

# Construction Resources Management System for Gaza Strip Building Contractors

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## Abstract

Effective construction resources management process is a key to success of a construction project. Nowadays, successful management of construction resources has to be based on thorough and updated information, and processed utilizing a well designed construction resources management software. (1)

The aim of the study has been to explore the local practice in construction resources management and develop a construction resources management system to facilitate the management of construction resources mainly in the building construction. Construction resources management related literature has been generally reviewed; meanwhile some construction resources management software packages have been reviewed also. A survey questionnaire supported by interviews is used to explore the local practice in construction resources management. One hundred and twenty questionnaires were distributed to contractors of first, second, and third class, eighty questionnaires were received and analyzed.

The researcher concluded that all contracting companies are interested in using some techniques of managing construction resources 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 resources 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 resources manually. The researcher developed a Construction Resources Management Software (GSCRMS) based on Microsoft Excel. GSCRMS has been evaluated to test its suitability to local practice. One of the main recommendations of this research is to encourage local contracting companies to have a construction resources management software package and use it in determining the required quantities of construction resources in order to get resources with required quantities in time and save time.

## 1. Introduction

Definition of project is “A unique temporary process of definite start and end, comprising controlled activities achieving objectives which conform to constraints of time, cost, resources, quality, safety and environmental protection”. Process means “A set of interrelated or interacting activities which adds value to inputs and converts them to acceptable outputs”. Procedure (Design and Construction) means “A specified way of carrying out a series of processes to achieve a defined objective” (3).

The general scope of any project of same categories may almost be the same but uniquely different only by the constraints which may directly or indirectly have impact on the design and construction process (2). In this study, the existing construction resources 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 resources management system. Construction projects can be accomplished utilizing management processes. These processes include planning, organizing, executing, monitoring, and controlling (2). 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. Resources management is considered as a means to achieve better productivity, which should be translated into cost reduction (2).

## 2. Study aim and objectives

The aim of this study is to explore the existing common practices in construction resources management for the building construction projects in Gaza strip. This aim can be broken down into the following objectives: to review literature related to the construction resources management, and also to review the relevant software packages; to investigate the local practices of construction resources management in contracting companies in Gaza strip; to explore the influence of the Israeli closure on resources prices, resources availability, and resources management; and to assess the impact of computerization on construction resources management.

## 3. Methodology Outline

The study is conducted through the following stages: the first stage was literature review. In this stage resources 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 resources management software packages. The second stage was

field survey. During this stage, a survey of the local resources management practices of contracting companies in Gaza Strip was made. An (80) structured questionnaire with 40 personal interviews is used together in this study and the person in charge of managing construction resources 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.

#### **4. Population and sample**

The studied population includes the contracting companies in Gaza strip who have a contractor's union valid registration in January 2012. As resources 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 80 companies and they are stratified as follows: the first class has 35 companies; the second class has 20 companies; the third class has 25 companies.

#### **5. Data collection and questionnaire design**

Few methods of data collection were used including observation, documentations, interviews and questionnaire and documentary analysis. The questions of the research questionnaire are constructed based on: Literature review, 5 interviews with contractors to obtain different thoughts, which can be useful for creating questions, and 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: company profile, of construction resources management tools and techniques in construction projects, the effect of closure in Gaza strip on materials, equipment, skilled workers and technicians' availability and cost, computer applications in resources management systems in construction projects, and Implementation of construction resources management systems.

#### **5. Data analysis and results**

##### **5.1 Company profile**

The result demonstrates that the building represents the highest field of work for contractors with 96.3 % (77) in buildings, 50 % (40) of work were in roads and transportation, and 37.5 % (30) in water and sewage. The frequency and percent of job title of the respondent was 35 % (28) of contracting companies respondents were Director / deputy director, 35 % (28) were projects managers, 22.5 % (18) were Site engineer and 7.5 % (6) were Others. Also the number and value of executed projects during the last five years result was (31.3%) of contractors executed less than 10 projects and only 6 contractors executed more than 50 projects. The majority of contracting companies (49%) executed from 20 – 50 projects in the same period.

