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QUALITY MANAGEMENT PRACTICES IN THE PALESTINIAN CONSTRUCTION INDUSTRY

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الملخص إن هدف هذا البحث هو فحص تطبيقات إدارة الجوده و استخدام برمجيات الحاسوب في دعم اداره المشروعات لكل من الملاك و المقاولين في قطاع غزة. لقد تم إجراء هذا البحث باستخدام الاستبيان حيث وزع ثلاثة و سبعين استبانة على المقاولين و خمسة و عشرين على الملاك و تم استعادة و تحليل ستون استبانة من المقولين و ثلاثة و عشرين من الملاك. اظهرت النتائج إن وسائل ادارة الجوده مستخدمة بشكل معقول من الملاك و المقاولين. و اظهرت النتائج ايضا ان برمجيات الحاسوب الخاصة بالجدولة و الاعمال الادارية مستخدمة بشكل مرضي. بينما اظهرت النتائج ان برمجيات الحاسوب الخاصة بالتسعير و التحكم بالتكلفة غير مستخدمين بشكل واسع. لقد اوصت الدراسة بضرورة استحداث برامج محلية للتسعير و التحكم بالتكافة تتوافق مع الاتجاهات المحلية لتحقيق النجاح في هذا المجال. كما اوصت الدراسة ان على المقاولين بذل المزيد من الاستثمارات في سبيل تدريب العاملين لديهم على استخدام برامج التسعير و التحكم بالتكلفة.

Abstract The objective of this paper is to investigate the implementation of project quality management practices and using computer software in supporting the projects management by public owners and contractors in the Gaza Strip. This study has been conducted by means of a survey questionnaire. Seventy-three questionnaires were distributed to contractors and twenty-five questionnaires for public owners. Sixty questionnaires from contractors and twenty-three questionnaires from public owners were received and analyzed. The results indicate that project quality management tools and techniques are fairly used among contractors and owners. Furthermore, the use of computer soft-ware in scheduling and administrative issues is satisfactorily used by both owners and contractors. However, the computers software for cost estimate and cost control is not widely used. The results of this study recommended that there is a need to establish computer models for cost estimate and cost control which takes into consideration the local trends and methodologies to achieve improvement in this area. Finally, the contractors have to make investment in improving the abilities of their staff for best use of computer based applications for cost estimate and cost control techniques.

Keywords: management tools, contractors, owners, quality, computer, Gaza Strip.

Introduction

The Palestinian economy may be characterized by its limited size. In 1999, the GDP accounted for approximately US $ 4.15 billion; the total population was approximately 2.8 million; and thus GDP per capita reached approximately $ 1,500 (World Bank, 2001). The GNP per capita was higher, around $ 1,800, given the large inflow of remittances from Palestinian workers in Israel and international aid. By using GNP or GDP criteria, the West Bank and Gaza Strip rank within the group of lower middle income

countries, while the demographic growth rate is among the highest in the world (World Bank, 2001).

From 1994 to 2000, the total disbursements by donors were US$3,057 millions (53.3% of total pledged funds) to specific projects. The average of yearly total commitments for the period from 1994 to September 2000 was US$688 million, and the average yearly total disbursement for the same period was US$ 453 million (MOPIC, 2000). The construction industry (infrastructure development and natural resource management) received US$ 1.023 million, which represents 33.5% of the total disbursement (MOPIC, 2000).

The construction sector showed a steady increase from 1991, due to high demand from the Intifada, and to accommodate Palestinian returnees from the Gulf and after the Gulf War. The peace process accelerated this increase, especially after the return of many Palestinians with the Palestinian National Authority (PNA).In 1994, services and commerce represented 48% of GDP, construction 26%, agriculture 14%, and industry 12%, (PECDAR, 1997). However, it appears that the contribution of the construction sector to the GDP in 1998 has been reduced to 10.63% (PCBS, 2000). By the fall of 1996, the construction sector was employing 12.6 percent of employed Palestinian workers (MAS, 2001). Later, many projects were lunched from the coming of the Palestinian Authority. It has been noticed that the project management gets more involvement in the construction industry in the Gaza Strip due to the increase of the number, the size and complexity of the projects. The local practices indicate that a lot of failures have occurred to considerable numbers of contracting companies during the last ten years which makes it very important to investigate the existing practices.

