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Examination of Usage and Effectiveness of Information Technology Management within Construction Organizations

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Abstract: Information management is considered as one of the most important factors of construction projects success. Nowadays, management of information is a challenge issue and needs high skills, experiences and sufficient tools. Information technology is a tool used to manage and monitor knowledge and information. This paper examines the usage and effectiveness of information technology management within construction organizations in Gaza. In addition, it describes the effective way of sharing information, coordinating tasks, flow of information between project participants. Moreover, it identifies the areas required to support information technology. Questionnaire survey was presented for respondents of construction organizations to identify the range of usage and effectiveness of technologies and techniques for knowledge management in construction organizations. Interviews were conducted also to support and discuss the reached results. The results indicates that mobile, electronic reports, scheduling programs, face to face meeting, team work, graphic programs, phone, fax, micro computer and bulletin boards are among the top ten most important used and effective IT means for knowledge management. It is hoped that managers recognize the benefits of IT and implement changes according to the specific organizational requirements. Such implementation must be accompanied by sufficient training and education for staff to ensue that IT is being used effectively.

Keywords: IT, Construction, Management, Effectiveness

دراسة استخدام ومدى تأثير فاعلية إدارة تكنولوجيا المعلومات في شركات البناء

الملخص: تعتبر إدارة المعلومات من أهم عوامل نجاح المشاريع في قطاع الإنشاءات كما تعتبر من القضايا المليئة بالتحدي وتحتاج إلى مهارات عالية وخبرات كبيرة بالإضافة إلى أدوات كافية .إن تكنولوجيا المعلومات تمثل أداة لإدارة ومراقبة المعرفة والمعلومات، تبحث هذه الورقة في الاستخدام والفعالية لإدارة تكنولوجيا المعلومات في قطاع غزة. إضافة لتحديد الطريقة المثلى لمشاركة المعلومات، تنسيق النشاطات، تدفق المعلومات بين المشاركين في المشروع، علاوة على ذلك فإنه يحدد المجالات المطلوبة لدعم تكنولوجيا المعلومات، تم توزيع استبانه على العاملين في شركات المقاولات لتحديد إلى أي مدى يتم استخدام ودرجة فاعلية تكنولوجيا وتقنيات إدارة المعلومات في قطاع الإنشاءات، كما تم إجراء مقابلات لدعم ومناقشة النتائج التي تم التوصل إليها.

وقد أشارت النتائج أن الهاتف النقال (المحمول) ، التقارير الإلكترونية وبـــرامج الجدولـــة الزمنيـــة والاجتماعات وجهاً لوجه، والعمل ضمن فريق، وبرامج الرسم، والتليفونات والفاكسات ، وأجهـــزة الكمبيوتر الشخصية، ولوحات الإعلانات هي في مقدمة أهم عشر وسائل مستخدمة ومؤثرة في إدارة المعرفة، ويؤمل أن يدرك المدراء فوائد التكنولوجيا وتنفيذ التغييرات المطلوبـــة وفـــق احتياجـــات الشركة المحددة، إن تطبيق هذه التغييرات في مجال التكنولوجيا يجب أن يكون مـــصحوباً بتـــدريب وتعليم كافي طواقم العاملين للتأكيد أن تكنولوجيا المعلومات تستخدم بفعالية .

1. INTRODUCTION

Information technology technique is very important in the entire world. IT opens new visions in the businesses and industries of the world. The construction industry is considered as one of the industries using IT technique. For many years, many processes, functions, operation were done difficulty because of absence of IT field. In addition, most of the work was done manually which lead to more cost, time and error. Further more, IT age in the construction industry leads to many changes, innovations and developing in many aspects as an information communication and sharing.

Many construction organizations employ IT in one form or another to manage their knowledge. It is primarily used to store and transfer explicit forms of knowledge. However, IT is not just about computers. Tools such as video-conferencing may also be useful for the transmission of tacit knowledge as it is, in crude terms, a form of socialization [1]. The exchange of information in computerized environments now covers new research areas in information modeling, such as computer-based documentation, the construction of information models, the development of product models and computer integration of design and construction knowledge [2].

