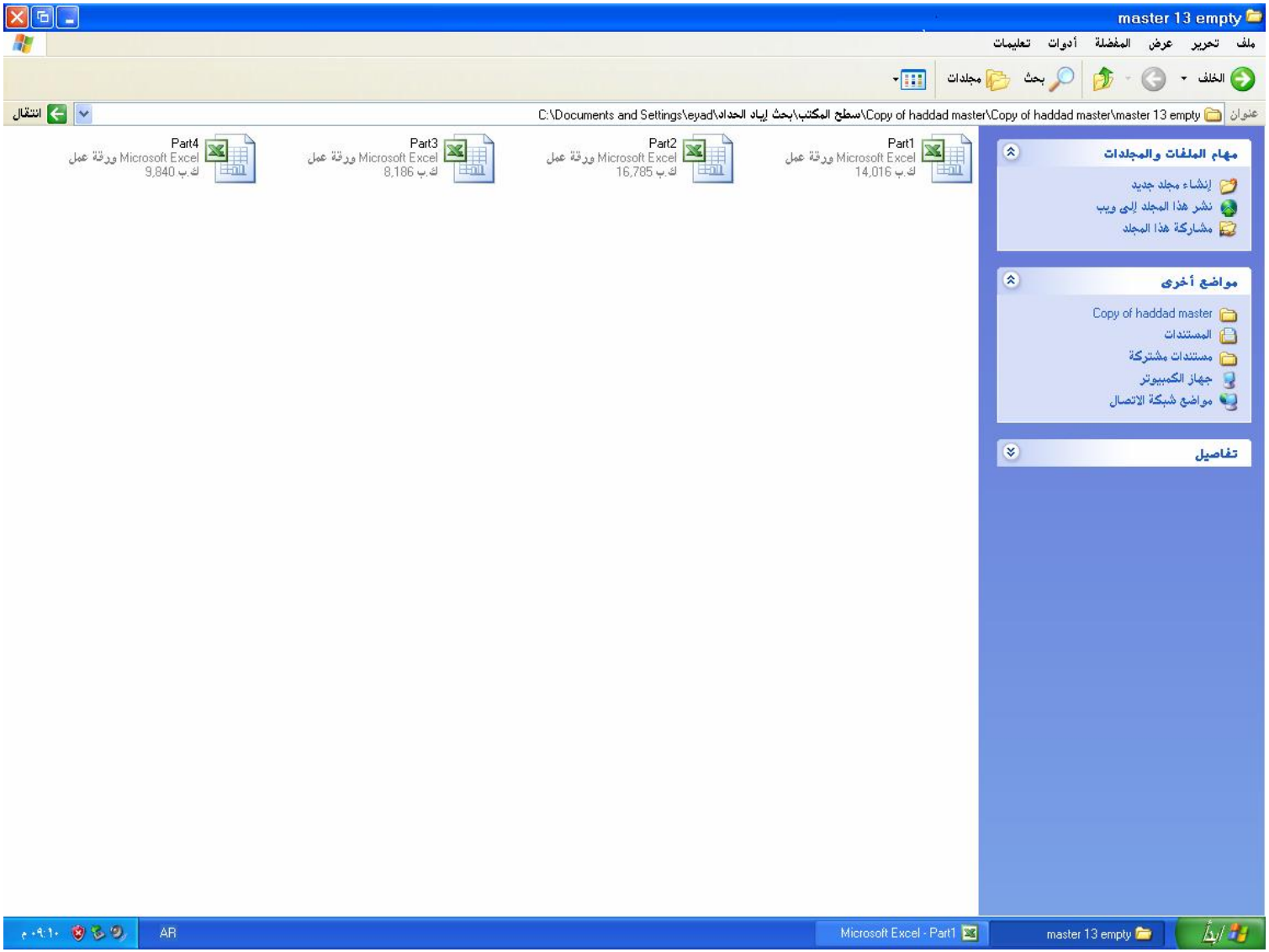


Figure A3.1: a sample of CMMS files.

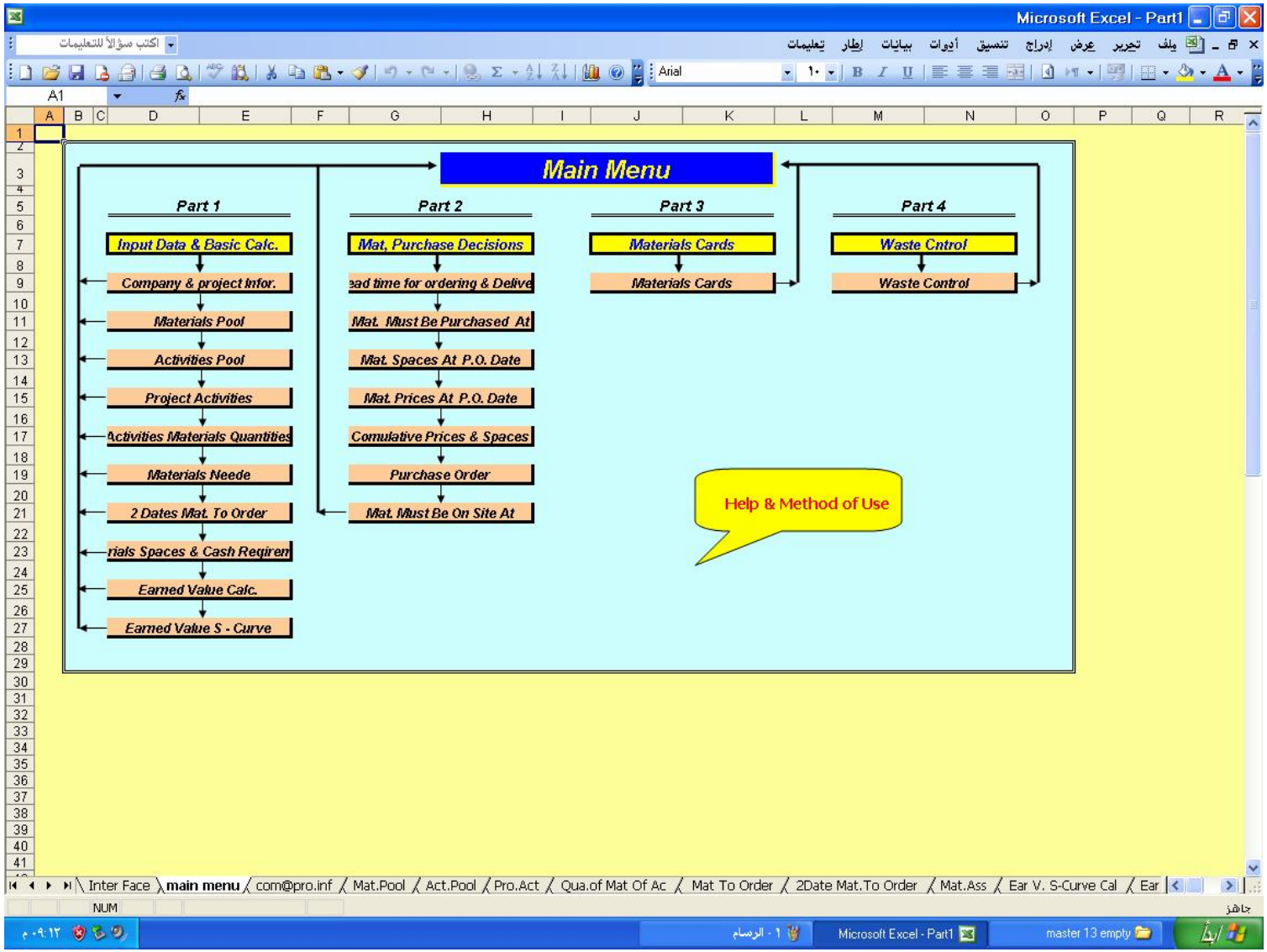


Figure A3.2: a sample of "Main Menu "sheet.

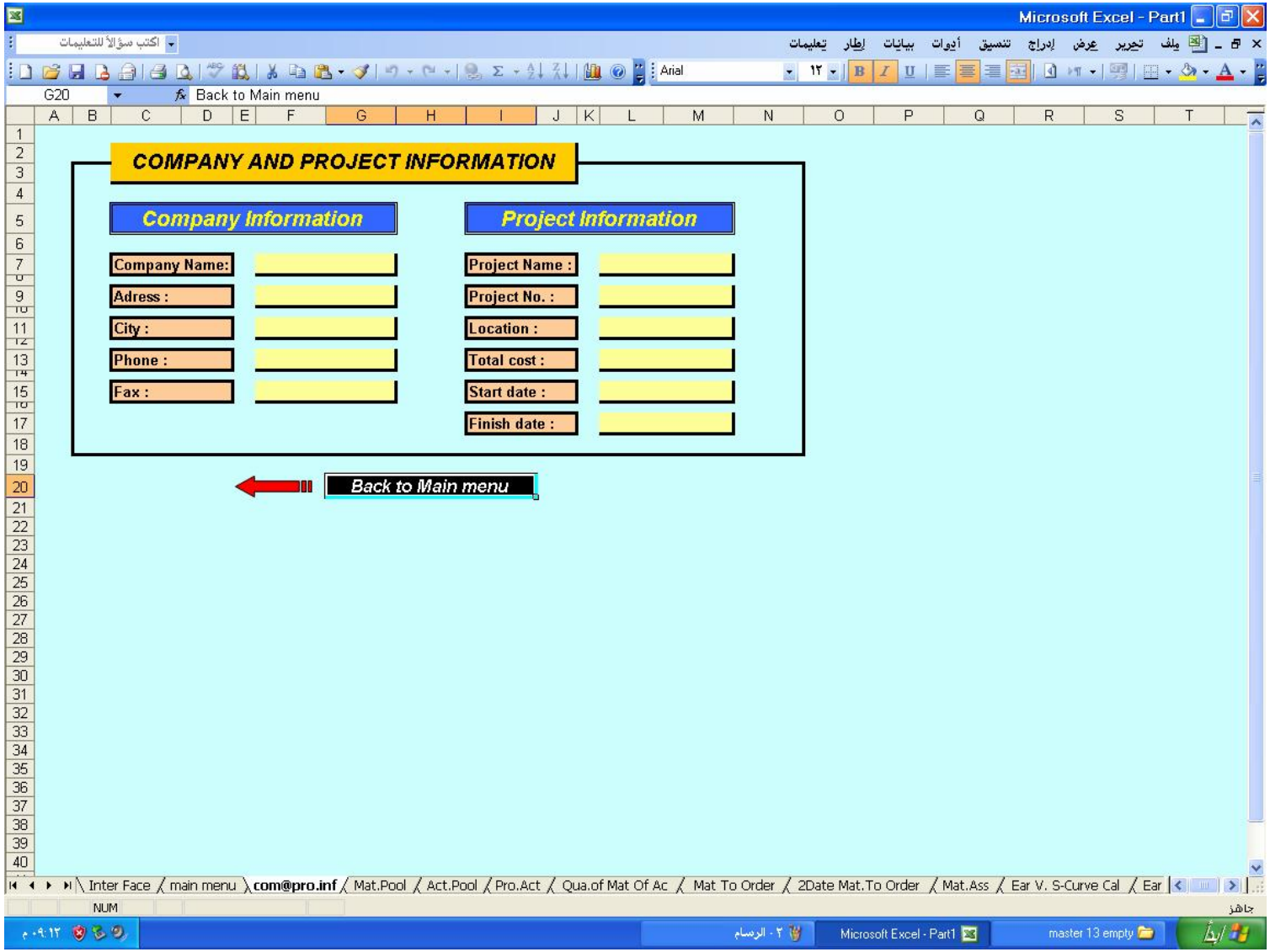


Figure A3.3 a sample of "Company and project information" sheet

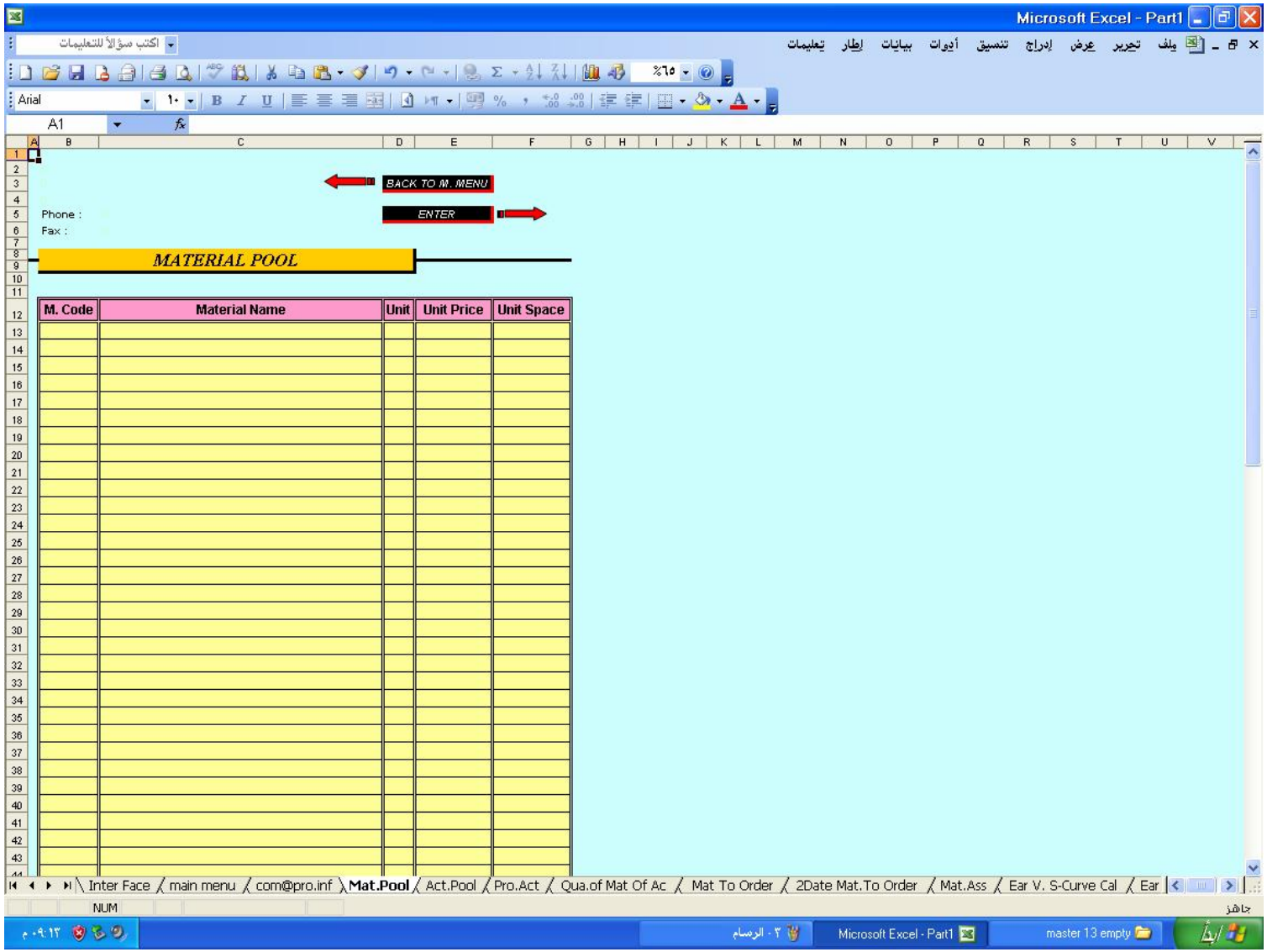


Figure A3.4: a sample of "Materials Pool" sheet.