(haddad E. 2006) concluded that 45.2% of the respondent contractors executed less than 10 projects and only 3 contractors executed more than 40 projects (7). This is because Gaza Strip is in crisis and severe siege and the lack of construction projects, While in the analysis of the data obtained for this year (2013). The Gaza Strip is undergoing a comprehensive development and reconstruction so it was expected to get the number of the largest projects.

The result of the total value of projects carried out during the past five years (\$ Million) was (55.1%) of respondents executed projects with a value of less than 3 million dollars. (23.8%) of contracting companies executed projects with a value between 3 and 6 million dollars, and (16.3%) of contractors executed projects with a value of more than 6 million dollars. This indicates that most of executed projects are of small size. The distribution of respondent's person in-charge-of managing resources in construction projects result was only one of contracting companies has a specific section for managing construction resources. For other companies, the person in-charge-of managing construction resource is the director in (31.3%) of companies and the project manager in (46.3%) of companies. While (20%) is site engineer

##### **5.2 Application of construction resource management tools and techniques in construction projects**

Data result demonstrates that “establishing databases for construction materials techniques” group was in the highest position and the importance technique in this group is establishing categorized materials database. While, “Updating the databases of skilled workers and technicians” group was in the lowest position and the importance technique in this group is updating the database of local skilled workers and technicians. Also, the importance technique in “Creating databases for skilled workers and technicians” group is establishing categorized database for skilled workers and technicians. And, the importance technique in “Updating databases for construction materials” group is Updating the database of local suppliers.

##### **5.3 Method of use some techniques in construction resources management**

The result demonstrates that the contracting companies used many techniques for managing construction resources. It shows that (26.3%) of the contractors companies using a computerized form for providing a list of

materials in project that includes for example (material name, material number unit price). But Al Ostaz, 2002 concluded that (75.6%) of the contractors using this technique without recording (in memory). This result indicates that Gaza projects became big sized projects (5).

Also, (26.3%) of them using a computerized form for providing a list of equipment in project that includes for example (equipment name, equipment number, and equipment price). And (30%) of them using a computerized form for providing a list of names and numbers of skilled workers and technicians required for the project.

#### **5.4 The effect of closure of Gaza strip on resources (materials, equipment, skilled workers and technicians) availability and price**

The result shows that (98.8%) of the respondents agree that the closure causes a noticeable increase in the main material prices specially (cement, aggregate, and steel). This result comes with Al-Shanti, 2003 where (100%) of his sample emphasis this result (9). (92.6%) of them agree that the closure the closure causes a noticeable increase on the required equipment. However there is a consensus that closure causes an increase of the total project cost. This ascertains that the net effect of closure on construction is negative. These results are supported by the study done by Madi (2003) about the factors affecting the accuracy of estimating. He concludes that the factor of continuous increase in unit cost of construction materials was ranked at the first position in the group of the factors related to market requirements. Also he mentioned that of continuous increase in materials rate may be justified by the repeated closure on Gaza Strip and the instability of local market.

On the other hand, the results show that (70%) of contracting companies believe that the causes a noticeable increase on the prices of skilled workers and technicians needed for the construction project

#### **5.5 Using software for supporting the construction resources management**

The result demonstrates that (1.3%) of the respondents do not use computer applications in resources management systems in construction projects and (90%) use spreadsheet-based software like (Ms Excel) because it is a familiar application for all construction companies. On the other hand (8%) of the contracting companies Use specialized software and this is somehow very good to implement GSCRMS on construction projects. Haddad (2006) concluded that (28.6%) of the respondents do not use computer applications in resources management systems in construction projects and (61.9%) use spreadsheet-based software (7).

This difference indicates Contractors reliance on computerized programs in their business and increase awareness among contractor's modern techniques.