Task of managing all the information needed to design and construct any major facility is a real challenge, and many persons believe that more efficient information management is a primary mechanism for the construction industry to increase its productivity [3]. Thus a large part of the documents handled in today's business world are stored in individual computer files and are treated as units by the operating and email systems [3]. Technology will continue to be invented to assist humans at work and, even more apparent now, in their daily lives. The fundamental benefits to be derived are in speed, precision, convenience, innovation, effective communication, easy coordination and flow of information between project participants [4].

There is little IT research in the construction industry in Palestine. Therefore, the objectives of this paper are to examinant the usage and effectiveness of information technology management within construction organizations in Gaza, to describe the effective way of sharing information, coordinating tasks, flow of information between project participants, to identify the area required to support of information technology.

2.INFORMATION MANAGEMENT IN CONSTRUCTION INDUSTRIES

The construction industry has a reputation for low productivity, waste, low use of new technologies, and poor quality. It is estimated that up to 30% of construction is rework, and recognized that site teams spend too much time and effort making designs work in practice [5]. The task of managing all the information needed to design and construct any major facility is a real challenge and problem, and many believe that more efficient information management is a primary mechanism for the construction industry to increase its productivity. The rapid advances of web-based project management and collaboration technology offer new opportunities to improve existing construction project communication and enhance the collaboration [6].

It was estimated that nearly 45% of all quality problems occurring on construction sites are due to inadequate project information management [5]. For example, it was remarked that during the construction process, subcontractors face a number of problems, one of which is interpreting intricate design details, they sometimes spend too much time and effort trying to understand the design intent and may need help from the site team [5]. The site management team may, in turn, need to contact the designer to clarify these details and how they can be implemented [5]. This may require additional drawings to be produced. IT facilitates the flow of information and knowledge management related to Constructability between design and construction teams during the construction stage [5].

It was studied the use of IT for knowledge management. It was found that many organizations employ IT in one form or another to manage their knowledge. It is primarily used to store and transfer explicit forms of knowledge. However, IT is not just about computers. Tools such as video conferencing may also be useful for the transmission of tacit knowledge as it is, in crude terms, a form of socialization [1].

New technologies such as mobile devices, wireless networks and other technologies are available and support nearly unlimited accessibility to digital information [7]. In common language the word document usually means an information carrier (usually on paper) containing written or drawn information for a particular purpose [3]. On standards and standardization, It was remarked that it is reasonable to assume that in the knowledge age, standards will play an even greater role as the cultures of business, technology and knowledge will demand more standards. After all, IT is intended to be a means to better and more efficient information management and exchange [4].

The chief executive officer (CEO) in an organization plays a significant role in managing IT-enabled change. Essentially, the CEO has to maintain a balance between top-down control and bottom-up empowerment in order to manage IT investment effectively [4]. It is investigated that the main related innovations due to using IT in the construction industry as complementary workplace communication, new products and services, constitute a significant skill-biased technical change affecting labor demand [8].

IT is very important for communication. Communication is a personal, intentional, transactional, symbolic process for the purpose of exchanging ideas, feelings, etc. Information technology should naturally provide the necessary services for a successful communication and coordination between project participants. In technical terms it is focused on data transfer, its possibilities and implications for true communication purposes [9]. Therefore, extensive coordination, communication and data exchange processes are performed during the planning, construction, and operation phases of a built artifact among the different actors involved in one specific project [7].

The history of Internet-mediated communication of architectural information is rich in magnitude and diversity. For example, in 1993 Jerzy Wojtowicz addressed this challenge, and opportunity, by the use of File Transfer Protocol in order to move files between design partners [10]. The internal exploitation of IT within the contractor is more advanced than between the separate legal entities of contractor and supplier. Hard copy transfer dominates information transmission with few companies experimenting with technologies such as Electronic Data Interchange (EDI) [11].