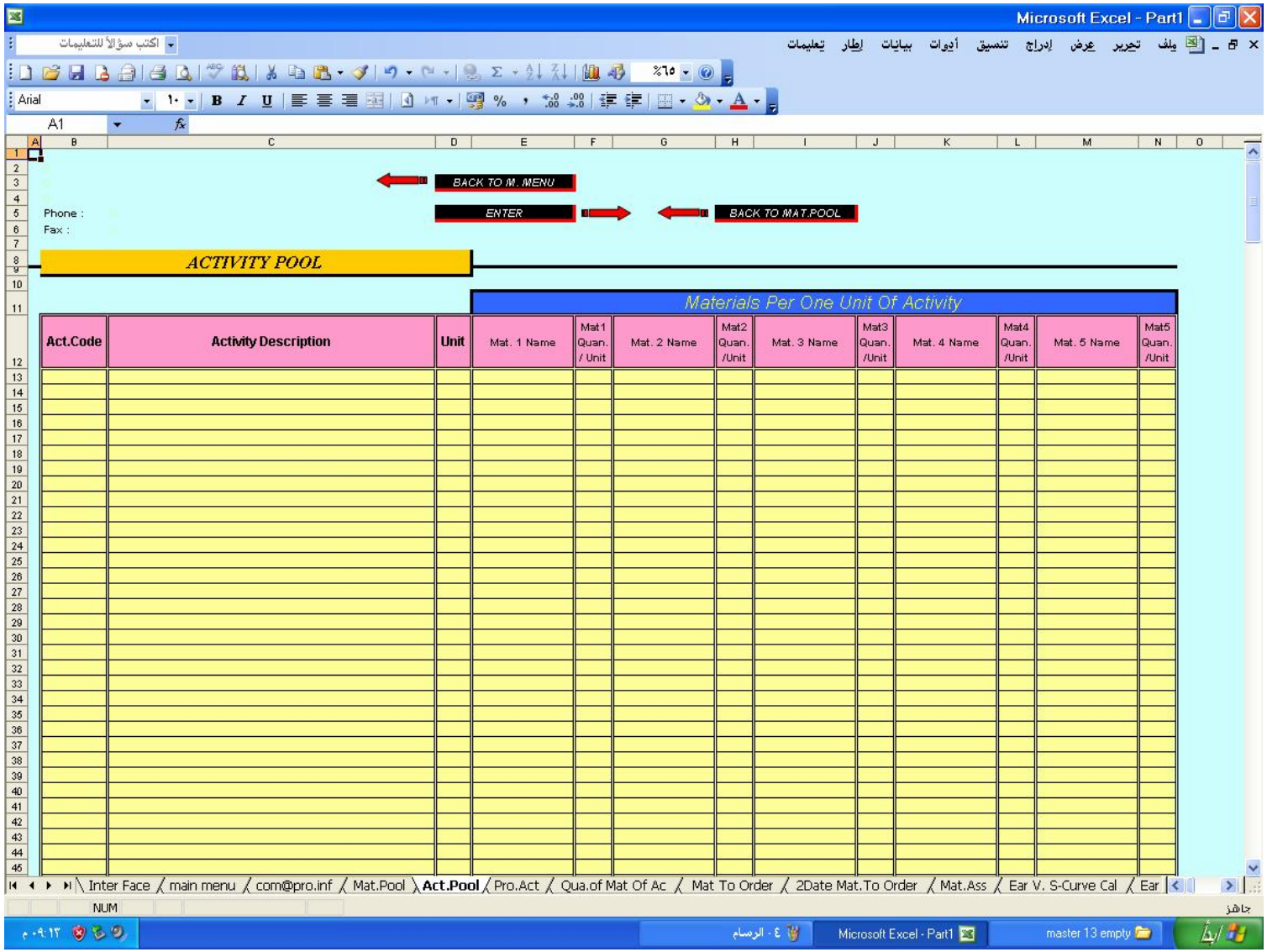


Figure A3.5: a sample "Activity Pool" sheet.

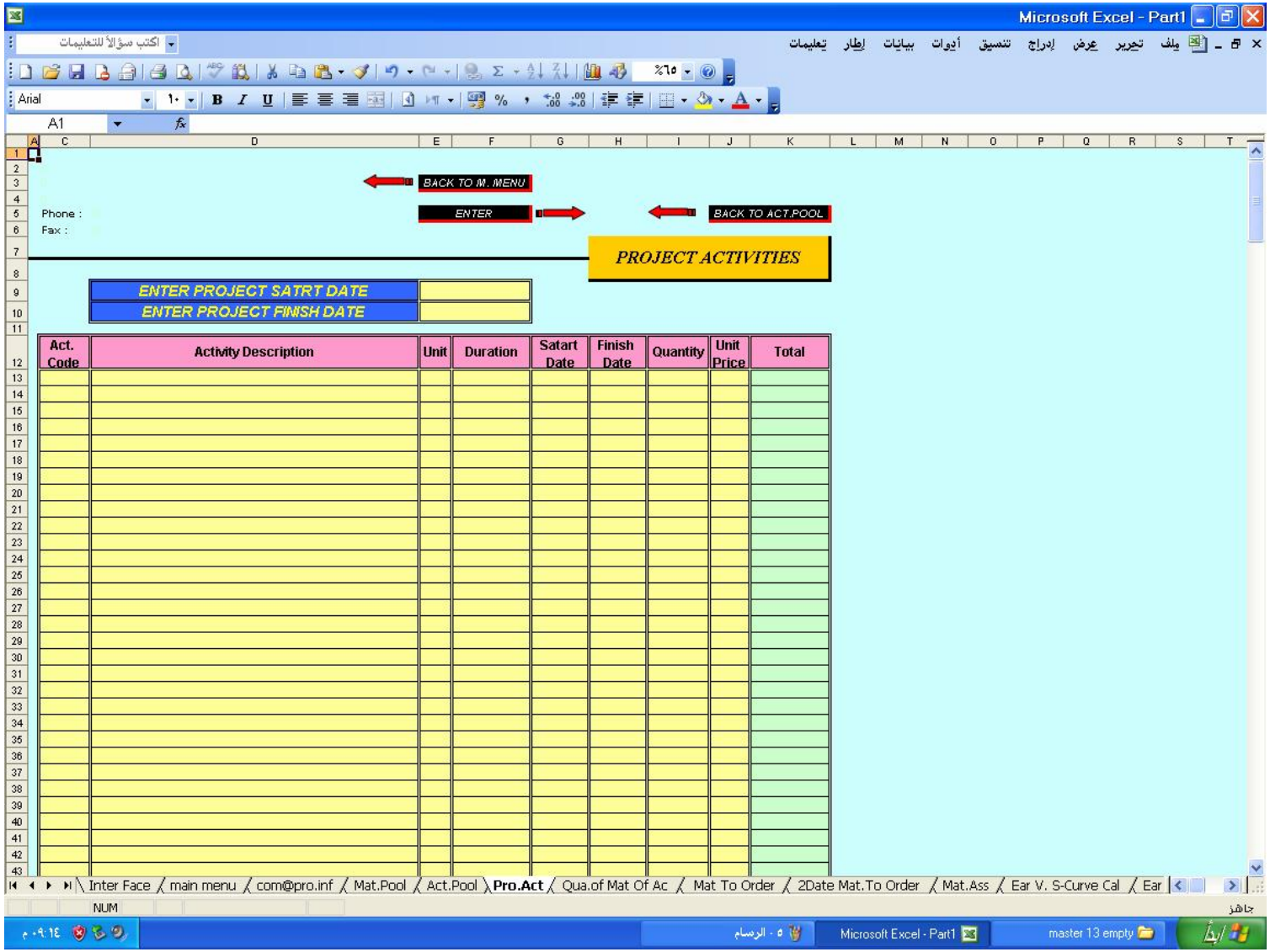


Figure A3.6: a sample of "Project Activities" sheet.

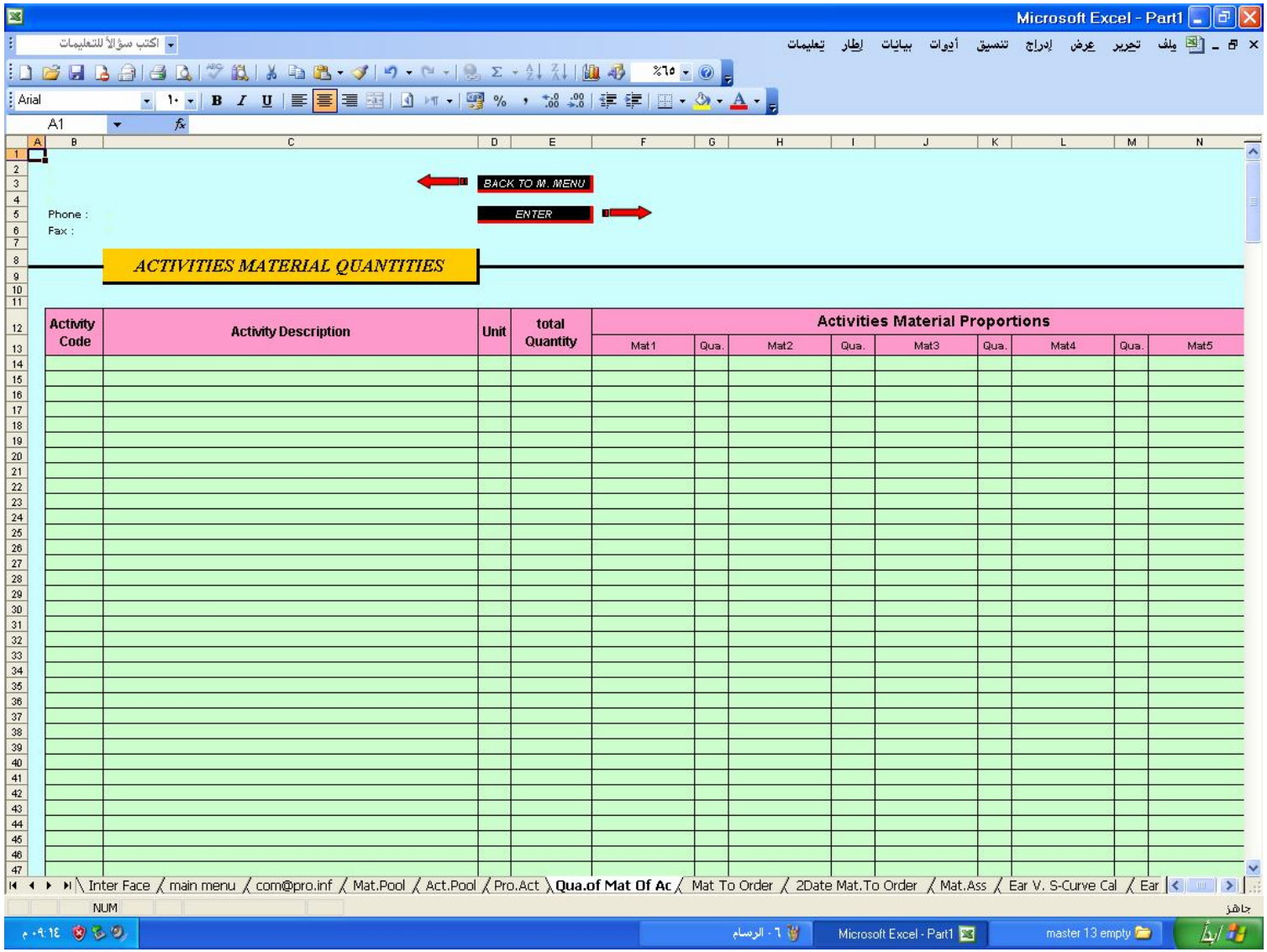


Figure A3.7: a sample of "Activities Materials Quantities" sheet.