#### **5.6 Obstacles that are facing the local companies in using construction resources management software**

The majority of respondents (76.3%) consider non- realization of importance of construction resources management system by the contractor is the most important obstacle that affects the using of computerized resources management packages. (67.5%) of the respondents think that shortage of qualified persons in using a construction resources management system has big effect on using computerized resources management packages. Another result, (40%) of the contractors believes that implementing the system wastes the time of project supervisors. The researcher notices that the most important obstacles are the technical ones, while the least important obstacles are the cost related obstacles. The importance of technical obstacles has been supported by Navon study (2002); he concluded that the main reason for non-using computer in resources management is the lack of suitable software for managing construction materials (10).

#### **5.7 Benefits of implementation of resources management on construction projects**

The most important benefits are: reducing the costs of project resources. (77.6%), resources are timely available on site with the right quantity. (73.8%), improving labour productivity (71.3%), and complying with time schedule (76.3%).

On the other hand the benefits, which have lesser effect, are: obtaining better price for the construction resources.. (58%), better handling of materials. (46.3%), complying with enhancement of quality control (48.8%), and reducing the space for materials on site (76.3%).

#### **5.8 Importance of resource management systems to solve some problems**

The result shows that (35%) of the respondents believe that using resource management systems can reduce deliver materials with wrong quantities. And implementing the system reduce destroyed equipment when deliver problem. Also, (18.8%) of the contractors said that resources management system can solve the unavailability of workers and technicians. it also concluded that the application of construction resources management system has an effective role in reducing many of the problems and lack of material entirely, lack of material in the quantities required, and the late arrival of materials and accumulation of material in the stores.

### **5.9 Techniques used for ordering materials and equipment from suppliers**

From the result obtained, it has been found that most of contractors (100%) use the telephone for ordering materials and equipment from suppliers and (97.5%) use personal meeting for ordering, (90%) of them prefer to use the fax for ordering materials and equipment, while (82.6%) of respondents use the E-Mail, and (82.5%) of them use internet for ordering materials and equipment 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 and equipment are ordered from local suppliers. It is noticed that the modern techniques for ordering materials such as websites are not use in Gaza strip.

### **5.10 Available covered and open storages**

As illustrated from the result, most of respondents (100%) have an area of 1000m<sup>2</sup> and below of covered storages, and (97.5%) of them have an area of 3,000 m<sup>2</sup> and below of opened storages. It is noted that none of the contractors have an area more than 1,000 m<sup>2</sup> of covered storages, and more than 1,000 m<sup>2</sup> of opened storages.

### **5.11 The importance of knowing waste percentage for different building materials**

Most contractors strongly agree and agree that knowing waste for different building materials helps them to prepare accurate bill of quantities (78.8%), finish the project successfully and have profits(77.6%), know the real requirements for the project (materials-time-cost) (76.3%), and to price tenders more accurately (71.3%)respectively.

### **5.12 Material waste on construction site**

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**

The majority of contracting companies believe that the factors which have bigger effect on causing waste increase on construction site are poor Materials damage on site (88.8%), Existence of unnecessary materials on site and poor quality of materials (62.5%). On the other hand, the factor which they believe has the lowest effect on causing waste increase on construction site, burglary, theft and vandalism (47.6%).

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 (4).

#### **B. Materials handling**

As illustrated from the result, (63.8%) of the contracting companies think that "Duplication of transporting material on site." causes waste increase, (62.5%) of them believe that " Improper handling of materials on site." causes waste increase, and (50%) of the respondents believe that " Improper handling of materials on site." causes waste increase.

#### **D. Site management**

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 "Poor qualification of the contractor's technical staff assigned to the project " (73.8%), " Shortage of technical professionals in the contractor's organization." (65.1%). On the other hand, the factors, which have lower effect on causing waste increase on construction site, are "Providing project team with insufficient information." And "Lack of a quality management system aimed at waste minimization. " (64.7%) respectively. Finally, "contractors slowness in taking decisions." (48.8%).