Historically construction IT emerged form "computing in civil engineering" but since every civil engineering discipline started to use computers [12]. There are many benefits and relations of using IT in the construction industry such as:

greater use of IT correlates with better project performance, owners and contractors realize meaningful benefits: There is a pronounced IT learning curve, but the benefits outweigh the risks, IT affects schedule compression beneficially, and overall project cost savings and construction cost savings of 4 % accrue due to increased use of IT [13].

Construction organizations are developing methodologies of integrating information technology in the work environment of their operations. All construction process improvement strategy is based on integration of effective project planning, monitoring and control techniques provided by an enterprise level of integration of all organizational parameters, functions, members and incorporated technologies [2]. For example, Electronic document management (EDM) technology has the potential to enhance the information management in construction projects considerably, without radical changes to current practice [3]. In addition, the construction sectors are aware of the potentials arising from the usage of mobile technology in construction industry for streamlining their business processes effectively and efficiency [7].

It is noticed that information technology management leads to increasing of productivity in the construction industries. General administration, design, project management, site management were enhanced by using of IT. In addition, there were more advantages as quick working, good quality of work and fast access of information [4]. Planning and scheduling techniques, have proven to be more beneficial than traditional tools and are increasingly being employed on complex projects. Some programs can effectively visualise and analyse problems regarding sequential, spatial, process conflicts and temporal aspects of construction schedules, prior to actual construction operations on site[14].

The use of IT as a strategic tool has been used for national construction industry, professional institution, construction enterprise, construction project and construction product [11]. The last decade witnessed a phenomenal growth in the use of computer technology at all levels of the architectural profession strategies. More architects are being convinced with the technology and its enhancements to their architectural work. They are starting to accept, plan and budget for the use of Information Technology (IT) as an integral part of their practices. Indications show that the technology is no more considered an excessive expensive luxury tool, but rather a necessity that offices are starting to invest in both human resources and in financial terms [15].

The role of information technology (IT) in knowledge management (KM) is an essential consideration for any company wishing to exploit emerging technologies to manage their knowledge assets. Construction is known for its conservative attitude towards adopting new technologies. Today, many contractors have Enterprise Web Sites or use Project Specific Web Sites (PSWS) to share information with other partners, customers and suppliers [16]. The World Wide Web provides the opportunity as a tool required for a radically changed and much more efficient communication process in the construction industry [17]. However, There are many additional tools can be used as the area for IT in the construction industries as telephone, mobile, fax, internet, databases, video conferencing, and special programs [1].

3. METHODOLOGY

The research discusses the usage and effectiveness of information technology management within construction organizations in Gaza. A questionnaire survey was conducted and used in order to identify the most techniques and technologies which are value in usage and effectiveness for information management within the construction industry. The questionnaires considered random sample from the respondents of experienced contractors. They were office managers, project managers and site engineers; they have a practical experience in construction industries field. Their sufficient experiences were a suitable indication of examination the usage and effectiveness of IT in construction projects as they know the importance of IT in their works by experience. Forty questionnaires were distributed but thirty of them (75 %) were received. The respondents were asked to express their opinion about the degree of usage and effectiveness of each one of the 31 technological factors of information management within construction organizations in Gaza.

The factors which are considered in the questionnaire are identified from previous studies [1, 2, 7, 14, 15, 18] and other factors are added as recommended by local experts.

There are many methods can be used for analysis of results. However, the mean score is determined for each technology and technique according to their usage in construction organizations and how effective they are in managing

knowledge. The mean values for the usage of the technologies and techniques were calculated on the following scale 5=Always, 4=Very often, 3=Sometimes, 2=rarely and 1=Never. Similarly, the mean values for the perceived effectiveness of the technologies and techniques were calculated on the following scale 5=highly effective, 4=Effective, 3=of some effect, 2=of little effect and 1=of no effect (Egbu and Botterill, 2002). The equation used to calculate the mean value as following:

$$Mean\ \ value\ \ = \frac{\sum_{i=1}^{5} W_i X_i}{\sum_{i=1}^{5} X_i}$$

Where:

i = response category mean value with scale as shown above
W_i = the weight assigned to the *i*th response respectively
X_i = frequency of the *i*th response given as percentage of the total responses for each factor