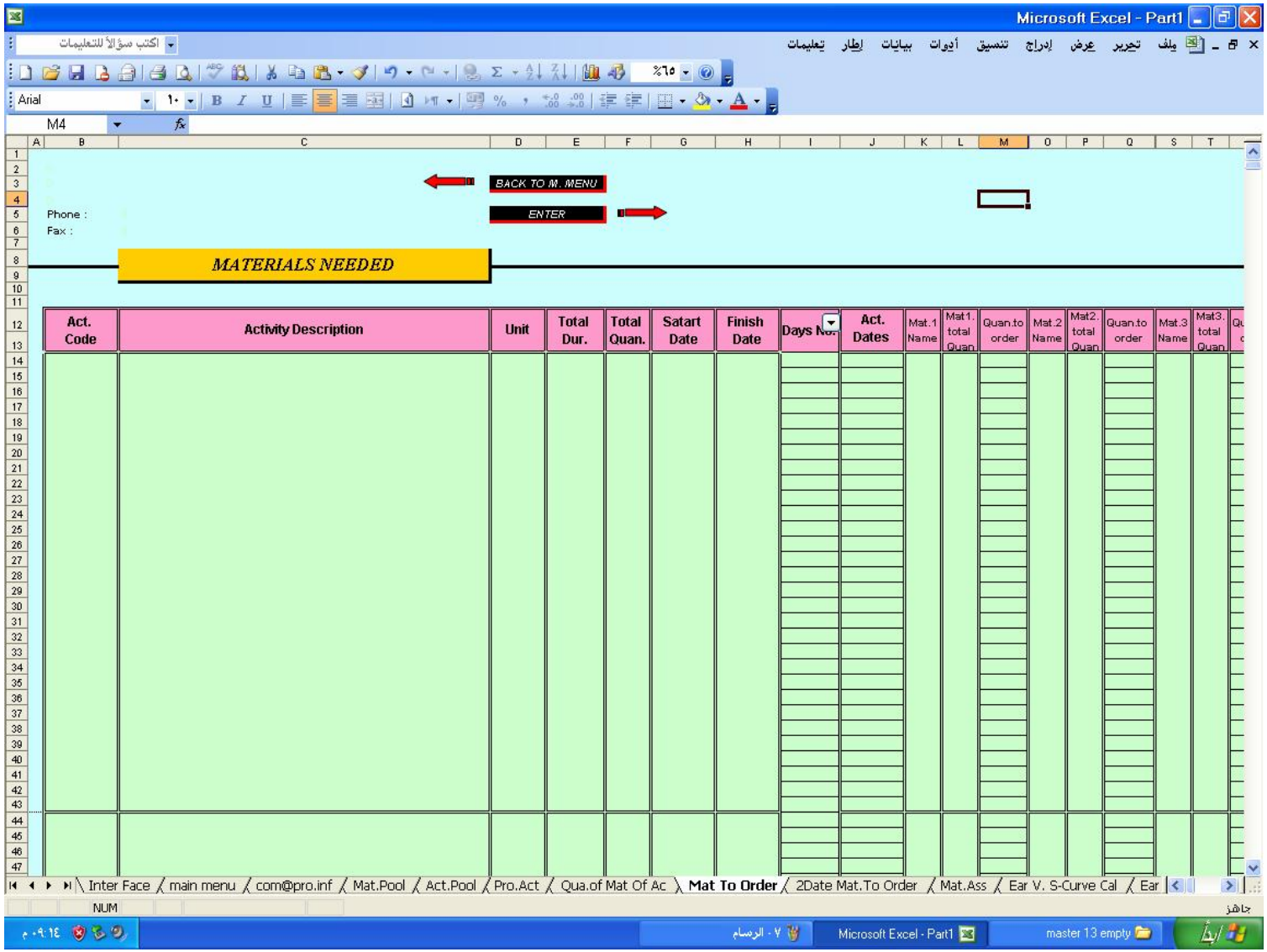


Figure A3.8: a sample of "Materials Needed" sheet.

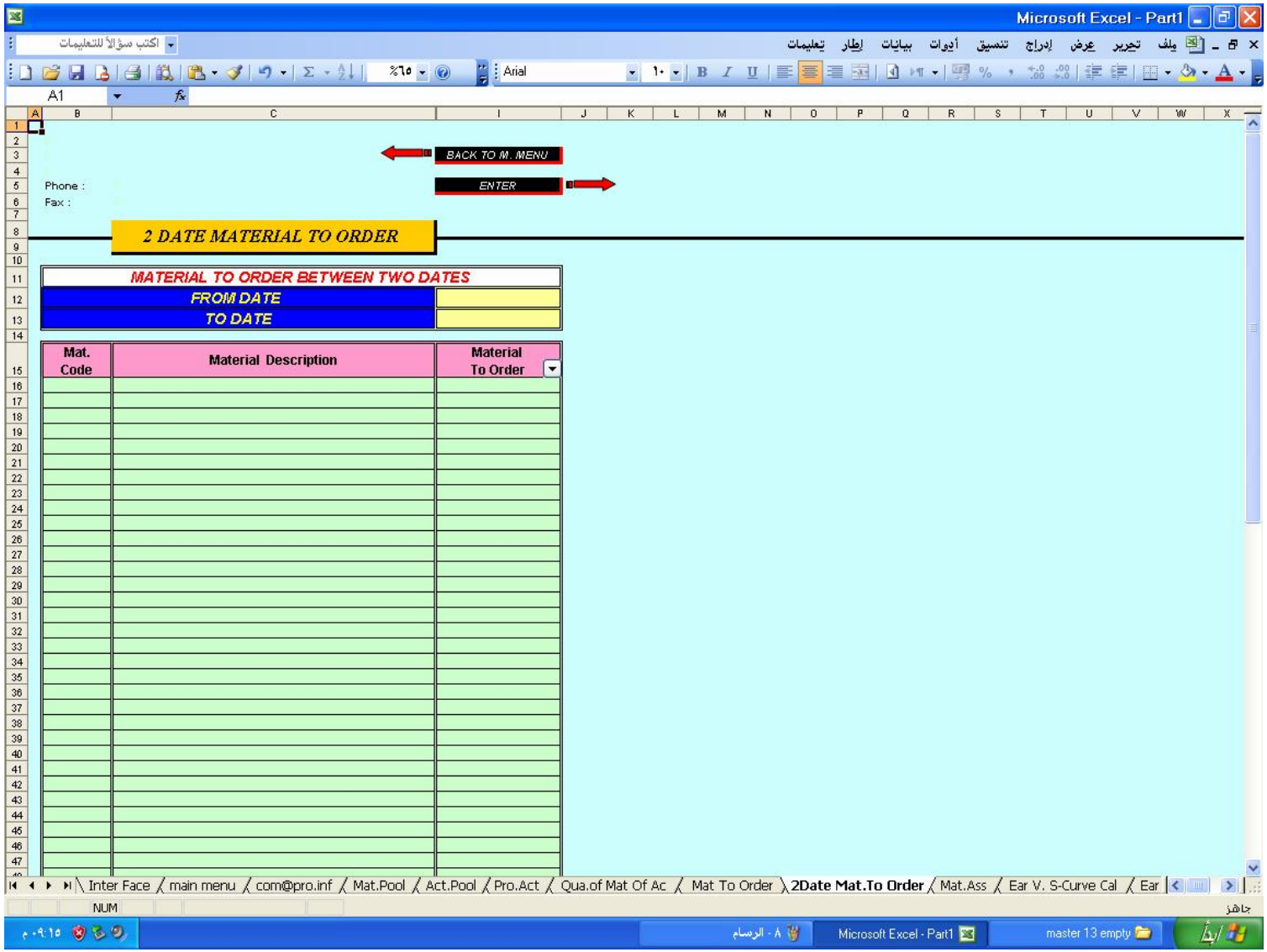


Figure A3.9: a sample of "Materials to Order between Two Dates" sheet.

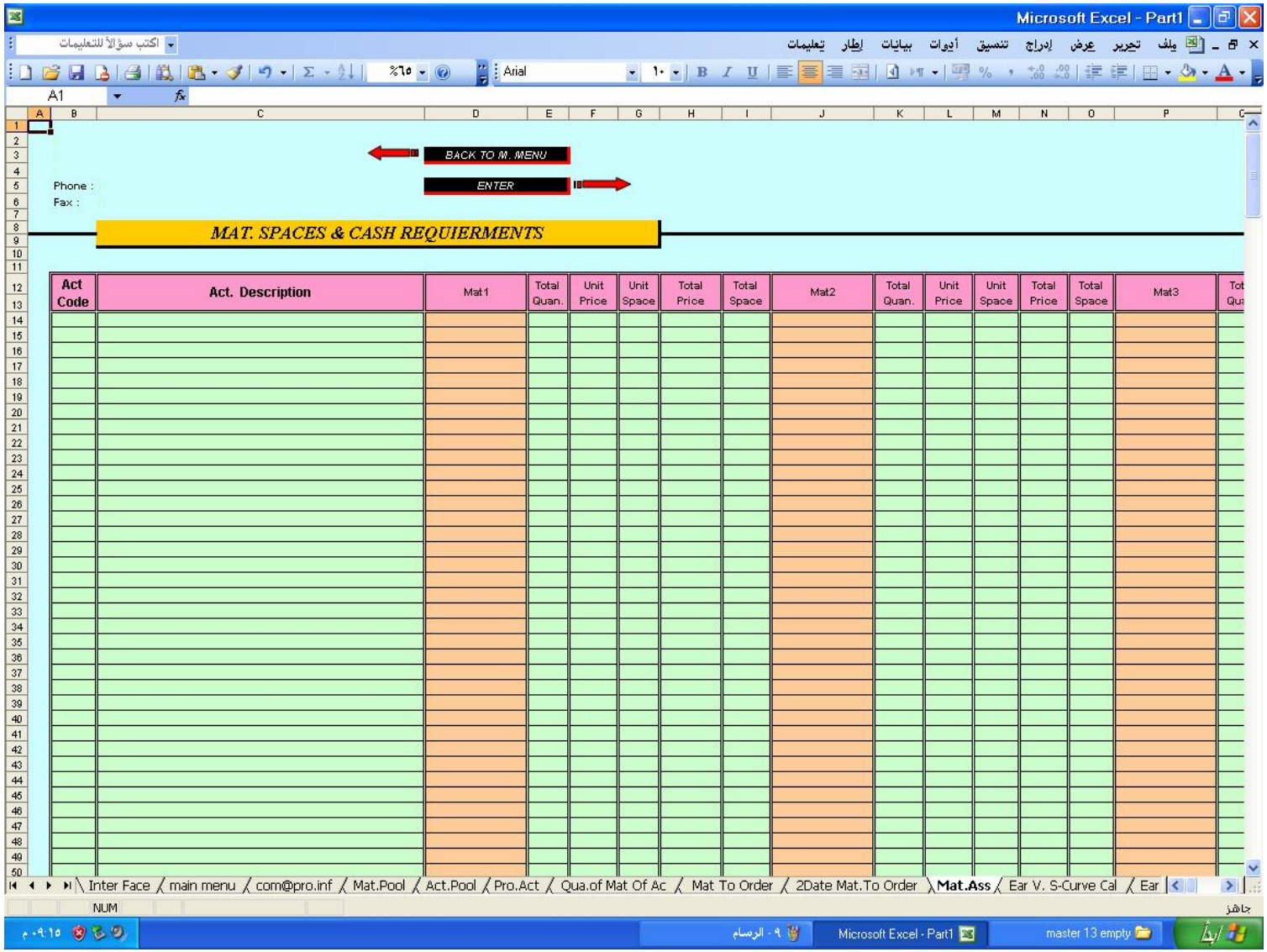


Figure A3.10: a sample of "Materials Spaces and Cash Requirements" sheet.