#### **E. Site supervision**

As illustrated from the result, the highest factor which causing increase in material waste on construction site is poor control of supervision and delay in giving instructions. And the lowest factor is owner's delay in handing over the site to the contractor.

### **5.13 Gaza Strip Construction Resources Management Software (GSCRMS)**

The researcher developed a computerized system to help the Gaze strip contractors to improve their practice in construction recourses management. This software named Gaza Strip Construction Recourses Management Software (GSCRMS). The software consists of four parts. Part 1 (Input data and basic calculations): The input data and basic calculations can be classified into company and project information; materials pool; labour pool; equipment pool; activity pool; project activities; activities materials quantities; activities labour quantities;

activities equipment quantities; materials to order; labour to order; equipment to order; "2 dates materials to order"; "2 dates labour to order"; "2 dates equipment 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. GSCRMS basically consists of number of spreadsheets processed by functions. Template sheets with embedded formulas are also utilized to make GSCRMS more users friendly. The following is a general description of GSCRMS components:

### 1. Start sheet

Figure 1 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 1: Start sheet

### 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), and Help and method of use.

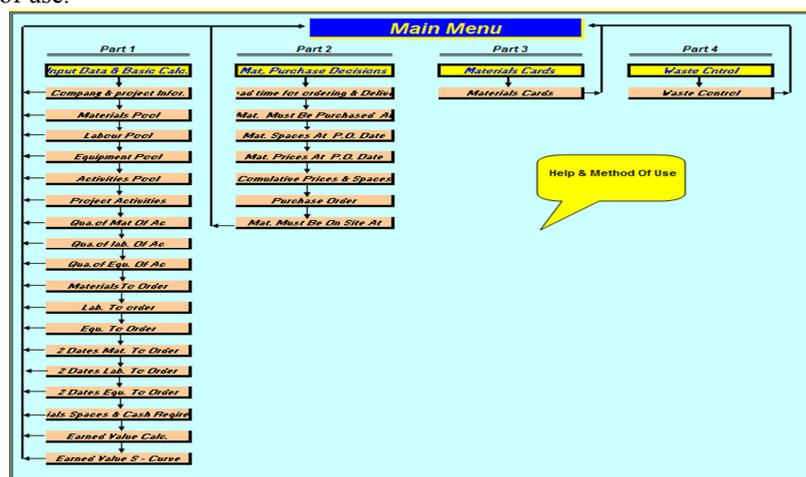
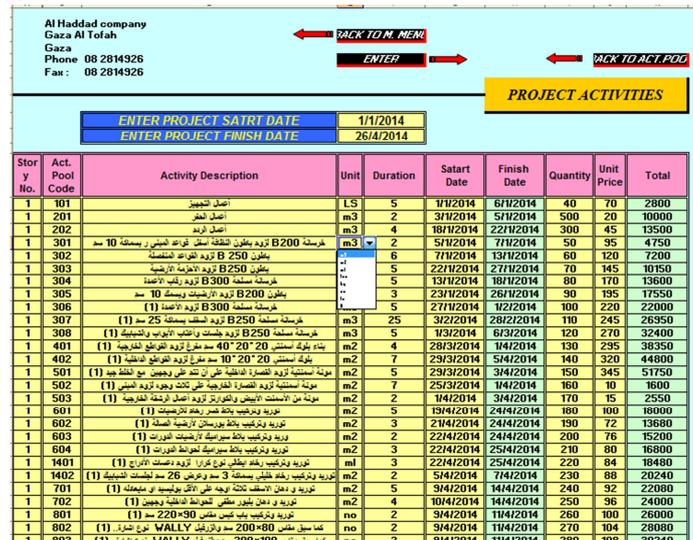


Figure 2: "Main Menu" sheet.

### 3. 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 3 shows a sample of project activities. Uniqueness of activity code is achieved by combining the storey No. and activity code.