In addition, to indicate the agreement between the usage and effectiveness of technologies and techniques for information management in construction organizations, correlation coefficients are calculated for the ranking using the following equation [19]:

Where:

$$r_s = 1 - \frac{6\sum d^2}{N\left(N^2 - 1\right)}$$

r_s = Spearman's rank correlation coefficient
d = the difference in ranking between the usage and effectiveness of factors
N = the number of variables (factors), equals to 31 factors as technologies and techniques

4. RESULTS AND DISCUSSION

The results of the study provide an indication of the typical tools and technologies employed by construction organizations to manage knowledge. Tables 1 and 2 present the mean score and rank for each technology and

technique according to their usage in construction organizations and how effective they are in managing knowledge.

Table (1): Usage of technologies and techniques for Knowledge management in construction organizations

Technologies and Techniques	Usage	
	Mean value	Rank
Mobile	4.7	1
Electronic reports	4.6	2
Scheduling programs	4.3	3
Face to face meeting	4.1	4
Graphics programs	3.9	5
Teamwork	3.9	5
Technologies and Techniques	**Usage**	
	Mean value	**Mean value**
Wiry Telephone	3.8	7
Fax	3.8	7
Micro computer	3.8	7
Bulletin boards	3.8	7
Email	3.7	11
Brainstorming	3.6	12
Design programs	3.5	13
CD writer	3.2	14
Internet	3.2	14
Accounting programs	3.2	14
Planning programs	3.2	14
Mainframe computer	3.0	18
Costing programs	2.9	19
Quality systems	2.9	19
Wireless telephone	3.0	18
Scanner	2.7	21
Cash flow programs	2.7	21

Database	2.6	24
Mini computer	2.5	25
Formal education	2.5	25
Monitory systems	2.5	25
Formal training	2.3	28
Decision making system	2.3	28
Risk analysis programs	1.9	30
Video-conferencing	1.8	31

Table (2): Effectiveness of technologies and techniques for Knowledge management in construction organizations

Technologies and Techniques	**Effectiveness**	
	Mean value	**Rank**
Mobile	4.7	1
Technologies and Techniques	**Effectiveness**	
	Mean value	**Rank**
Electronic reports	4.4	2
Scheduling programs	4.1	3
Face to face meeting	4.1	3
Teamwork	4.1	3
Graphics programs	3.9	6
Micro computer	3.9	6
Brainstorming	3.8	8
Wiry Telephone	3.7	9
Fax	3.7	9
Bulletin boards	3.7	9

Email	3.5	12
Design programs	3.5	12
CD writer	3.3	14
Accounting programs	3.3	14
Planning programs	3.3	14
Internet	3.1	17
Costing programs	3.1	17
No wiry telephone	2.8	19
Mainframe computer	2.8	19
Quality systems	2.8	19
Cash flow programs	2.8	19
Database	2.7	23
Mini computer	2.7	23
Monitory systems	2.7	23
Scanner	2.6	26
Formal education	2.5	27
Decision making system	2.4	28
Formal training	2.3	29
Risk analysis programs	2.3	29
Video-conferencing	2.1	31

In addition, the Spearman's correlation coefficient of the ranking of usage and effectiveness of technologies and techniques for information management in construction organizations is determined as **0.981** [19].

If the strength is strong, then correlation will be close to 1. If the strength is weak, then correlation will be close to 0. If the strength is moderate, then correlation will be close to 0.5. It is noticed that the value of Spearman's correlation coefficient of the ranking of usage and effectiveness of technologies and techniques is high as the values was equal **0.981**. Therefore, there is strong

agreement between the ranking of all the factors according to their usage and effectiveness. Table 3 shows the value of Spearman's correlation coefficient.