The political, economic condition and culture in the Gaza Strip, in addition to the lack of planning, and weak performance of both public owners and contractors, have left their marks on the project management considerations in the Gaza Strip. The unpredictable success or failure of major contracting companies, the long delays of important projects, and the low quality of some projects reflects an ambiguous picture on the practices used in project management (Enshassi, 1997a).

Background

Woodward (1997) defines the Quality in construction as" a comparison between the standard achieved and the standard required and specified. It is sometimes referred as conformance or compliance with specification "(Woodward, 1997).

Project quality management includes the processes required to ensure that the project will satisfy the needs for which it was undertaken. These processes are quality planning, quality assurance, and quality control (PMI, 1996).

Hutchings and christofferson (2000, 2001), Yang et al (1997), El-Sawah (1998), and Kazi (2002) have examined various quality management tools and techniques. Four tools and techniques are adopted which are the most popular tools among others. These tools are Inspection, control chart, statistical sampling, and quality audits.

Inspection

BS EN ISO 8402 defines inspection as 'activity such as measuring, examining, testing or gauging one or more characteristics of an entity and comparing these results with specified requirements in order to establish whether conformity is achieved in each characteristic' (McCabe, 1998). The inspection is the examination or measurement of work during construction to check weather-specified standards are being achieved (Woodward, 1997). McCabe (1998) explained that "What is built to be compared with the drawing and specifications". Inspection does not of itself prevent or correct mistakes unless appropriate corrective action is taken subsequently (Woodward, 1997).

Control Chart

Control charts are graphic display of the results, overtime, of a process. They are used to determine if the process is "in control" (PMI, 1996). Control charts can be used to monitor cost and schedule variances, volume and frequency of scope changes (PMI, 1996). Control charts documenting the central tendency and dispersion most commonly record (1) average and range of sample and (2) average and standard deviation (Barrie and Paulson, 1992). Using statistical process control (SPC) produces control chart. SPC is one of the most significant quality tools. The objective is to measure the inputs against the output. Data on parts that can be measured are collected. Using simple formulas is then possible to establish the control limits, upper and lower, on what is known as the control chart. Variation in the process can be assigned to either special or common causes. If the variation is within the control limits, it is due to common causes otherwise outside the limits is due to special causes (McCabe, 1998). Common causes are those which beyond the influence of the workers. They are due to the system (McCabe, 1998).

Statistical sampling

For the purpose of increasing compliance, random samples and statistical methods are commonly used as the basis for accepting or rejecting work

completed and batches of material (Hendrickson, 2000). Statistical sampling involves choosing part of a population of interest for inspection (e.g., selecting ten engineering drawings at random from a list of 75). Appropriate sampling can often reduce the cost of quality control (PMI, 1996). The use of statistics is essential in interpreting the results of testing on a small sample. Without adequate interpretation; small sample testing results can be quite misleading (Hendrickson, 2000). It is necessary for the project management team to be familiar with a variety of sampling technique (PMI, 1996). There are two types of statistical sampling:

1. Sampling by attributes: which is the acceptance or rejection of a lot is based on the number of defective or good items in the sample.
2. Sampling by variable: which is a quantitative quality measure or value of a measured variable is used as quality indicator (Hendrickson, 2000).

Quality audits

A quality audit is a structured review of other quality management activity (PMI, 1996). Internal audits shall be scheduled on the basis of the importance of the activity to be audited and shall be conducted by personnel independent of the activity being audited (Nee, 1996). Audits monitor the performance of a system, it is very important to carry them out effectively. Auditing is the only way to discover how well the system is working (McCabe, 1998).

The objectives of quality audits are

To ensure that the system is operating as designed

To ensure that the quality assurance is helping to meet the client requirements

To ensure that the system's procedures are followed consistently

To discover and explain any problem (McCabe, 1998)

The audit results shall be recorded and brought to the attention of the personnel responsible for activity being audited. Follow-up audit activities shall verify the effectiveness of the corrective actions taken. Results of the internal audits from an integral part of the management review activities (Nee, 1996).

Project management software

Project management soft-wares are widely used to assist with schedule development. These products automate the calculation of mathematical analysis and resource leveling and thus allow for rapid consideration of many schedule alternatives (PMI, 1996). Currently, over 1000 international vendors claim to offer construction software. The historical developments of such application areas are typified by that for planning and scheduling system (Bramble et al, 1990). The computer is applied to project budgeting

and scheduling, program reports, schedule updating, labor and equipment cost report, job status report, project cost forecast, progress payment and quality control (clough, 1986).