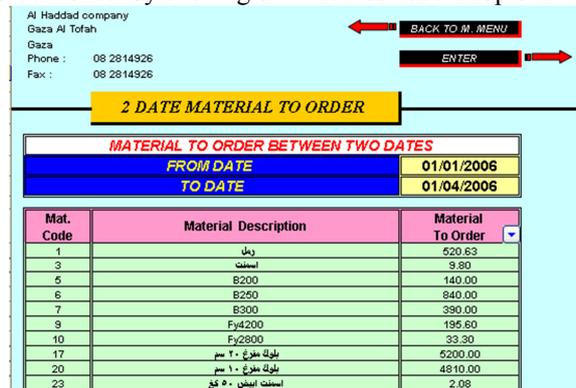
Storey No.	Act. Pool Code	Activity Description	Unit	Duration	Start Date	Finish Date	Quantity	Unit Price	Total
1	101	اعمال التجبير	LS	5	1/1/2014	6/1/2014	40	70	2800
1	201	اعمال الحفر	m3	2	3/1/2014	5/1/2014	500	20	10000
1	202	اعمال الرد	m3	4	10/1/2014	22/1/2014	300	45	13500
1	301	خرسانة B200 زود بفلون للشفا اسفل قواعد الاعمدة بسمكته 10 سم	m3	2	5/1/2014	7/1/2014	50	95	4750
1	302	بفلون B250 زود القواعد المتصلة	m3	6	7/1/2014	13/1/2014	60	120	7200
1	303	بفلون B250 زود الاعرابه الاربعه	m3	5	22/1/2014	27/1/2014	70	145	10150
1	304	خرسانة بصله B300 زود ركاب الاعمدة	m3	5	13/1/2014	18/1/2014	80	170	13600
1	305	بفلون B200 زود الاعمدة بسمكته 10 سم	m3	3	23/1/2014	28/1/2014	90	195	17550
1	306	خرسانة بصله B300 زود الاعمدة (1)	m3	5	27/1/2014	1/2/2014	100	220	22000
1	307	خرسانة بصله B250 زود الصقف بسمكته 25 سم (1)	m3	25	3/2/2014	28/2/2014	110	245	26950
1	308	خرسانة بصله B250 زود طبقات وانساب الاعمدة والشبابيك (1)	m3	5	1/3/2014	6/3/2014	120	270	32400
1	401	بناء بركب اسفل 40*20*20 سم بفرز زود القواعد الخارجيه (1)	m2	4	28/3/2014	1/4/2014	130	295	38350
1	402	بركب اسفل 40*20*20 سم بفرز زود القواعد الخارجيه (1)	m2	7	29/3/2014	5/4/2014	140	320	44800
1	501	مولد اسمنتيه زود الصغار المتصلة القوي ان تحت حفر وجوبين مع الخطه جده (1)	m2	5	29/3/2014	3/4/2014	150	345	51750
1	502	مولد اسمنتيه زود الصغار الخارجيه غير تحت وجود زود الصفيح (1)	m2	7	25/3/2014	1/4/2014	160	10	1600
1	503	مولد من الاسمنت الابيض والمواد زود اعمال الرصه الخارجيه (1)	m2	2	1/4/2014	3/4/2014	170	15	2550
1	601	توريد وربط بظفر بغير رده الارصيات (1)	m2	5	13/4/2014	24/4/2014	180	100	18000
1	602	توريد وربط بظفر بورصان الارصيات اسفل (1)	m2	3	21/4/2014	24/4/2014	190	72	13680
1	603	توريد وربط بظفر بورصان الارصيات القويات (1)	m2	2	22/4/2014	24/4/2014	200	76	15200
1	604	توريد وربط بظفر بورصان الارصيات القويات (1)	m2	3	22/4/2014	25/4/2014	210	80	16800
1	1401	توريد وربط بظفر بغير حفر كبريا زود عماس الاربع (1)	m1	3	22/4/2014	25/4/2014	220	84	18480
1	1402	توريد وربط بظفر بغير حفر بسمكته 3 سم وبفرس 26 سم لاجلوات الشبكيه (1)	m2	2	5/4/2014	7/4/2014	230	88	20240
1	701	توريد في دهان الاسقف تلاته روجه على الاقل بوليميد او ميويلته (1)	m2	5	9/4/2014	14/4/2014	240	32	22080
1	102	توريد و دهان القوي على الخرسانه الاسمنتيه وجوبين (1)	m2	4	10/4/2014	14/4/2014	250	96	24000
1	801	توريد وربط بظفر بغير حفر بسمكته 220*90 سم (1)	no	2	9/4/2014	11/4/2014	260	100	26000
1	802	عكاس فلينس 200*80 سم وبفرس WALLY حفر اسفل (1)	no	2	9/4/2014	11/4/2014	270	104	28080
1	803	عكاس فلينس 200*100 سم وبفرس WALLY حفر اسفل (1)	no	2	9/4/2014	11/4/2014	280	108	30240