Table (3): Spearman's correlation coefficient of the ranking of usage and effectiveness of technologies and techniques for Knowledge management in construction organizations

Technologies and Techniques	Usage	Effectiveness	d	d^2
	Rank	Rank		
Wiry Telephone	7	9	-2	4
No wiry telephone	18	19	-1	1
Mobile	1	1	0	0
Fax	7	9	-2	4
Mainframe computer	21	19	2	4
Mini computer	25	23	2	4
Micro computer	7	6	1	1
CD writer	14	14	0	0
Scanner	22	26	-4	16
Internet	14	17	-3	9
Email	11	12	-1	1
Database	24	23	1	1
Design programs	13	12	1	1
Accounting programs	14	14	0	0
Costing programs	19	17	2	4
Cash flow programs	19	19	0	0
Risk analysis programs	30	29	1	1
Graphics programs	5	6	-1	1
Scheduling programs	3	3	0	0
Planning programs	14	14	0	0
Electronic reports	2	2	0	0
Technologies and	**Usage**	**Effectiveness**	**d**	**d^2**

Techniques	Rank	Rank		
Bulletin boards	7	9	-2	4
Face to face meeting	4	3	1	1
Brainstorming	12	8	4	16
Teamwork	5	3	2	4
Formal education	25	27	-2	4
Formal training	28	29	-1	1
Monitory systems	25	23	2	4
Decision making system	28	28	0	0
Quality systems	22	19	3	9
Video-conferencing	31	31	0	0
			Sum d^2	**95**
			r_s	**0.981**

The mobile has been ranked in the first position with a mean value equal 4.7 for both usage and effectiveness for information management in the construction industry. This can be explained and argued the majority of respondents noted that the mobile device is the most technological mean used in their job for information management. They stated the mobile has many advantages as it is easy to be used for most people, it is available in markets, its cost is low compared with other techniques, it facilitates the communication and save the time of work as possible, it is proper to the culture of Palestinian people and the mobile technology does not need training courses or education as some techniques need. In addition the mobile can be used everywhere, every when for information sharing, storage and management.

This evidence can be supported and emphasizes by Egbu and Botterill [1] when they said that the mobile is a simple and familiar tool for communication and sharing knowledge. In addition, it is the most effective tool for IT. On the other side, mobile devices not only provide users with the computing support needed but also with newly developed input and output technologies supporting alternative ways of interaction when using the computing device on the construction site [7].

Examination of Usage and Effectiveness of Information

Electronic reports technique has been ranked in the second position with a mean value equal 4.6 for usage and 4.4 for effectiveness. It is noticed that there is no high different between the values of mean for usage and effectiveness. From interviews it is understood that many construction organization used this technique because it is familiar tool for all participants, it can be used strongly for decision making process and innovation of the organization. One of interviewee noted that the electronic reports technique can play an important role in communication between employees of construction organizations. In addition, the electronic reports have an effective impact on the formulation, implementation and evaluation of organization strategy. The report technique has the third rank for usage and effectiveness of IT in the study of [1]. This emphasis the evidences of interviewed and the importance of reports for information management technology.

Scheduling programs has been ranked in the third position with a mean value equal 4.3 for usage and 4.1 for effectiveness. In addition, it is noticed that the mean value of usage is higher than of effectiveness but with a little degree. This high value of usage and effectiveness mean can be supported by the interviewee people who noted that scheduling programs have a high usage and effectiveness on the process of work in the construction site in Palestine. Scheduling programs have rank and mean score less than mobile and electronic reports because these types of programs as Ms Project need some of training, education, skills, high sense and expert of managing, controlling and dealing. However, scheduling program is one of the top five ranked factors as computerized scheduling systems maintain detailed project schedule data and generate the required schedules and reports.