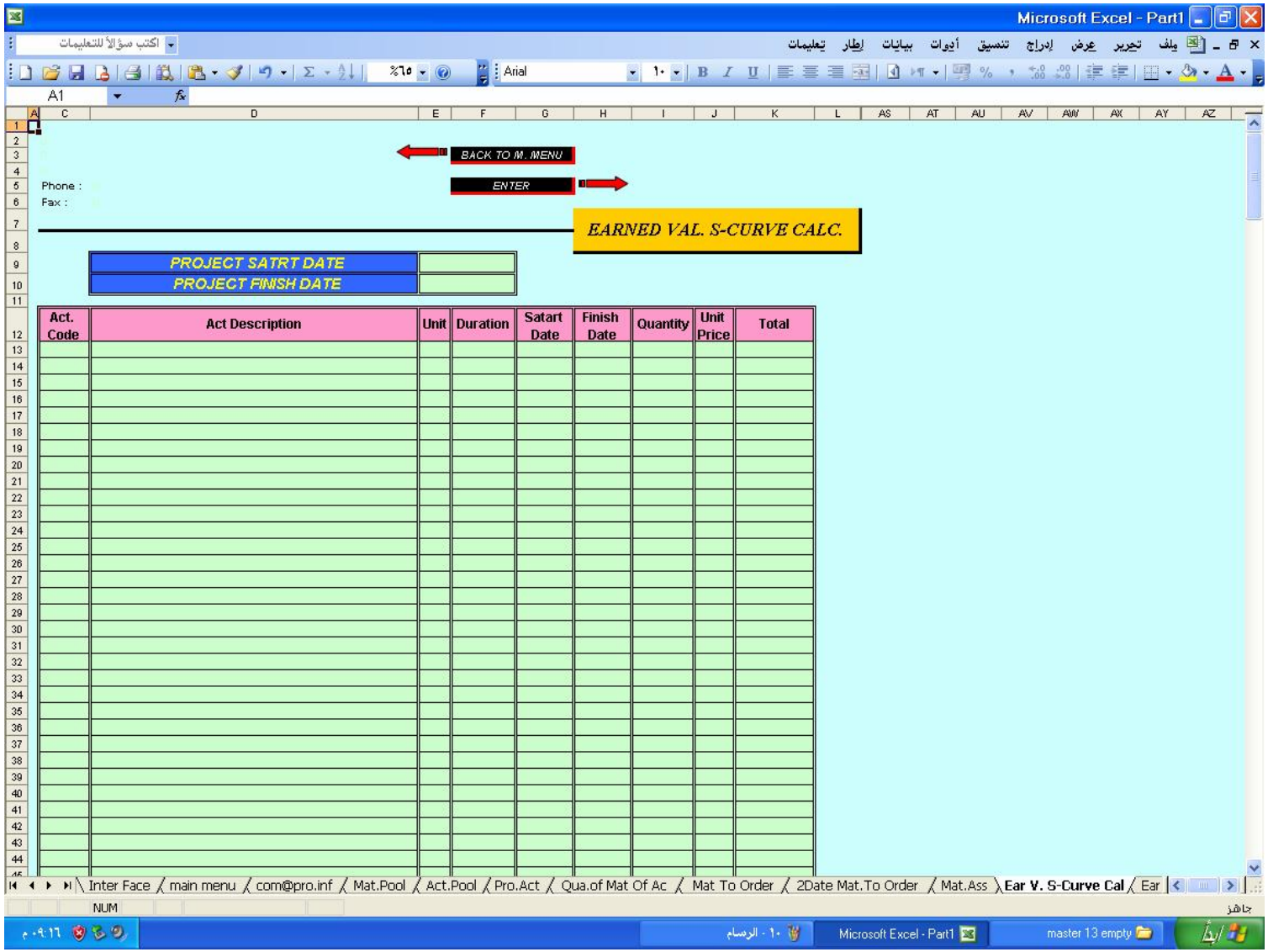


Figure A3.11: a sample of "Earned value S-curve calculation" sheet.

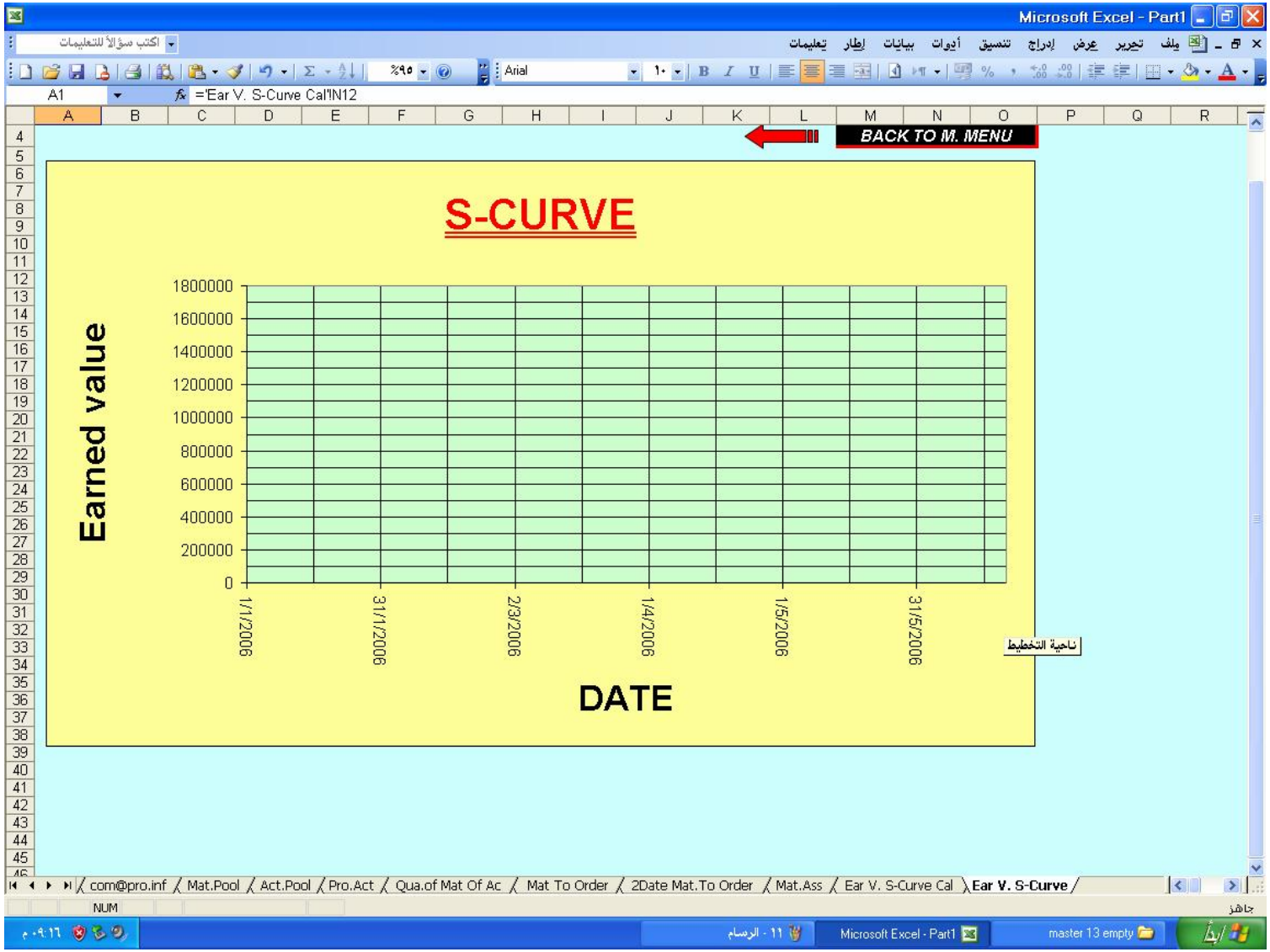


Figure A3.12: a sample of "Earned value S-curve".

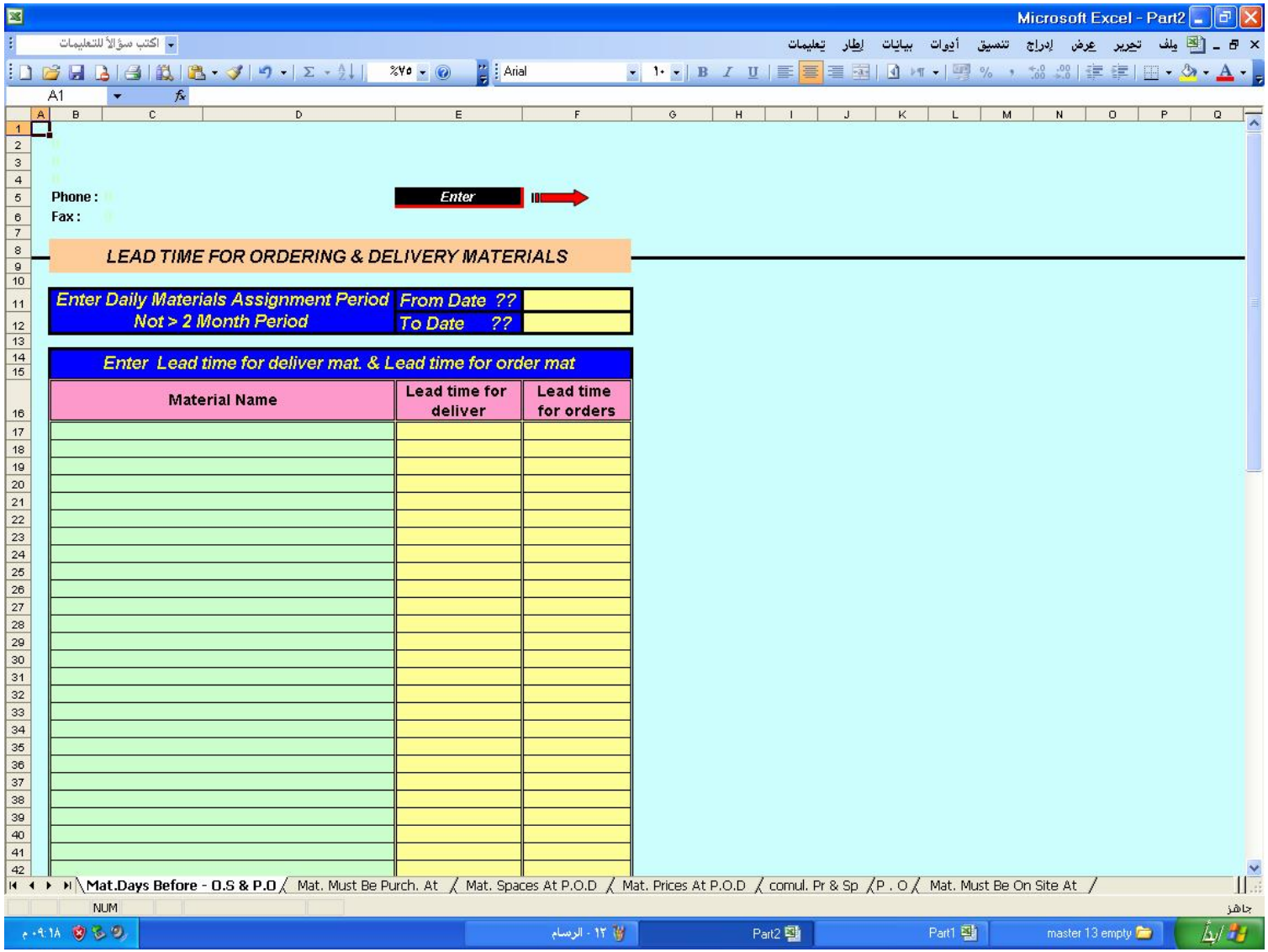


Figure A3.13: a sample of "Materials to order and deliver on site" sheet.

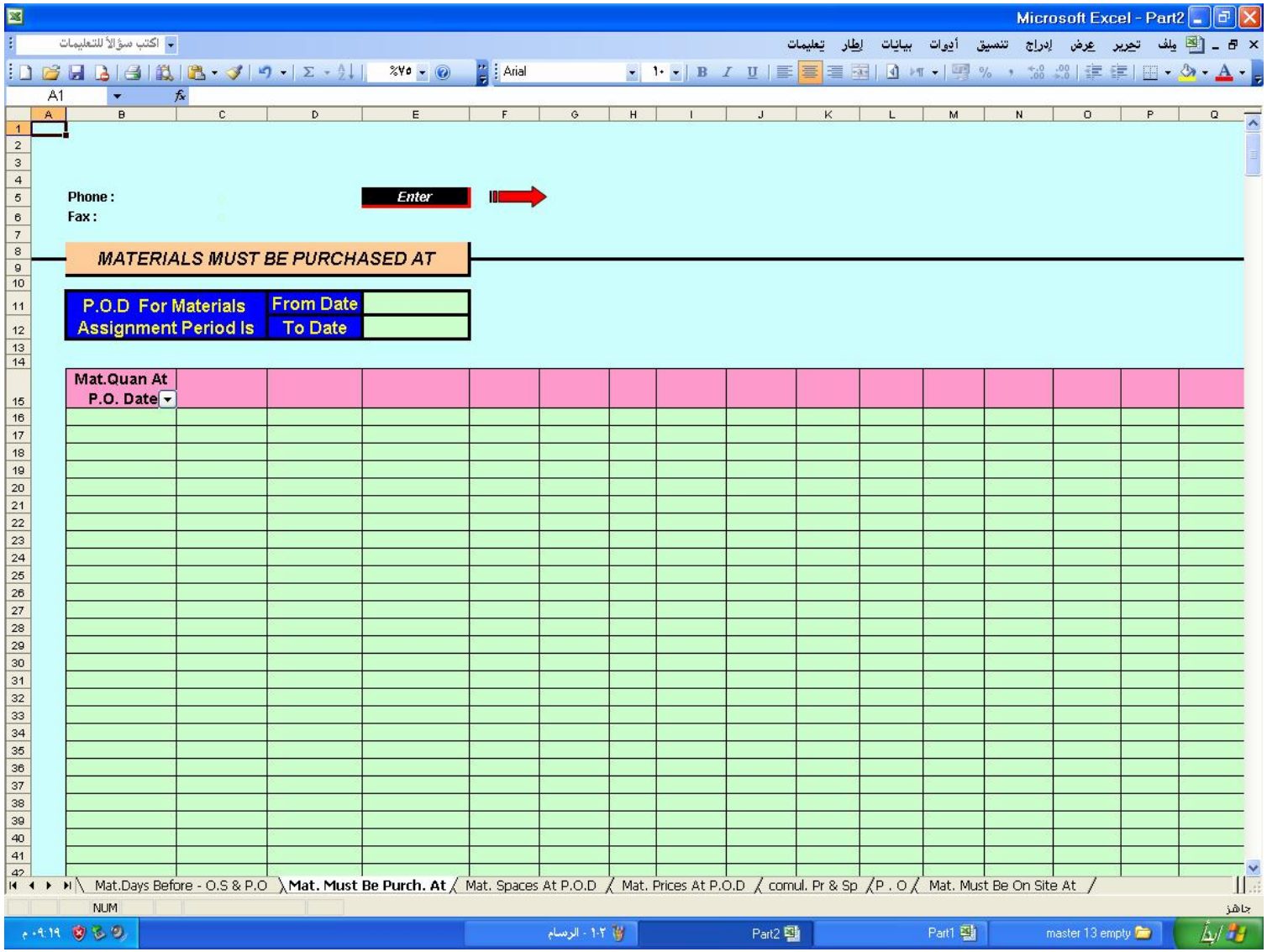


Figure A3.14: a sample of "Materials Must be purchased at' sheet.