Figure 3: "Project Activities" sheet

#### 4. "Materials to Order between two Dates" sheet

"Materials to order between two dates" sheet contains material code, material description, and quantity of material. Figure 4 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.

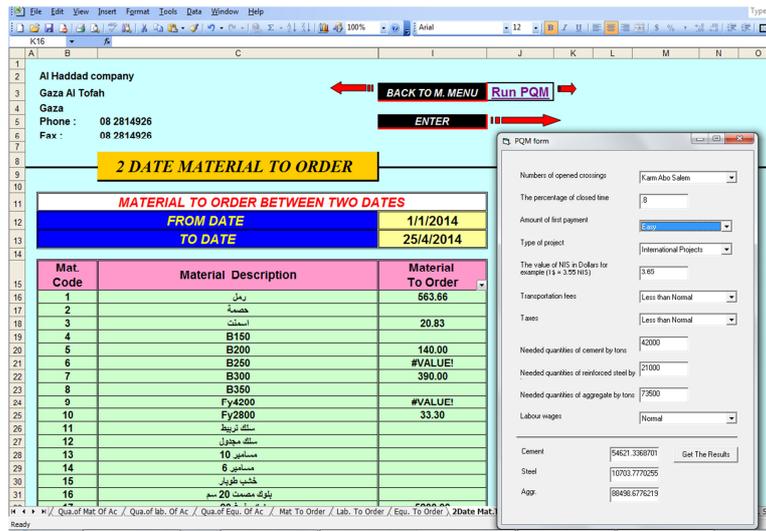
The user can return to the main menu sheet by clicking on Back to Main Menu icon, and he or she can open the "2 dates Labour to order" sheet by clicking on Enter icon at the top of this sheet.



Mat. Code	Material Description	Material To Order
1	رمل	520.63
3	اسمنتيه	9.90
5	B200	140.00
6	B250	840.00
7	B300	390.00
9	Fy4200	195.60
10	Fy2800	33.30
17	بلوك مطوق 20 سم	5200.00
20	بلوك مطوق 10 سم	4810.00
23	اسمنتيه ابيض 50 كغ	2.08

Figure 4: "Materials to Order between two Dates" sheet

"Materials to order between two dates" sheet link together with Quantities Predictor Model (QPM). The user can go to the QPM by clicking on "Run QPM" icon behind "Back to Main Menu" icon at the top of this sheet. See Figure 5.