Face to face meeting has been ranked in the fourth position for usage and has been ranked in the third position for effectiveness with a mean value equal 4.1 for both. Generally, this technique is important for information management within construction firms as it is needed to meet others face to face either in the office or in the site to get and give needed information during project stages. However, it is noticed that it has lower ranks than mobile, report and scheduling programs. One respondent argued that because this tool need more time, effort and cost. Egbu and Botterill [1] obtained face to face meeting as the fourth rank

also. They said that face to face meetings are preferable to a more formal investment in sophisticated IT packages. So, this tool is incremental in implementation of IT.

Teamwork technique has been ranked in the 5th position with a mean value equal 3.9 for usage and has been ranked in the 3rd position with a mean score equal 4.1 for effectiveness. It is noticed from these values that this tool has higher rank in effectiveness than in usage. This can be explained as the nature of Palestinian culture does not prefer the teamwork, but Palestinian people believe that this tool has an important and effective role in management of information. Egbu and Botterill [1] obtained a teamwork technique as the thirteenth rank with low usage mean equal 2.5 and low effectiveness mean equal 2.9.

Graphic programs technique has been ranked in the fifth position for usage and has been ranked in the sixth position for effectiveness with a mean value equal 3.9 for both. It is noticed that the rank of usage is higher than effectiveness but they have the same mean value. Therefore, it is known that graphic programs are used frequently in offices or sites as for shop drawings, but these programs used in design firms more than constructor firms.

5. CONCLUSIONS

The following table is summary for the top five significant used and effective technologies and techniques for Knowledge management in construction organizations.

Table (4): The top five significant used and effective technologies and techniques for Knowledge management in construction organizations

Technologies and	Usage

Examination of Usage and Effectiveness of Information

	Mean value	Rank
Mobile	4.7	1
Electronic reports	4.6	2
Scheduling programs	4.3	3
Face to face meeting	4.1	4
Graphics programs	3.9	5
Teamwork	3.9	5

Technologies and Techniques	Effectiveness	
	Mean value	Rank
Mobile	4.7	1
Electronic reports	4.4	2
Scheduling programs	4.1	3
Face to face meeting	4.1	3
Teamwork	4.1	3

According to ranking of all technologies and techniques, it is obtained that mobile, reports, scheduling programs, face to face meeting, team work and graphic programs are among the top five significant used and effective technologies and techniques for knowledge management in construction organizations.

The mobile was the most important technical factor for usage and effectiveness for information management in the construction industry as it is easy to be used for most people, it is available in markets, its cost is low compared with other techniques, it facilitates the communication and save the time of work as possible, it is proper to the culture of people and the mobile technology does not need training courses or education as some techniques need.

There are some factors have more importance than the other does. So, the installation of IT must be complemented by a willingness to share information and knowledge. Therefore, in some construction firms, there is some reluctant among older employees to use IT, or use it effectively, generating doubt about the success of IT in this organizations.
Internet and Emails have a moderate ranks for usage and effectiveness because these factors are not familiar to be used for contractor to manage information within the office or the site. He depends more up on the mobile and reports.

Video-conferencing has the lowest rank because it is not practical, needs high cost, requires more time, it is not easily available, it has some problems and it is not familiar for communication between participants.

The Spearman's correlation coefficient of the ranking of techniques and technologies factors is equal 0.981. The high value of rank correlation coefficients indicates strong agreement between ranking of usage and ranking of effectiveness of factors.
It is preferred to develop and improve the managerial skills to use the technique and technology in the construction industries. In addition, it is recommended that managers recognize the benefits of IT and implement changes according to the specific organizational requirements. Such implementation must be accompanied by sufficient training and education for staff to ensue that IT is being used effectively.

The construction organizations must have a clear mission and vision to formulate, implement and evaluate the needed strategy of using IT for knowledge management. It is needed to understand IT in the context of the corporate strategy and organizational culture so that IT usage can be tailored to the needs of the business. The environment of construction organizations should be proper to implement technology systems for information management. It is necessary to have the needed resources for empowerment of technology within the works. It is recommended to simulate other developing organizations which use IT in their jobs, also it is important to know the weaknesses in knowledge management in order to solve and overcome by using new techniques and technologies.

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