As heavy users of project management software, professionals in the construction industry have a strong interest in improving the tools and techniques available for better project planning and control (Libertore et al, 2001). Primavera Project Planner, Microsoft Project, Project Planner 5, Artemis and Pert master Advance are the most powerful software available (Enshasi, 1997b). In a study for Construction Company requirement in project management software, Andersson (2001), states that the use of computer supported planning systems is still not very common (Andersson, 2001).

The computer provides a cost system with flexibility and depth that manual system often can not match. The programs commonly used by contractors actually perform a whole series of cost accounting and financial accounting functions. The computer generates pay-roll checks, keeps payroll records, and maintains the equipment accounts and performs other functions as well as producing a variety of productivity and cost reports and project cost forecast (Clough, 1986). The benefits of having computer spreadsheets for cost estimating and control they are inexpensive, they are easy to use, they can be customized to your style of doing business, and they are very powerful (Christofferson, 1999).

Methodology

This study has been conducted by means of a survey questionnaire supported by personal interviews. Seventy-three questionnaires were distributed to contractors and twenty-five questionnaires to public owners. Sixty questionnaires from contractors and twenty-three questionnaires from public owners were received and analyzed. The total number of contractors in the Gaza Strip who have valid registration by the contractor's union categorized under first, second and third category are 90 enterprises. The samples were selected randomly from each level of three contractor's categories. The person in charge of the planning and management was expected to fill out the questionnaire was also interviewed. Personal interviews were conducted to facilitate the process of filling the questionnaire in terms of better accuracy and more seriousness. For analyzing the data of an ordinal scale, an importance index (I) was used. The importance index was computed using the following equation.

$I_1 = \sum_{i=1}^{n} aixi / n - 1$ Where: I = importance index; a_i = Constant expressing the weight of the *i*th response, where a_i = 0, 1, 2, 3 respectively; If the first level of ranking rate the nonuse/no importance (Mezher and Tawil, 1998).
x_i = frequency of the *i*th response given as a percentage of the total responses for each cause. *i* = response category index where *i* = 1, 2, 3, 4,… .The importance index (I) for all causes was calculated. The indexes were ranked for public owners, and contractors. The group index is the average of factors in each group. The agreement between the rankings of any two parties was measured using the rank correlation coefficient (Mezher and Tawil, 1998).

Results and Discussion

Characteristics of study population

The characteristics of study population are outlined in Table 1. More than half of the public owner's organizations (56.5%) were established before the existence of the Palestinian National Authorities (PNA), while more than three-fourths of the contracting companies (79.4%) were established after 1994, after the establishment of PNA. This means that most contracting companies have limited experience which is likely to affect the level of use of project management tools and techniques (PMTT). Furthermore, the sudden increase in establishing new contracting companies after the arrival of PNA indicated that most of the new companies were very optimistic after getting more projects. Nearly all contracting companies (98.3%) and 82.6% of the public owners are involved in building works, While about 70% of the owners and 55% of contractors were working in water, drainage and road fields. All owners and contractors were employing peoples who have B.Sc. degrees, while 18.2% of the owners and 6.7% of the contractors employed persons who have Ph.D.'s. In addition, 56.5% of the owners and 20% of the contractors have employed persons who hold M.Sc. degrees.

Table 1 Summary of the main characteristics of the study population

Variable		**Owners**		**Total**	**Contractors**		**Total**
		No.	**%**		**No.**	**%**	
Year of establishment	Before 1994	13	56.5	23	12	20.6	58
	1994 – 1995	6	26.1		32	55.2	
	After 1995	4	17.4		14	24.2	
Field of work	Building	19	82.6	23	59	98.3	60
	Water & Drainage	16	69.6		33	55	
	Roads	16	69.6		33	55	
	Others	14	60.9		7	11.7	
Education	Ph.D.	4	18.2	22	4	6.7	60
	M.Sc.	13	56.5		12	20	
	B.Sc.	23	100		60	100	
	Diploma	20	90.9		57	95	
Employees specialization	Civil	21	100	21	57	96.6	59
	Architect	14	66.6		31	52.5	
	Electrical	16	76.2		20	33.9	
	Mechanical	13	61.9		18	30.5	
	Technician	18	85.7		49	83.1	

The total number of respondents=83, 23 owners and 60 contractors. Missing number was due to not answering some questions.