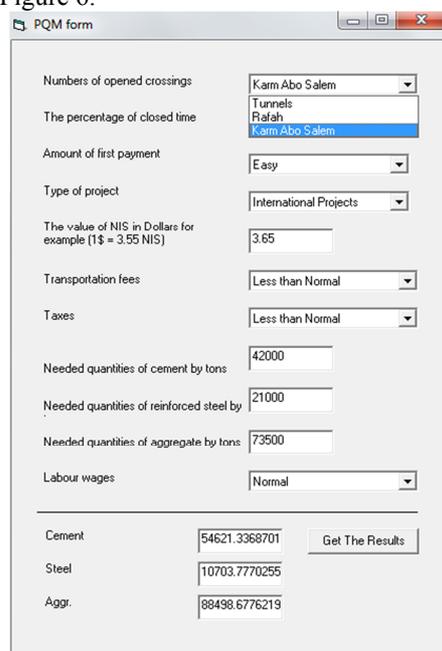


**Figure 5: Run the Quantities Predicting Model (QPM)**

Quantities Predictor Model (QPM) with Gaza Strip Construction Resources Management System (GSCRMS) gives the contractor a mechanism to decide if he can go ahead on the construction project or not according to the predicting quantities of the key materials (cement, steel, and aggregate).

Every contracting company has a lot of construction materials quantities which enter Gaza Strip according to the company classification. For example, the cota of accompany which has a first class classification in building projects is 0.008, 0.0010, and 0.007 cement, aggregate, and Reinforced steel respectively.

Quantities Predictor Model (QPM) consist of 11 factors; Numbers of opened crossings, the percentage of closed time, amount of first payment, type of project, the value of NIS in Dollars for example (1\$ = 3.55 NIS), transportation fees, taxes, needed quantities of cement by tons, needed quantities of reinforced steel by tons, needed quantities of aggregate by tons, and labour wages. The desired parameter (output) are the quantities of cement, steel, and aggregate that reach from several crossings. The user can choose number of opened crossings from a drop-down list as shown in Figure 6.



**Figure 6: Number of opened crossings**

## 6. 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, and depending heavily on subcontractors.

- Some obstacles that face the contractors in using computerized resources management systems are: Lack of awareness of the importance of resource management system for the construction contractor, absence of understanding of construction resources management system, lack of qualified people to use specialized computer programs, shortage of user friendly of construction resources management system, the high cost of a construction resources management system, and the contractor belief that the application of these systems are wasted time of the project supervisors.
- Many benefits can be obtained when the contractor use Construction Resources Management Software on construction projects such as: Reducing the costs of project resources, resources are timely available on site with the right quantity, improving labour productivity, Complying with time schedule, and Obtaining better price for the construction resources can be found at the construction site at the right time and the right quantity etc...
- Many of contracting companies agree to use specialized construction resources management systems
- Many problems related to materials, equipment, workers and technicians can be reduced when contractors implement construction resources management systems
- Many benefits can be obtained from knowing waste percentage for different building materials such as: Help for preparing accurate bill of quantities, help to finish the project successfully and have profits, knowing the real requirements for the project (materials-time-cost), help contractors to price tenders more accurately.
- There isn't any contracting company have any covered story more than 1000 m<sup>2</sup> and more than 3000 m<sup>2</sup> of uncovered story. This result gives an indication that most construction projects in Gaza Strip are small sized.
- All surveyed contractors believe that the Israeli closure on Gaza strip is the main element that affects construction resources availability and cost especially materials and equipment. In addition, the Israeli closure affects clearly the prices of main materials such as cement, aggregates, and reinforcement steel. Also The Israeli closure has big effect on equipments availability and cost
- Most contracting companies are interested in using some techniques of managing construction resources.
- Developing ANN model passed through several steps started with selecting the application to be used in building the model. The Neurosolution5.07 program was selected for its efficiency in several previous researches in addition to its ease of use and extract results. The data sets were encoded and entered into MS excel spreadsheet to start training process for different models.
- According to Quantities Predictor Model (QPM) the result shows that the quantities of key materials (cement, steel, and aggregate) which passing from all Gaza Strip crossings can be affected by several factors such as numbers of opened crossings, the percentage of closed time, Amount of first payment, type of project, the value of NIS in Dollars for example, transportation fees, and taxes, respectively.

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