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Obstacles to Information Technology adoption in Construction projects in the Gulf Cooperation Council (GCC)

Abstract

This study investigates the obstacles hindering the reasonable benefits from Information technology (IT) in the construction projects. The need for IT to manage projects' processes is necessary to enhance projects' output. However, the construction industry has not yet been able to gain the expected benefits from IT implementation. The focus of the study, therefore, is on obstacles to IT adoption in GCC countries construction projects. Exploratory Sequential Mixed Method was used wherein an initial qualitative phase of data collection and analysis is followed by a further phase of quantitative data collection and analysis. Significant relationships (p=05%) were found between the items identified as IT adoption obstacles and construction project success in the GCC countries. Furthermore, significant differences were found in the ranking of these factors among the GCC countries, disciplines, and organizations indicating that GCC countries have specific needs in their construction projects mainly due to lack of skills and technical knowledge.

Key words**:** Information Technology (IT); Adoption; Construction Project; GCC; Implementation

1. Introduction

Over the years, the six-member states of the Gulf Cooperation Council (GCC), Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates, governments have increased their public sector employment and spending on infrastructure, health, and education. The standard of living and support for the private sector activity are raised in the non-tradable sector and higher budget allocation toward the construction sector as part of the strategic vision of the member nations that lends an added push to the construction industry in this region [1].

1.1 Background

Construction industry projects in the GCC is enormous. Total GCC active projects is estimated at $2.6 trillion - equivalent to 160 percent of Gross Domestic Product (GDP) indicating that the regional construction market presents enough depth and opportunities for investors and regional market participants [37]. Despite the recent obstacles such as oil price slump and budget adjustments in many GCC countries, the region witnessed $130 billion completed projects in 2017 and $100 billion for the full year of 2016. Such numbers remain at par with an annual average of $135 billion during the 2009-2014 period [2]. However, there are innumerable challenges encountered in the construction industry in the GCC. Some of these challenges include, and not limited to; wrong cost estimation, absence of documented change management process with the appropriate approval levels which results in approving unsubstantiated change orders and/or over-paying

change orders, and the lack of capturing and documenting a project's data, lack of proper communication channels, improper records that could potentially be misleading.

The absence of a real-time and correct data increase the risk of project owners and contractors making wrong decisions, which could severely delay the progress of construction and or harm the project financial or otherwise [3]. In this century, information technology (IT) is viewed as an apparatus that helps organizations to sustain their business engagements for more productive and successful outcomes. In any case, numerous researchers have examined whether the advantages exceed the interests specifically in the construction industry. The industry has its own inclination where there are factors that limit execution, for example, absence of training, insufficient utilization of IT infrastructures, and absence of support and negative staff's recognitions as to IT usage [4]

1.2 Research Problem

The need for IT adoption to manage the construction projects' processes is necessary for the enhancement of projects' output. IT plays a key role in supporting the construction industry to develop and improve performances, but the industry has not yet been able to gain the expected benefits from IT implementation. Previous researches related to the subject was classified into three categories, namely:

- *General*: Obstacles to IT adoption or to a specific program in the construction projects without restriction to a specific location or region.
- International locations: Obstacles to IT adoption or to a specific program in the construction projects in a specific location or region except GCC.
- *GCC countries*: Obstacles to IT adoption or to a specific program in the construction projects in a specific country within GCC.

Based on the listed categories of previous studies done in the area of the research topic, which did not fully establish comprehensively most of potentials of IT that can be used to mitigate the problems in construction projects and improve performance. The researcher, therefore, is motivated by the immense potential in IT that has not been fully utilized in the construction projects across the GCC.

This study therefore, highlights the relationship between IT and the construction activities from design stage up to the handing over of the executed project, logistics, services and all processes of project management. It includes a comprehensive study about the processes of the construction project management, stages, and the impact of utilizing IT in the construction projects. The opinions of all the involved stakeholders within the three types of organizations in the construction industry such as the client (owner), the consultant, and the contractor are taken into consideration. The study surveyed the opinions of all the specialists during all the stages of the project up to completion i.e. design, logistics and execution, from all the GCC countries, as well the different levels of positions. This triangulation gives the validity and reliability of this study.

As per the review of literature, there are no specific studies in the GCC that identifies obstacles to ICT adoption in the construction projects, and the cited literatures in chapter two did not include a comprehensive study about the processes of the construction project management and the impact of IT on each process. No study has

been undertaken so far that involved all stakeholders within the three types of organizations in the construction industry (the client, the consultant and the contractor) in the GCC

The concentration of the previous studies was mostly only on engineers and project managers, despite that there are other important specialists that has an influential role over the course of events during the life of the project. In addition, no study took into consideration all stages involved in completing a project i.e. design, logistics and execution. The Gaps in the previous literature can be summarized as follows:

- Most of the reviewed literature did not survey all the involved stakeholders within the three types of organizations (the client, the consultant and the contractor) with different levels of positions, design, execution and enabling functions experiences.
- There is no comprehensive study that includes all stages and its participants (design, logistics and execution) into consideration, most researches focused only on the execution phase or design phase.
- Most of the studies did not impose solid conditions on the experience of the respondents, based on the author view, the more experience the respondents have, the more accurate results the research will give.
- Even though other researches tried to give solutions to overcome obstacles of IT adoption in the construction industry, these solutions are either suitable for the country in which the research was conducted or they were not enough and effective as such solutions did not take into account all stage of the construction project
- Most research analyzed by the author related to the topic of the research depended on small samples, the author conducted the survey on 50 respondents for the qualitative study and 429 for the quantitative study. Larger samples increase the chance of significance, as they are more reliably to reflect the population mean.
- Most of the researchers are working in the academic field; they have no applied experience in the construction industry, and this in turn might have affected their results.