As shown in figure 1, very few owners (4.3%) have less than 14 employees, whilst 29.3% of contractors have less than 7 employees. Around half of contractors (51.7%) have from 7-14 employees. Almost all owners (91.3%) have more than 14 employees. Meanwhile only small numbers of contractors (19%) have more than 14 employees.

This means that the majority of the contractors are categorized as small size companies, which would limit the volume and capacity of the work done by them. The small volume of projects, the seasonally of work and uneven of work volume may explain the small size of the contracting firms. It was found that there is a very weak correlation between the number of employees of respondent organizations and using time tools and techniques. This can be explained by the fact that most organizations employ a small number of persons. The management system does not appear to profit from the experience of staff at their disposal.

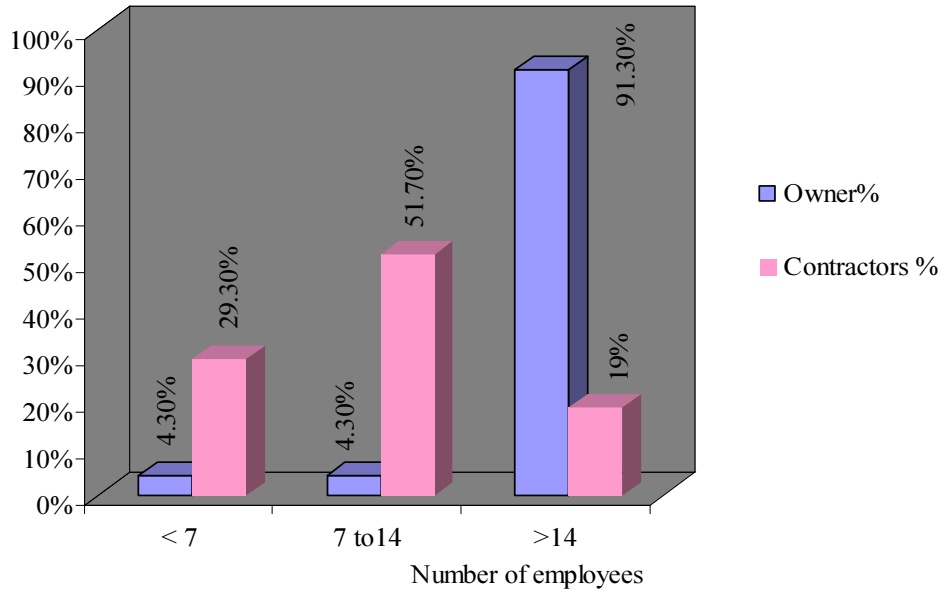

Figure 1 Distribution of respondents by number of employees

The study population comprises of 23 public owners (27.7%) which represents 92% of the total public owner population, while the 60 respondent contractors represent 82.2% of the contractors sample size. Regarding the classification of the respondent contracting company, Figure 2 illustrates that 60% of the companies were classified in the first class, 30% of them were classified in the second class, while only 10% of the contracting companies were classified in the third class. This distribution shows that the strata of the first class contractors are very high when compared with other categories.

Figure 3 shows the distribution of the respondent's positions, with 73% of respondents being either president or vice president. The higher position of the respondent will give considerable confidence in the quality of answers and also express the respondent's concern to deal seriously with this research. It was found that there is no significant difference in relation of the position of respondents and the use of PMTT. However, project mangers have a higher concern on rating time tools and techniques. This can be explained that the project managers have a great awareness and knowledge of these tools. Other reason may be that project managers are the persons who are more qualified than others on implementing of project management techniques.