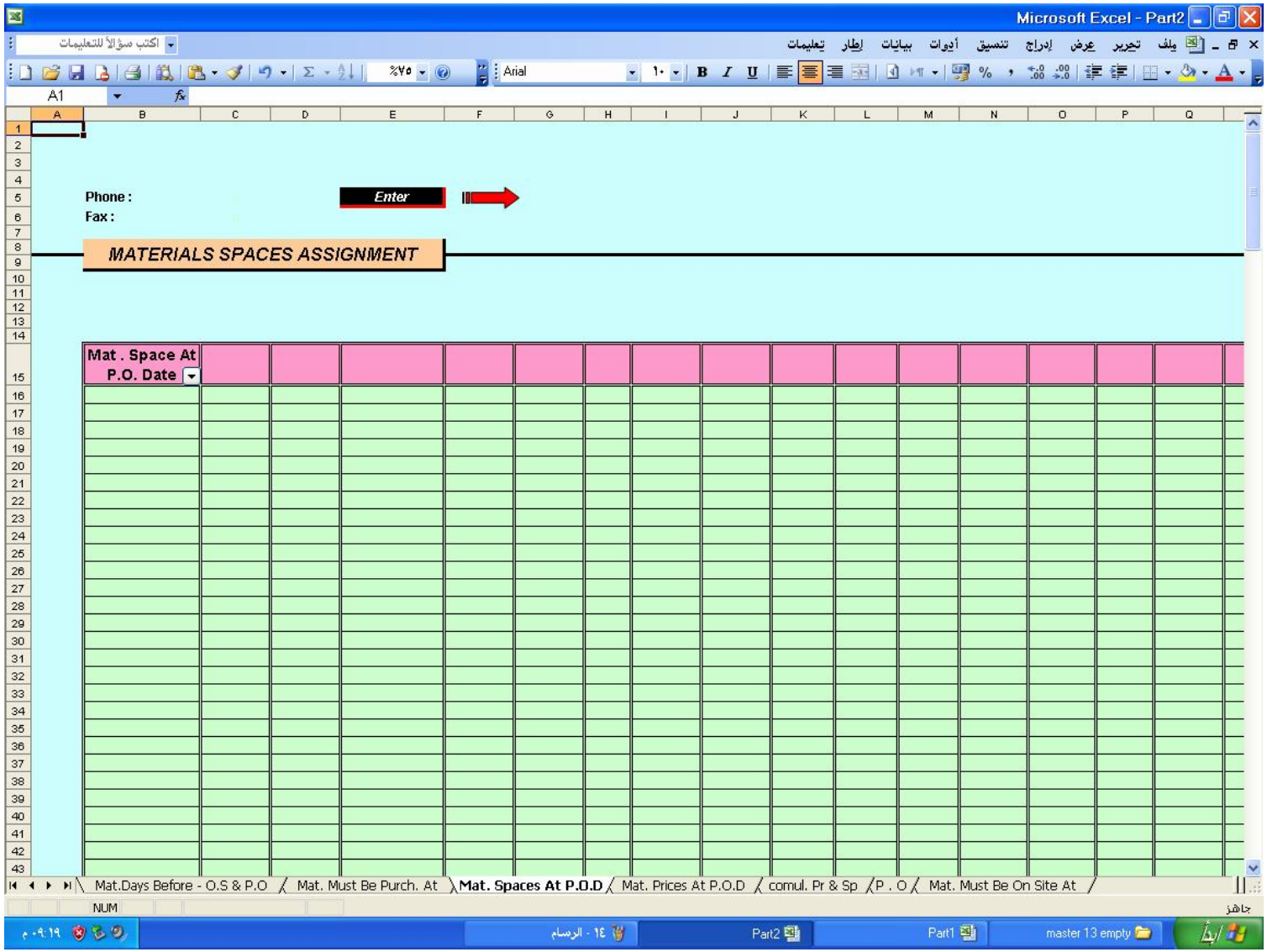


Figure A3.15: a sample of "Materials Spaces Assignment" sheet.

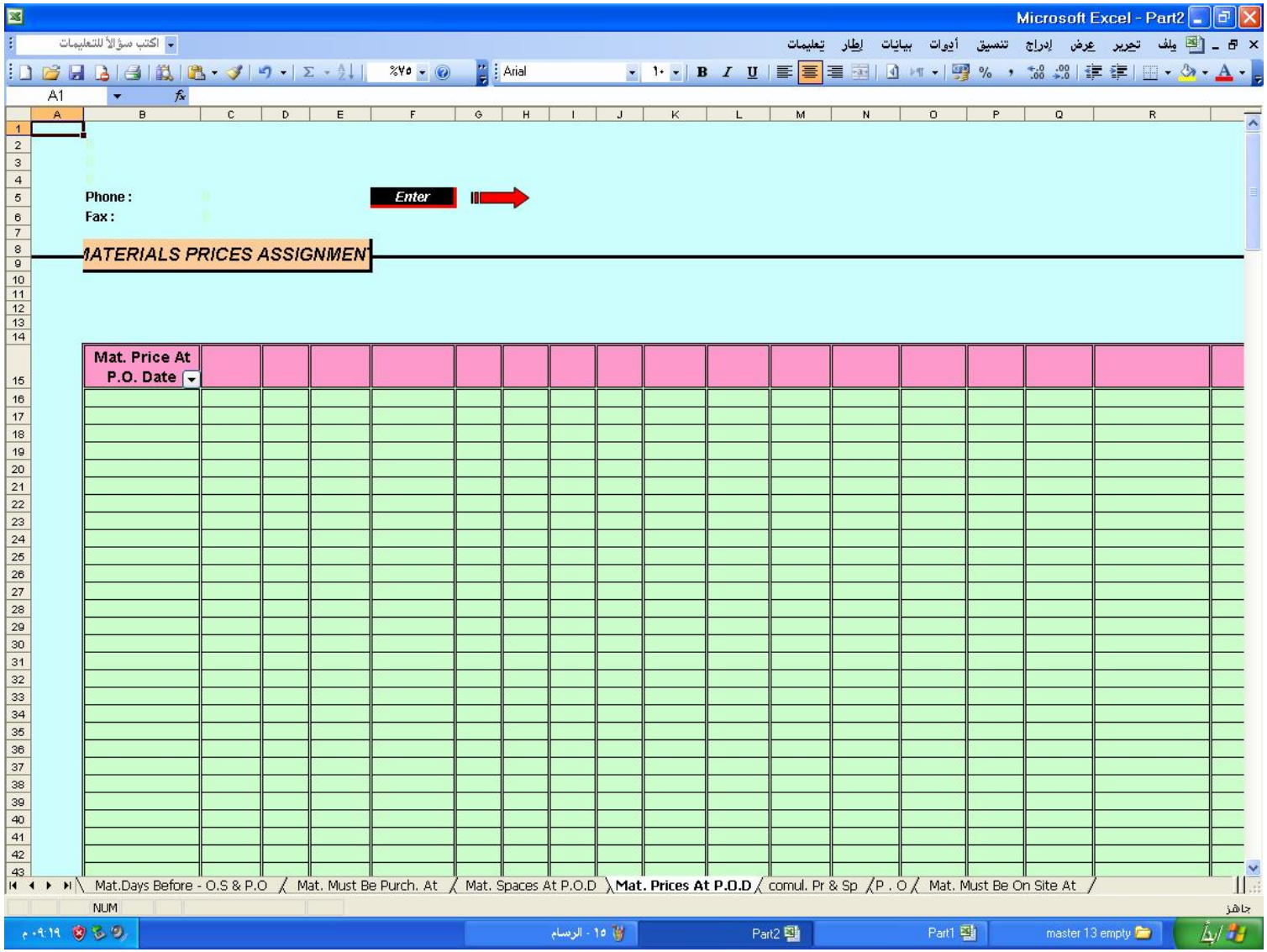


Figure A3.16: a sample of 'Materials Prices Assignment" sheet.

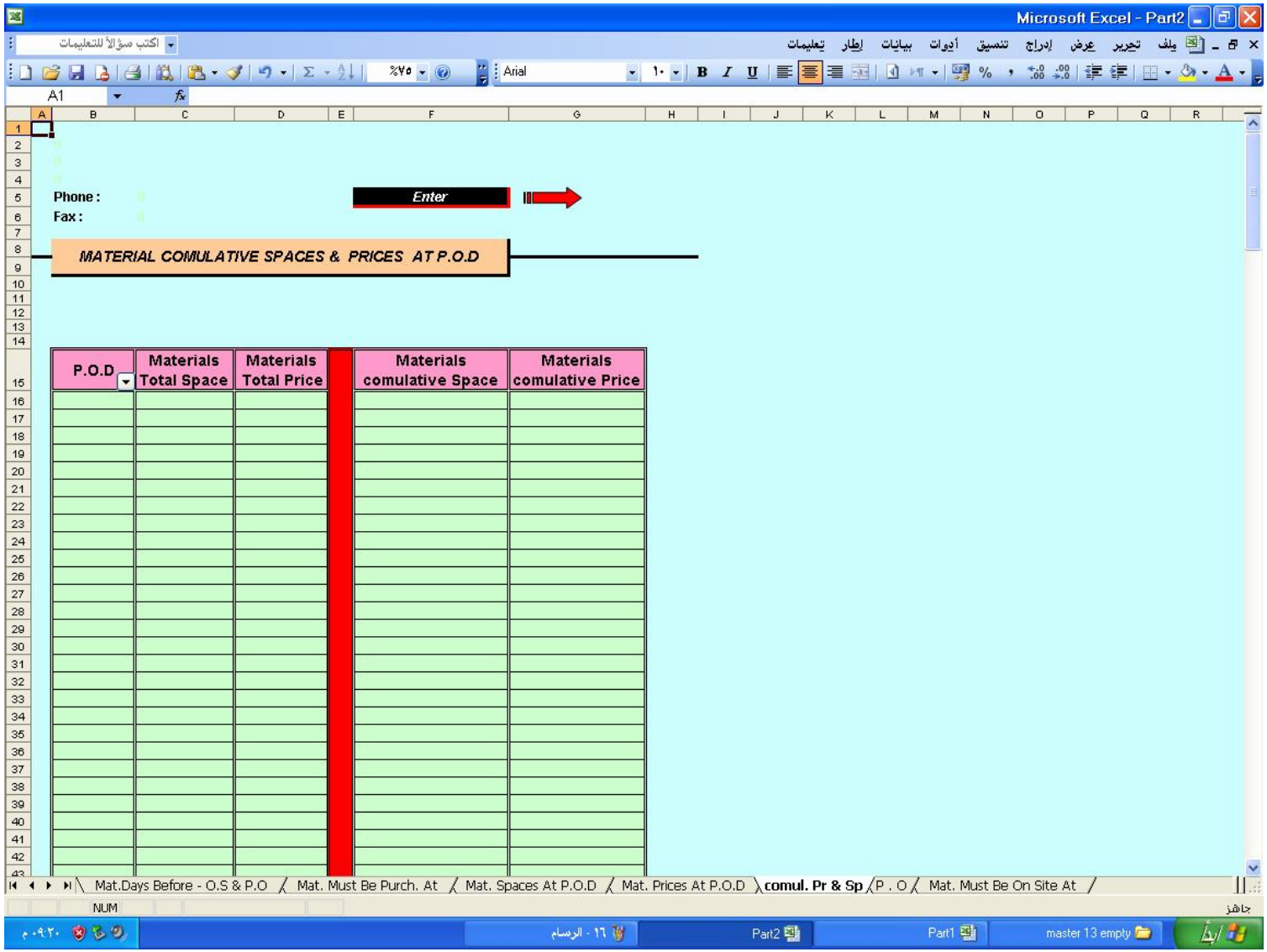


Figure A3.17: a sample of "Materials Cumulative Spaces & Prices at P.O.D" sheet.