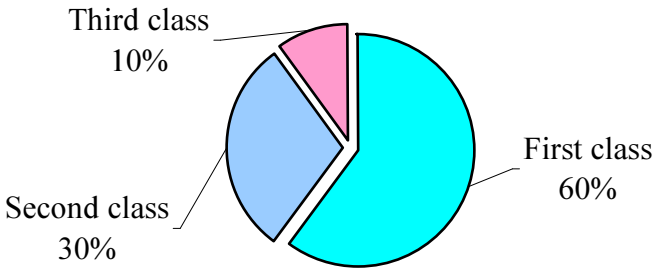

Figure 2 Distribution of respondent contractors by their classification

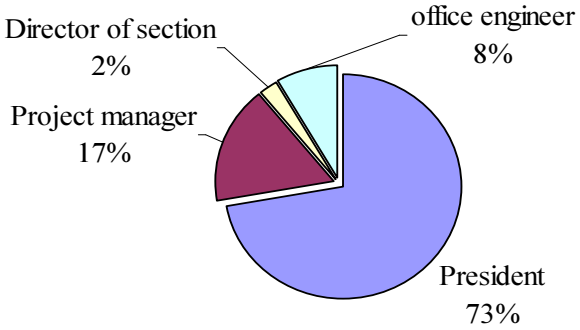

Figure 3 Distribution of respondent's occupation

Using of quality management tools and techniques

Table 2 Degree of using quality tools and techniques

Quality tools and techniques		**Degree of using**				
		N	**O**	**U**	**A**	**Total**
Inspection	No	0.0	4	17	61	83
	%	0.0	4.9	20.7	74.4	
Control charts	No	31	22	14	15	82
	%	37.8	26.8	17.1	18.3	
Statistical sampling	No	9	29	16	29	83
	%	10.8	34.9	19.4	34.9	
Quality audit	No	6	25	15	37	83
	%	7.2	30.1	18.1	44.6	

(N = never used, O = occasionally, U = usually, A = always)

No one of the respondents expressed never used 'inspection' tool (Table 2). The control charts were 'frequently' (frequently is used to indicate both usually and always scale) used by 35.4% of the respondents. Concurrently,

45.3% of organizations were 'frequently' using statistical sampling. About two-third of the study population (62.7%) was 'frequently' using quality audit. The difference between owners and contractors in scoring the quality practices revealed significant differences between owners and contractors in using inspection tool (Pv = 0.01) with preference to owners.

Table 3 Ranking for using quality tools and techniques

Group	Tools & Techniques	Owners		Contractors	
		Importance Index	Rank	Importance Index	Rank
Quality tools and techniques	Inspection	98.57	1	86.43	1
	Quality audit	76.83	2	62.73	3
	Statistical sampling	50.70	3	62.77	2
	Control charts	42.43	4	37.20	4

Table 3 shows that inspection is the most used tool by owners and contractors among other quality practices. Similar findings were reported by El-Sawah study (1998) in Egypt. El-Sawah disclosed that 93% of the respondents were using "inspection". This result is generally consistent with our research findings that almost all the organizations are using inspection tool as an essential tool for testing the quality of work. That is, the nature of contractors works requesting to implement the inspection.

The control charts is ranked the forth. The owners ranked quality audits in the second priority while the contractors rated it the third. The extensive use of quality practices may be explained by the following reasons; first is most of the projects are supervised by more than one level of management which introduces a strict quality control to the supervised project. The second is the well-established system in the contract documents and specification that every work conducted must be tested and should comply with standards. The third is that both owners and contractors are interested to make good reputation, which regularly connected, directly to the quality performed. The higher concern of owners to quality rather than contractors may be interpreted by the fact that owners are interested in high quality regardless of cost while the contractors trying to reach high quality with making such balance against the time and the cost.

Testing the correlation of agreement on ranking quality practices revealed that there is a high correlation between owners and contractors (rho = 0.80). Both parties are highly agreed on the ranking of these factors. T-test indicated that the correlation is not significant at 0.05 level which directs to accept the null hypothesis $H_0(r) = 0$. That is, both owners and contractors are generally had no equal ranking for these factors.

Table 4 Relationships between type of organization and necessity of quality tools

Quality tools		Organization						P_v
		Contractor		Owner		Total		
		No.	%	No.	%	No.	%	
Inspection	Required	56	94.9	23	100	79	96.3	0.271
	Optional	3	5.1	0.0	0.0	3	3.7	
Statistical sampling	Required	39	65	14	60.9	53	63.9	0.726
	Optional	21	35	9	39.1	30	36.1	
Control charts	Required	21	35	11	50	32	39	0.217
	Optional	39	65	11	50	50	61	
Quality audits	Required	41	68.3	21	91.3	62	74.7	0.031*
	Optional	19	31.7	2	8.7	21	25.3	

** Statistically significant*

As shown in Table 4, almost all owners and contractors considered 'inspection' as 'required'. Meanwhile, about two-thirds of contractors (65%) believe that control charts were evaluated as an 'optional'. Also the same ratio of contractors considered the quality audit as 'required'. Meanwhile, 91.3% of owners rated the quality audit as 'required'. The chi square test indicated significant differences between the two groups in relation to quality audit with preference to the owners (Pv = 0.031). The higher use of quality audits may comes from the public owners who participated in the survey and from the companies who were registered by ISO or from companies that planning to be involved by ISO registration as quality audits is one of the essential requirements.