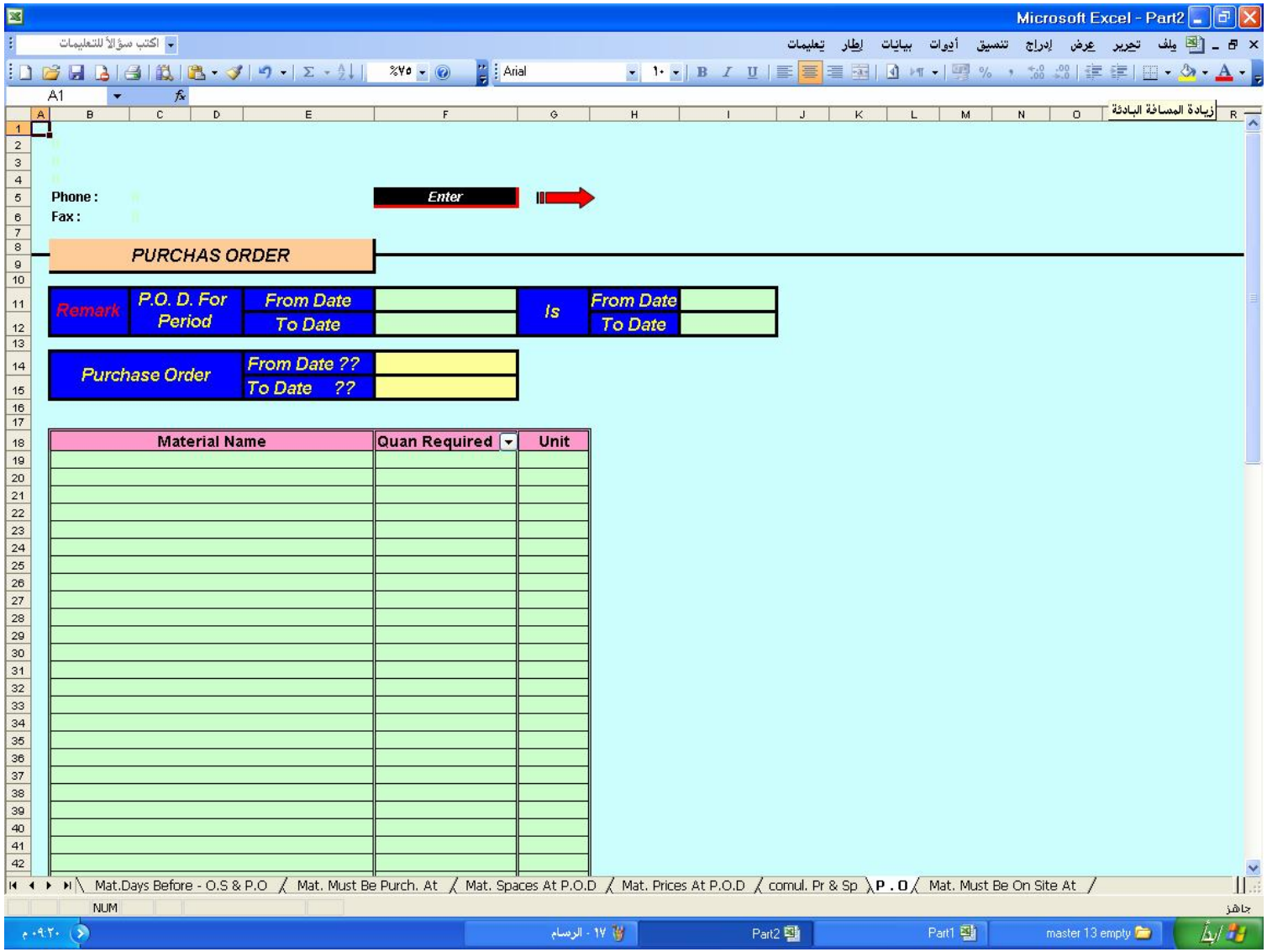


Figure A3.18: a sample of "Purchase order" sheet.

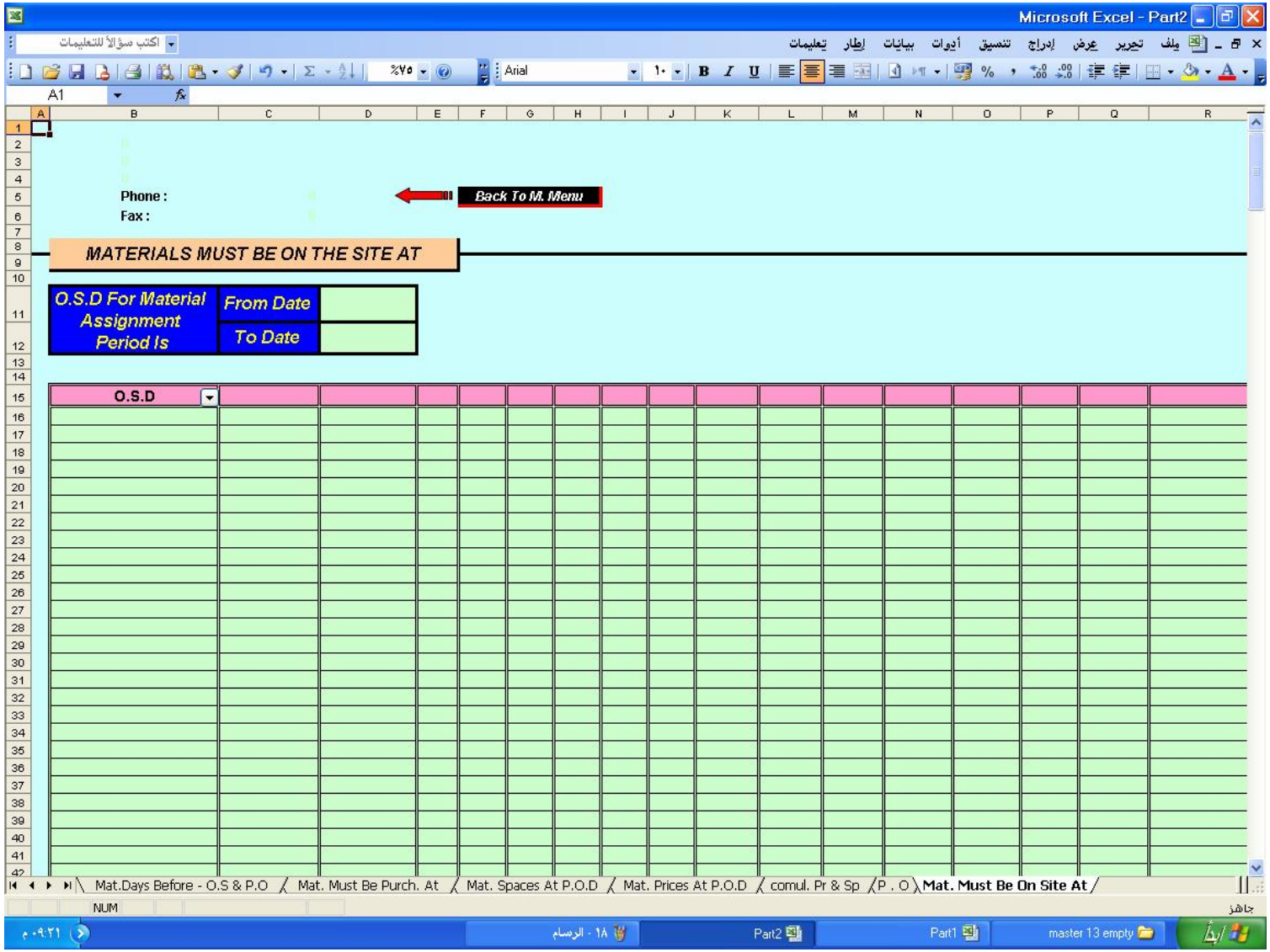


Figure A3.19: a sample of "Materials Must be on the site at" sheet.

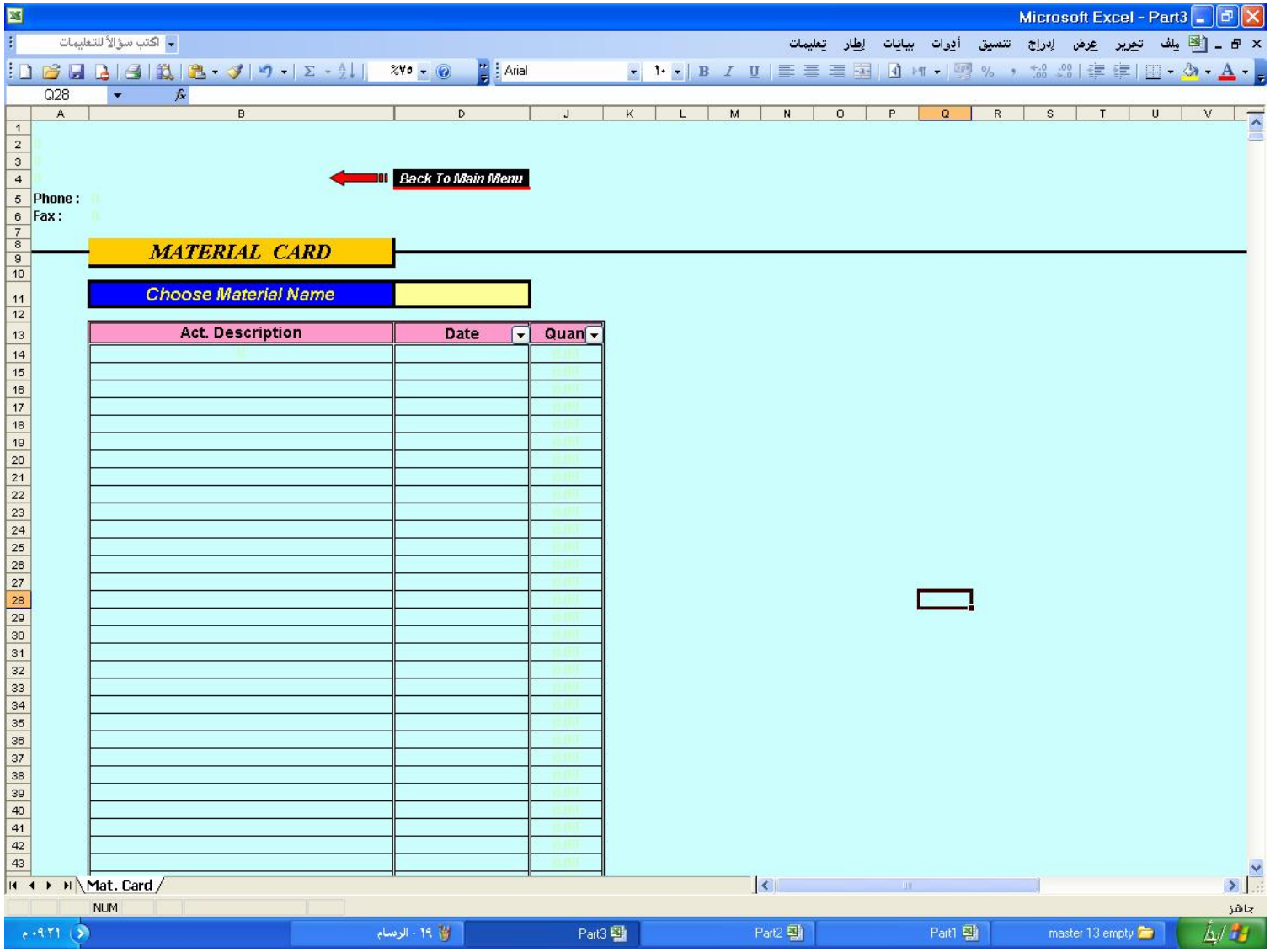


Figure A3.20: a sample of "Materials Card" sheet.

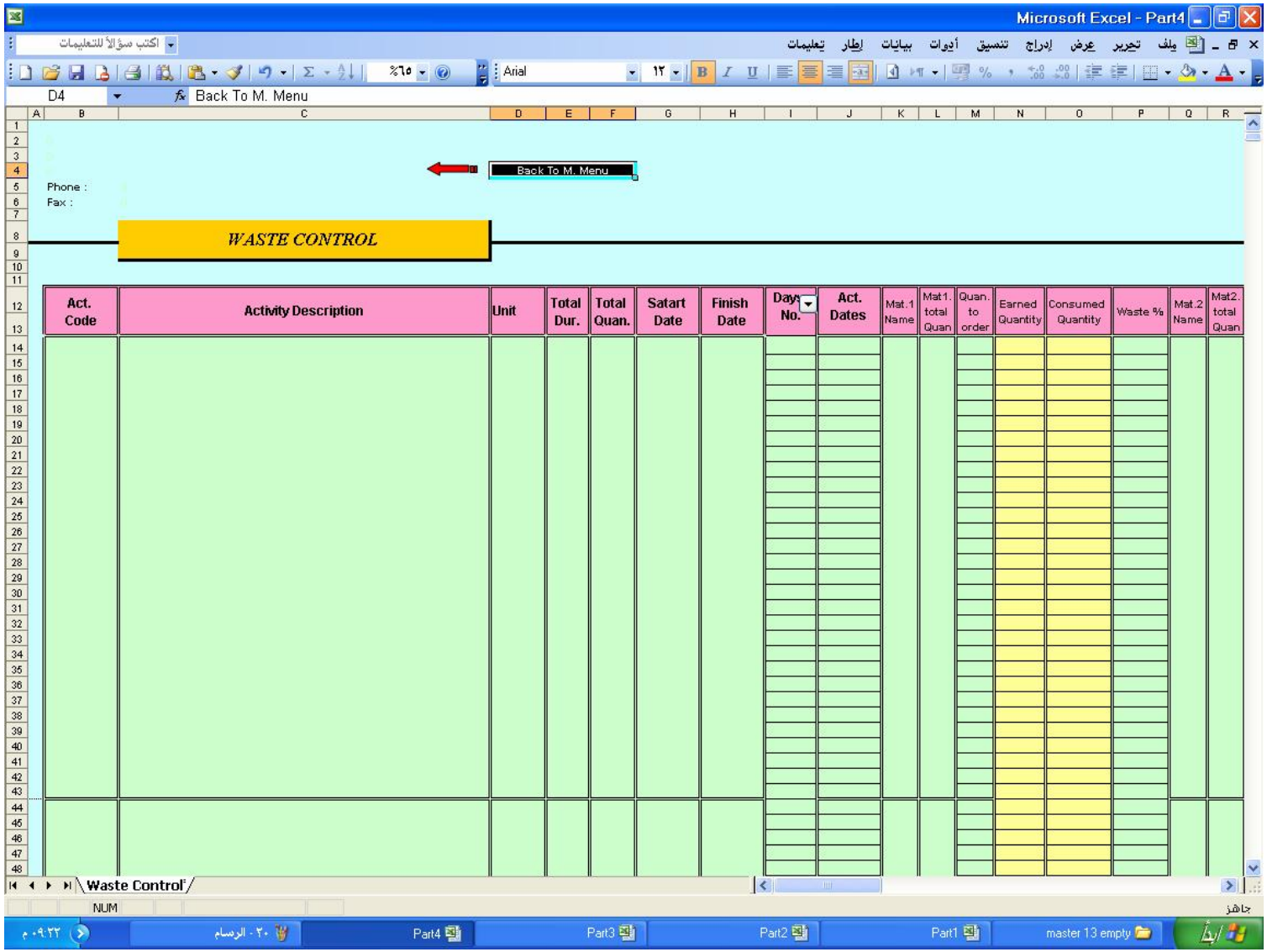


Figure A3.21: a sample of "Waste control" sheet.