Using computer in supporting the implementation of project management

As detailed in Table 6, 96.4% of the study population reported that they were using computer in construction works. The results exhibit very high level of computer usage, which expresses the ability of the respondents to follow up the modern computer tools and techniques. Most of the participants in the survey (83.1%) were 'frequently' using computer in project scheduling. In contrary, only 3.6% of them did not use computer in scheduling works.

Table 6 Distribution of the study population for using computer applications

Computer applications	Not used		Occasionally		Usually		Always	
	No.	%	No.	%	No.	%	No.	%
Project scheduling	3	3.6	11	13.3	18	21.7	51	61.4
Project cost estimate	20	24.1	18	21.7	16	19.3	29	34.9
Project control	19	22.9	23	27.7	15	18.1	26	31.3
Word processing & accounting	6	7.2	13	15.7	16	19.3	48	57.8

(The total number of respondent's =83)

Around quarter of respondents (24.1%) were not using computer to prepare cost estimate, while more than half of respondents (54.2%) were 'frequently' using computer in cost estimate. Similar results were noticed for project monitoring and control. The main reason for low using of computer application in cost estimate and cost control may be explained by the non-efficient using of computer application suitable to the estimate and control methods used in the Gaza Strip. Furthermore, there is no efficient training for using such programs. In addition to the wrong believes by the respondents that such applications will increase the general overheads for the contractor.

77.1% of respondents were using computer for business issues. The difference between owners and contractors in scoring computer application indicated no significant differences in using computer applications (Pv > 0.05).

Table 7 Ranking of using computer applications by owners and contractors

Group	Tool	Owners		Contractors	
		Importance Index	Rank	Importance Index	Rank
computer applications	Project scheduling	76.80	1	81.63	1
	General business	69.60	2	78.33	2
	Cost estimate	55.03	3	54.97	3
	Cost control	50.67	4	53.40	4

The Spearman's correlation test for agreement on ranking computer applications in supporting project management revealed that there is a very strong correlation and linear association between owners and contractors (rho = 1.00). That is, both parties agree on the ranking of these factors. The correlation is significant at Pv < 0.01.

The same evaluation of both owners and contractors in ranking computer applications is reported (Table 7). The highest rank was using the computer in project scheduling with preference to contractors (I = 81.63), while using computer for cost control was the lowest with preference to contractors (I = 53.4). It is noticed that both parties have low concern in using computer applications for cost control.

The reason behind the agreement is that both parties have equal knowledge about these practices. Furthermore, they have the same degree of interest for using such practices. Finally, the level of using such tools by contractors is affected by owner's requirements. Therefore, strong relation between both samples is expected. However, the contractors have to be more aware about using computer application. The unawareness of the importance of such tools makes the contractors use these tools only upon owner's request.

Contrary, the contractors should be aware that the use of such tools shall improve the time and cost control of projects in addition to enhance the quality and the safe performance of the project.

There were some differences between this study and the study done by Hutchings and Christofferson (2001). That is, the priority of using such applications in Hutchings and Christofferson (2001) research was for word processing & accounting, cost control, cost estimating and scheduling respectively. While in this study the high preference was for scheduling, word processing & accountings, cost estimate and cost control respectively. The difference can be explained that the residential construction companies in USA have less concern in using time scheduling application because they are not related to the public sector where strict time control is needed in addition that the residential buildings are not mostly restricted by tightened time frame.

Conclusions and Recommendations

The use of quality practices revealed that the consensus is that the inspection tool is the most effective and influential practice ever used. The owners regarded significantly the quality audits to be very essential practice. The contractors are using statistical sampling more than quality audits while the owners reported the inverse. The results shows low use of control charts by both parties. The results also showed an overall higher use quality tools by owners rather than contractors. The use of computer in supporting the implementation of project management is another issue that was investigated. The findings of this research confirm that the time scheduling application is the most used one by both samples. Generally, both owners and contractors have the same priority in using computer applications. The contractors showed more use of projects scheduling, general business and cost control applications than owners. The cost control applications are found to be the lowest used applications.

There is an urgent need to establish a professional body such as Institute of Buildings to review local project management practices in terms of education and training required for those participating in managing the projects. The contractors have to make investment in improving the abilities of their staff for best use of computer based application for cost estimate and cost control techniques. It is essential for researchers in project management in the Gaza Strip to develop a cost estimate and cost control models which take into consideration the local trends and methodologies to achieve improvement in this area.

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