Annex 4

A sample of Activities List

Act. No.	Activity Description	Unit
0100	**General Works**	
0101	Demolition Works	l.s
0200	**Earth Work**	
0201	Excavation	m3
0203	Fill with compacted clean sand	m3
0300	**Concrete Works**	
0301	Plain concrete B150	m3
0302	R. Concrete B300 for foundation	m3
0303	R. Concrete B250 for Ground beams and steps	m3
0304	R. Concrete B300 for Necks and Columns	m3
0305	R. Concrete B250 for Slaps 25 cm thick.	m3
0400	**Block Works**	
0401	Block works for walls 20cm thick.	m2
0402	Block works for internal walls 15cm thick.	m2
0403	Block works for internal walls 10cm thick.	m2
0500	**Plastering Works**	
0501	3-face internal plastering	m2
0502	External plastering on walls	m2
0600	**Tilling Works**	
0601	Pre cast terrazzo tiles 25*25 cm for floors	m2
0602	White ceramic tiles20*30cm for walls	m2
0603	White ceramic tiles 20*20cm for floor	m2
0700	**Painting Works**	
0701	Internal Painting-Poliside for Ceiling	m2
0702	Internal Painting-Supercryle for walls	m2
0800	**Carpentry Works**	
0900	**Metal and Aluminum Works**	
1000	**Electrical Works**	
1100	**Mechanical Works**	
1200	**Isolation Works**	
1300	**Special Works**	
1400	**Finishing Works**	

Figure A4.1 a sample of Activities List

Annex 5

System Evaluation Questionnaire (In Arabic**)**

استبيان تقيم برنامج الحاسوب

(CMMS) "Construction Materials Management Software"

السادة شركة / .....

نشكر لسيادتكم للمساهمة في أوقاتكم وجهودكم في تطبيق برنامج الحاسوب CMMS الخاص بإدارة مواد البناء في مشاريع التشييد والمقدم لسيادتكم لتجريبه في مشروع حقيقي.

يرجى من سيادتكم تعبئة هذا الاستبيان، وذلك من أجل التحقق من فعالية البرنامج المذكور. إن رأيكم وملاحظاتكم علي البرنامج مهمة جدا.

ولكم جزيل الشكر

الباحث

م. إياد عبد القادر الحداد

أولا/ التقنيات التي يوفرها البرنامج:

بين مدى موافقتك على التقنيات التي يوفرها البرنامج والخاصة بإدارة مواد البناء في مشاريع التشييد لديكم:

الرقم	التقنيات	موافق جدا	موافق	موافق بدرجة متوسطة	موافق بدرجة ضعيفة	موافق بدرجة ضعيفة جدا
1	تقرير عن المساحات المطلوبة لمواد المشروع في أي فترة زمنية.					
2	تقرير عن كميات المواد المطلوبة لأنشطة المشروع في أي فترة زمنية.					
3	تقرير عن تكاليف المواد المطلوبة لأنشطة المشروع في أي فترة زمنية.					
4	تقرير عن المواد المطلوب عمل أمر شراء لها في أية فترة زمنية.					
5	تقرير عن المواد التي يجب أن تتوفر في موقع العمل.					
6	المنحني S-Curve للتكلفة الفعلية للمشروع" Earned Value"					
7	تقرير مراقبة الفاقد في المواد لكافة أنشطة المشروع.					
8	توفير بيان لكيفية توزيع كل مادة على مدار المشروع على الأنشطة المختلفة.					

ثانيا/التصميم والتركيب:

بين مدى موافقتك على الخصائص والميزات التالية المتعلقة بتصميم وتركيب البرنامج.

الرقم	الخصائص/الميزات	موافق جدا	موافق	موافق بدرجة متوسطة	موافق بدرجة ضعيفة	موافق بدرجة ضعيفة جدا
1	البرنامج مرن ويمكن تحديث البيانات فيه بسهولة.					
2	استخدامه بصورة عامة سهل.					
3	يوفر الوقت والجهد.					
4	طريقة إدخال البيانات سهلة وواضحة.					
5	التقارير والمخرجات واضحة وسهلة القراءة والفهم.					
6	طريقة فرز البيانات سهلة.					
7	الجمل والأرقام الواردة فيه مختصرة ومفيدة وحجمها مناسب ومقروءة.					
8	يمكن إستخراج المعلومات منه بسهولة.					
9	طريقة الاستخدام المرفقة مفهومة.					
10	يوفر سهولة وارتياح في التعامل معه لأنة يعمل ضمن بيئة Ms Excel.					
11	التدريب عليه سهل ولا يحتاج لوقت كبير، كما انه لا يحتاج لموظف محترف للتعامل معه.					
12	يمكن تطبيقه في معظم المشاريع بأنواعها في قطاع غزة (مناسب لمقاولي قطاع غزة).					
13	يساهم في تطوير إدارة مواد البناء في مشاريع التشييد في قطاع غزة.					

ثالثا / أذكر الصعوبات التي واجهتك في استخدام البرنامج.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

رابعا / إذا كان لديك انتقادات أو تعليقات على البرنامج، يرجى ذكرها.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

خامسا / في رأيك، ما هي مميزات البرنامج.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Annex 6

System Evaluation Questionnaire (English Version)

Questionnaire about evaluation of

Construction Materials Management Software (CMMS)

Sire/……..

I strongly thank you for your contribution of time and effort to apply and test the CMMS software in a real project.

Please fill this questionnaire which aims to verify the construction materials management software (CMMS).

The researcher
Eng. Eyad A.Q.haddad

First / The construction materials management tools and techniques

Clarify your extent of agree with performance with the performance of the followings construction materials management tools and techniques which are provided by the CMMS software

No	Techniques	Strongly agree	Agree	Intermediately agree	Weakly agree	Very weakly agree
1	Needed storage area report for project materials at any date.					
2	Required quantities of materials report project activities at any date.					
3	Actual cost report for project activities at any date.					
4	Required materials report to be purchased at any date.					
5	Required materials, to be available on site.					
6	Earned value S-Curve.					
7	Waste monitoring report for activity materials.					
8	Provide a card for any material and its assignment on projects` activities.					

Second / The design and structure

Clarify your extent of agreeing with the following features of CMMS design and structure.

No	Techniques	Strongly agree	Agree	Intermediately agree	Weakly agree	Very weakly agree
1	The software is flexible, and the data can be updated easily.					
2	In general, it is easy to use.					
3	It saves time and effort.					
4	Method of entering data is easy and clear.					
5	The reports and outputs are clear, and easy to read and understand.					
6	Method of sorting data is easy.					
7	Text and numbers shown are concise, and their sizes are suitable and readable.					
8	The information can be inquired easily.					
9	The method of use is understandable.					
10	It is easy to handle as it is developed within Excel environment.					
11	Training to use the CMMS is easy and it does not need much time. In addition, it does not need a professional user to deal with it.					
12	It can be applied for most of Gaza strip projects. (It is suitable for Gaza strip contractors).					
13	It contributes in improving the construction materials management practice in Gaza strip.					

Third / Declare the difficulties that you faced during the use of CMMS.

……

……

……

……

……

……

……

……

……

……

Fourth / If you have any criticism or comment on the software, please state them.

……

……

……

……

……

……

……

……

……

……..

Fifth / According to your opinion, what are the CMMS advantages?

……

……

……

……

……

……

……

……

……

……

……

Annex 7

Recording Incoming of Construction Materials Device

Figure A7: Recording incoming of construction materials device

Annex 8

The Average waste percentage of construction material in different countries

Annex 8

Table A8: The Average waste percentage of construction material in different countries.

Material	Palestine	Palestine	Palestine	Egypt	Australia	Korea	Netherlands	Hong Kong		UK	USA
	Al Mogany study (2006)	Enshassi Study (1996)	Dahman Study (2004)	Garas Study (2003)	Ekanayake and Ofrie Study (2004)	Chen etal Study (2002)	Bassink and Brauwers Study (1996)	Poon et Study (2001a)		Poon etal Study (2004)	Chen etal Study (2002)
								Public	Privet		
Concrete	5.4	NA	4.7	4	NA	1.5	3	4-5	3-5	5	7.5
Steel Reinforcement	5.4	3.6	5.4	5	NA	NA	NA	1-8	3-5	5	NA
Timber Board	8.7	NA	10.4	13	13.8	16.7	NA	15	5	NA	10
Block	5.4	NA	4.6	6	NA	3	NA	4-8	6	NA	3.5
Tile	4.4	NA	3.8	5	NA	2.5	10	4-10	6-8	2	6.5
Cement	4.4	NA	5.3	5	19.6	NA	10	4-20	1-7	10	NA
Sand	10.5	NA	8.8	9	NA	NA	NA	NA	NA	NA	NA
Aggregate	8.9	NA	5.7	NA	NA	NA	NA	NA	NA	NA	NA
Paints	4	NA	NA	NA	NA	NA	NA	NA	NA	2	NA
Gypsum	4	NA	NA	NA	NA	NA	NA	6-10	5	NA	NA
Water Pipes	1.7	NA	NA	NA	NA	NA	NA	1-5	1	NA	NA
Sewage Pipes	2.1	NA	NA	NA	NA	NA	NA	1-5	2	NA	NA
Crushed Rock	8.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Annex 9

Help and Method of Use

Help and Method of Use

1. الجزء الأول Part 1: "Input Data & Basic Information"

هذا الجزء مخصص لعمليات الإدخال الرئيسية وبعض الحسابات الأساسية، ويتكون من واجهة واجهة المشروع وعدد 11 واجهة عمل مقسمة إلى أربع واجهات عمل مخصصة للمدخلات و6 واجهات عمل للحسابات الأساسية على النحو التالي:

واجهات العمل وتنقسم إلى:

1.1 واجهة التحكم Main Menu ويتم من خلالها إدارة عملية الانتقال بين واجهات المصنف الواحد والمصنفات المختلفة. وهناك 4 واجهات مدخلات وهي على التوالي:

1.2 واجهات العمل الخاصة بالمدخلات:

1.2.1 واجهة Company and Project Information:

ويتم في هده الواجهة إدخال البيانات التالية:

- بيانات الشركة وتتكون من اسم الشركة،المدينة،رقم الهاتف، رقم الفاكس الخاص بها.
- بيانات ومعلومات عن المشروع وتتكون من اسم المشروع، رقم المشروع، مكان المشروع، كلفة المشروع الإجمالية، تاريخ بداية المشروع، تاريخ نهاية المشروع.

1.2.2 واجهة Materials Pool:

ويتم في هذه الواجهة إدخال البيانات التالية:

- أسماء جميع المواد الداخلة في جميع أنشطة المشروع لمرة واحدة في خانة Material Name مع الحرص على عدم تكرار المواد الداخلة في أكثر من نشاط وبحيث لا يتجاوز عدد المواد عن 75 مادة كحد أقصى. وكمثال على ذلك مادة الرمل تدخل في أعمال القصارة والبلاط فنقوم بذكر مادة الرمل فقط لمرة واحدة.
- كود وحيد لكل مادة في خانة Material Code ويمكن أن يكون رقم تسلسلي 1,2,3،..
- وحدة قياس كمية المادة في خانة Unit مع ملاحظة أنه يمكن اختيار الوحدة من قائمة منسدلة أو كتابتها يدويا أو نسخها من ملف أخر.
- سعر الوحدة من تلك المادة في خانة Unit Price.ومثال على ذلك الرمل يقاس بوحدة m3 ، وسعر الوحدة m3 من الرمل يساوي $ 3 .
- المساحة التي تحتاجها الوحدة من تلك المادة في خانة Unit Space، ومثال عى ذلك يحتاج كوب الرمل m3 إلى 0.5 m2 من أجل تخزينه.

1.2.3 واجهة Activity Pool:

ويتم في هذه الواجهة إدخال البيانات التالية:

- اسم ووصف لكل الأنشطة الرئيسية الوحيدة في مشروع البناء ولمرة واحدة في خانة Activity Description مع الحرص على ذكر الاسم العام للنشاط مرة واحدة حتى ولو تكرر في أكثر من طابق أو مكان. ومثال على ذلك مبني يتألف من ثلاث طوابق، ولدينا أعمال أعمدة دور أرضي، دور ثاني، ودور ثالث وهكذا. ففي هذه الحالة في خانة Activity Description نذكر فقط أعمال خرسانة الأعمدة.
- إدخال كود وحيد لكل نشاط في خانة Activity Code بحيث لا يشترك نشاطين أو أكثر بنفس الكود مع ملاحظة أنة من المفضل أن يكون الكود مؤلف من أربع خانات 4 digit . 1234 الخانتين رقم 1و2 تستخدمان للنشاط الرئيسي ، الخانتين 3و4 تستخدمان للنشاط الفرعي،ومثال على ذلك نشاط بعنوان أعمال صب أعمدة والمستخدم يرمز لأعمال الباطون بكود أساسي 02، وأعمال الأعمدة بكود فرعي 06، فيصبح الكود الخاص بهذه الفعالية 0206.
- وحدة قياس النشاط في خانة Unit مع ملاحظة أنه يمكن اختيار الوحدة من قائمة منسدلة أو كتابتها يدويا أو نسخها من ملف أخر.
- أسماء المواد الداخلة في إنجاز كل نشاط في الخانات Mat.1 Name, Mat.1 Name, 2Mat. Name, 3Mat. Name, 4Mat. Name, 5Mat. Name. مع ملاحظة انه لا يمكن إدخال أكثر من خمس مواد لكل نشاط ، ففي حالة زيادة المواد اللازمة لكل نشاط عن خمس مواد نقوم بتجزئة النشاط لأكثر من نشاط فرعي كمخرج لهذه النقطة. يمكن اختيار أسماء المواد من قائمة منسدلة أو كتابتها يدويا أو نسخها من ملف أخر.
- كميات المواد الداخلة في إنجاز الواحدة من كل نشاط في الخانات التالية Mat.1 Qua./Unit, Mat.2 Qua. /Unit, Mat.3 Qua./Unit, Mat.4 Qua./Unit. Mat.5 Qua./Unit . وفي أغلب الأحيان تكون هذه الكميات ثابتة لكافة أعمال البناء مع إمكانية التعديل عليها عند حدوث أي تغير.

1.2.4. واجهة Project Activity:

ويتم في هذه الواجهة إدخال البيانات التالية:

- اسم ووصف لكل أنشط المشروع الوحيدة أو المتكررة في أكثر من طابق أو مكان. ومثال على ذلك، أعمال أعمدة دور أرضي، أعمال سقف دور أرضي، أعمال أعمدة دور أول، أعمال سقف دور أول. يمكن نسخ هذه القيم من برنامج *Microsoft Project* أو كتابتها يدويا.
- كود لهذه الأنشطة في خانة Activity Code مع الأخذ بعين الاعتبار أن جميع الأنشطة المتشابهة تأخذ نفس الكود وهو كود اسم النشاط العام الذي أدخلناه في واجهة Activity Pool . ومثال على ذلك في صفحة Activity Pool:

Activity Cod.	Activity Description
0260	أعمال خرسانة الأعمدة.

في صفحة Project Activity :

Activity Cod.	Activity Description
0260	أعمال خرسانة الأعمدة للدور الأرضي.
-	-
-	-
0260	أعمال خرسانة الأعمدة للدور الأول.

- وحدة قياس كل نشاط في خانة Unit مع ملاحظة أنه يمكن اختيار الوحدة من قائمة منسدلة أو كتابتها يدويا أو نسخها من ملف أخر.
- مدة إنجاز كل نشاط بالأيام في خانة Duration .
- تاريخ بداية النشاط في خانة Start Date.
- تاريخ نهاية النشاط في خانة Finish Date.
- كمية كل نشاط في خانة Quantity.
- سعر الوحدة لكل نشاط في خانة Unit Price.
- يتم حساب التكلفة الكلية لكل نشاط تلقائيا وبشكل أوتوماتيكي في خانة Total.
- وفي النهاية يتم إدخال تاريخ بداية المشروع وتاريخ نهاية المشروع في كلا من الخانتين التاليتين على التوالي Enter Start Project Date, Enter Finish Project Date.

1.3 واجهات الحسابات الأساسية:

1.3.1 واجهة Quantity OF Material of Activity:

فيها يتم سرد تلقائي وبشكل أوتوماتيكي لأسماء كل الأنشطة المدخلة في واجهة Project Activity وأكوادها ووحدات قياسها وكمياتها وأسماء المواد الداخلة في كل نشاط بشكل تلقائي. ومن ثم يتم حساب الكميات الكلية للمواد الداخلة في كل نشاط بضرب كمية كل مادة لواحدة النشاط بالكمية الكلية للنشاط، ونحصل بالتالي من هذه الواجهة على أسماء المواد الداخلة في كل نشاط والكمية الكلية لهذه المواد في الكمية الكلية للنشاط.

1.3.2 واجهة Materials Needed:

فيها يتم سرد تلقائي وبشكل أوتوماتيكي لأسماء كل الأنشطة الموجودة في واجهة Project Activity وأكوادها ووحدات قياسها ومدة كل نشاط، كمية كل نشاط، تاريخ بداية وتاريخ نهاية كل نشاط، عدد أيام النشاط، التاريخ في كل يوم. ثم يتم سرد أسماء المواد الداخلة في كل نشاط ، الكميات الكلية لكل مادة في الكمية الكلية لكل نشاط. ومن ثم يتم توزيع الكمية الكلية لكل مادة على عدد أيام النشاط بالتساوي.

1.3.3 واجهة 2 Date Materials to Order:

يتم في هذه الواجهة سرد تلقائي وبشكل أوتوماتيكي لأسماء المواد الداخلة في واجهة Materials Pool، وأكوادها، ويطلب منك البرنامج إدخال تاريخين لحصر كميات كل مادة من المواد والتي ستستهلك نظريا وحسب ما هو مخطط له بين هذين التاريخين في كل الأنشطة.

1.3.4 واجهة Materials Spaces and Cash requirements:

فيها يتم سرد تلقائي وبشكل ألي لأسماء الأنشطة المذكورة في Project Activity، أكوادها، أسماء المواد الداخلة في كل نشاط، كمياتها المستهلكة نظريا وحسب ما هو مخطط له بين التاريخين المدخلين في صفحة 2Date Materials to Order.

1.3.5 واجهة Earned Value S-Carve Calculations:

هي نسخة مطابقة لواجهة Project Activity مع عمل حسابات للدفعات المستحقة من المشروع كل 30 يوم من بداية المشروع وحتى نهايته.

1.3.6 واجهة S-Curve Diagram:

وهو عبارة عن رسم توضيحي للدفعات المستحقة المتراكمة كل 30 يوم من بداية المشروع وحتى نهايته

2. الجزء الثاني Part 2: " Materials Purchase Decision"

يستخدم هذا الجزء لإدارة طلبيات الشراء للمواد خلال فترات محدده من حيث كميات المواد التي يجب تحرير طلبات شراؤها عند تواريخ محدده والموارد المالية اللازمة لشرائها والمساحات اللازمة لتخزينها عند هذه التواريخ المحددة ومن ثم تحرير طلبات شراء لفترات محددة وكذلك تحديد التواريخ التي يجب أن تتواجد فيها كل كمية المواد في طلبات الشراء في موقع العمل.

يتكون هذا الجزء من 7 صفحات.

صفحة مدخلات و 6 صفحات حسابات تلقائية

صفحة المدخلات

2.1 واجهة Lead time for ordering and delivery materials:

و فيها يتم سرد تلقائي وبشكل ألي لأسماء المواد الداخلة في جميع أنشطة المشروع و يتم إدخال التالي في هذه الواجهة:

- عدد الأيام التي يجب أن تكون المادة متواجدة قيها في الموقع قبل تاريخ استخدامها في خانة Days Before On Site.
- عدد الأيام التي يجب أن تطلب المواد قبلها حتى قبل تاريخ تواجدها في الموقع.

مثال:

Mat. Name	Lead time for deliver	Lead time for order
رمل	1	3

هذا يعني أن الرمل يجب أن تطلب أي كمية منه قبل 3 أيام حتى يتواجد في الموقع قبل يوم من تاريخ استخدامه

- إدخال التاريخين الذين نريد إدارة طلبيات شراء المواد خلالهما في خانتي From Date, To Date بحيث لا تتجاوز الفترة الشهرين.

ملاحظة: يتم تقسيم مدة المشروع المدخل في Part 1 في خانة Pro Act. بين تاريخي البداية و النهاية إلي فترات كل فترة مدتها شهرين في هذه الصفحة لإدارة عمليات طلبات الشراء فيها.

2.2 واجهات الحسابات التلقائية: وهي على التوالي

2.2.1 واجهة: Materials must be purchased at

و فيها يتم سرد تلقائي للبيانات التالية:

- تحديد أول و أخر تاريخ طلب شراء للمواد في فترة الشهرين المحددة في صفحة Mat. Days Before O.S & P.O في خانتي

P.O.D For Materials Assignment Period Is	From Date ???	01/03/2006
	To Date ???	15/04/2006

ثم يتم سرد تلقائي للتواريخ بين أول تاريخ طلب شراء و آخر تاريخ طلب شراء يوم بيوم و سرد تلقائي لأسماء كل المواد الداخلة في المشروع ثم يتم حساب كمية كل مادة يجب شراؤها عند كل تاريخ طلب شراء.

2.2.2 واجهة: Materials Spaces assignments

البيانات التالية يتم سردها بشكل تلقائي:

- سرد تلقائي لأول تاريخ طلب شراء و آخر تاريخ طلب شراء لفترة الشهرين.
- سرد تلقائي لأسماء كل المواد الداخلة في المشروع ثم حساب المساحة اللازمة لكمية كل مادة يجب شراؤها عند كل تاريخ طلب شراء.

2.2.3 واجهة: Materials Prices assignments

البيانات التالية يتم سردها بشكل تلقائي:

- سرد تلقائي للتواريخ بين أول تاريخ طلب شراء لفترة الشهرين المدخلة في صفحة Material Days before On site & purchase order
- سرد تلقائي لأسماء كل المواد المدخلة في المشروع في حساب التكلفة اللازمة لشراء كمية كل مادة يجب شراؤها عند تاريخ طلب الشراء

2.2.4 واجهة : Cumulative Prices & Spaces

البيانات التالية يتم سردها بشكل تلقائي:

- سرد تلقائي للتواريخ بين أول تاريخ طلب شراء و اخر تاريخ طلب شراء لفترة الشهرين المدخلة في صفحة Mat days before On site & Purchase order.
- سرد تلقائي للمساحة الكلية التي يجب أن تتوافر لتخزين كل المواد التي يجب شراؤها عند كل تاريخ طلب شراء.

- سرد تلقائي للتكلفة الكلية التي يجب أن تتوافر لشراء كل المواد التي يجب شراؤها عند كل تاريخ طلب شراء.
- المساحة التراكمية اللازمة عند كل تاريخ طاب شراء.
- التكلفة التراكمية اللازمة عند كل تاريخ طلب شراء.

2.2.5 واجهة Purchase Order:

و فيها يتم تقسيم الفترة الزمنية" الشهرين" والتي تم إدخالها في واجهة Material Days before on site & purchase order إلي عدة فترات زمنية لطلب المواد خلالها. ثم يطلب منا البرنامج تحديد المدة الزمنية التي نريد تحرير طلبية الشراء للمواد خلالها بحيث تكون جزء من الفترة الزمنية الشهرين المحددة بشكل مسبق. ثم يقوم البرنامج بسرد أسماء وكميات المواد المطلوب شراؤها في هذه الفترة.

2.2.6 واجهة Materials Must Be On Site At:

البيانات التالية يتم سردها بشكل تلقائي:

- تحديد التواريخ التي يجب أن تكون فيه المواد في الموقع قبل استخدامها لفترة الشهرين المحددة في واجهة Mat days before On site & Purchase order
- المواد في الموقع قبل استخدامها لفترة الشهرين نفسها في خانتي
- حساب كمية كل مادة يجب ان تتواجد في موقع المشروع عند كل تاريخ من تواريخ الفترة الزمنية المحددة في الصفحة Material Days before On site & purchase order.

3. الجزء الثالث Part 3 "Waste Control" :

ويستخدم هذا الجزء لإدارة الفاقد الحقيقي والفعلي لمواد البناء المستخدمة في المشروع، ويتم سرد تلقائي للبيانات التالية:

- وصف لجميع أنشطة المشروع، كود كل نشاط، وحدة القياس لكل نشاط، كمية كل نشاط، مدة كل نشاط، تاريخ بداية ونهاية النشاط، عدد الأيام لكل نشاط.
- سرد تلقائي لجميع المواد وكمياتها الداخلة في تنفيذ كل نشاط.
- توزيع كمية كل مادة من مواد النشاط على عدد أيام النشاط بالتساوي.

أما البيانات التي يجب إدخالها في هذا الجزء هي على النحو التالي:

- الكمية المنفذة فعليا لكل مادة من مواد النشاط في كل يوم من أيام هذا النشاط وتوضع في خانة Earned quantity . ويتم حساب هذه القيمة بشكل يدوي بالمعادلة التالية:

Earned quantity = Today quantity – Yesterday quantity

Yesterday quantity الكميات المنفذة فعليا لغاية اليوم السابق.

Today quantity الكميات المنفذة فعليا حتى نهاية هذا اليوم.

- الكمية المستهلكة فعليا من كل مادة من مخازن الموقع واللازمة لإنجاز النشاط وتوضع في خانة Consumed quantity . ويتم حساب هذه القيمة بشكل يدوي بالمعادلة التالية:

Consumed quantity = quantity on site (Q) + IN quantity – Left quantity

  - Quantity on site (Q) الكمية المتواجدة في موقع المشروع في هذا اليوم.
  - IN quantity الكمية الداخلة لموقع المشروع في هذا اليوم.
  - Left quantity الكمية التي غادرت الموقع في هذا اليوم.

بعد ذلك يقوم البرنامج بحساب نسبة الفاقد Waste Percentage% الفعلية بالشكل التالي:

Waste % = (Consumed quantity – Earned quantity) X 100 / Errand quantity

على المستخدم مقارنة النسبة الفعلية مع النسبة النظرية للفاقد والتي يمكن أن نجدها في المراجع ولدى ذوي الخبرة في هذا المجال. الملحق رقم 8 يوضح بعض النسب النظرية للفاقد في عدة دول.

4. الجزء الرابع "Materials Control "

ويتم في هذا الجزء تحديد كميات وتواريخ استخدام كل مادة من مواد المشروع لكل نشاط من أنشطة المشروع. حيث يقوم المستخدم باختيار اسم المادة من خانة Choose Material Name ومن ثم يقوم البرنامج بإظهار تلقائي للبيانات التالية:

- أسماء الأنشطة التي تدخل المادة المختارة في انجازها.
- تواريخ استخدام هذه المادة في كل نشاط.
- كمية استهلاك هذه المادة عند كل تاريخ.