1.3 Research Objectives

The main objective of this study is to identify the obstacles of information technology (IT) adoption in the construction projects in the GCC countries; and to present a practical solution to overcome or mitigate these obstacles in order to expand the use of existing IT, which will have great impact on project management in the construction field of GCC. Furthermore, another main objective is to provide a feedback and lessons learned to organizations to improve their methodologies in construction as well as to provide an open door for new inventions and modifications in ICT related to project management in the construction projects.

The following aspects are examined:

- To determine the main obstacles to IT adoption in the construction projects in the GCC.

- Compare the obstacles in the GCC with other regions based on the literature review.
- Determine the solutions to face these obstacles.
- Specify the extent the related IT programs were utilized in the construction projects in the GCC.
- Test whether these obstacles are different in ranking amongst the GCC countries.
- Test whether these obstacles are different in ranking amongst the three types of organizations the client, the consultant, and the contractor.
- Test whether these obstacles are different in ranking according to the construction project types, i.e. design and execution

1.4 Theoretical background

1.4.1 Scope of Construction Industry in GCC

The nature of different aspects of construction projects in the GCC that necessitated the adoption of IT technologies are outlined in this section. Construction project can be defined as "all the activities involved in the erection, installation or construction of a portion or an entire project, these activities provided on the job site by the contractor, subcontractor, material suppliers and equipment suppliers, so the construction process is carried out with labor, machinery, equipment, materials, methods and money" [4]

As Jackson [5] stated, "construction management entails the planning, scheduling, evaluation, and controlling of construction tasks or activities to accomplish specific objectives by effectively allocating and utilizing appropriate labor, material, and time resources in a manner that minimizes costs and maximizes customer/owner satisfaction."

Although this definition explains the function of the construction management, the discipline or profession of the construction management is not quite so easy to be understood. That is because the construction management is not just a single task or activity. It is comprised of several tasks and a construction management team usually delivers that. At the same time, an individual member of a construction management team performing even one of the CM functions is said to be doing construction management.

The construction projects are diverse having good knowledge about the types of the construction project will ease the operation of specifying functions and tasks within all stages of the project and this in turn will have a positive impact on creating ICT solutions, according to Hendrickson and Au [6], there are four types of construction project:

1. Residential housing construction: this includes single-family houses, multi-family dwellings, usually less than three or four units. The owner takes charge in making contractual agreements for design and construction and arranging the financing and sale of the completed structures, these projects are usually performed by architects and engineers. The builder who hire subcontractors for the civil, mechanical and electrical work then executes the construction.

2. Institutional and commercial building: even though its similar residential building in terms of processes to produce the deliverables, it differs usually in terms of purpose. This type includes a great variety of project types and sizes, such as schools and universities, medical clinics and hospitals, building restaurants, grocery stores, and skyscrapers. The owners usually select professional consultants, architects, engineers involved for designing a specific type of building, and the contractors undertaking such projects may be specialized in only that type of building.
3. Specialized industrial construction: this term is interchangeable with the commercial construction, but it includes very large-scale project with a high degree of technological complexity, such as oil refineries, steel mills, power plants, manufacturing plants, solar wind farms, and refineries. The owners usually are deeply involved in the development of a project and prefer to work with designers-builders such that the total time for the completion of the project can be shortened.
4. Infrastructure and heavy construction: usually these types of projects are generally owned by the public and financed by the government. Example of these projects are highways, mass transit systems, tunnels, bridges, pipeline drainage, and sewage plants. The nature of these projects is the high degree of mechanization. The engineers and builders engaged in infrastructure construction are specialized since each segment of the market requires different types of skills.

One can notice that Hendrickson and Au [6] divided the types of the construction projects in terms of their sizes and the owner of the project. A better classifying can be done in terms of similarities of these projects. For instance, multi-family dwellings and schools belong to different categories even though both are buildings and they have nearly the same activities. Classifying the construction project based on similarities can ease the work of ICT developers and the researchers of the construction project management.

1. Kingdom of Saudi Arabia (KSA): The Saudi market is the biggest market amongst other GCC countries [7]. Growths over the forecast period (2017–2021) are expected to be supported by government focus on developing transport infrastructure, energy and utilities facilities, and affordable housing across the country. The up and coming undertakings in the GCC are focused on supporting the construction business and might reshape it.

Saudi Vision 2030 accompanies the expansive targets to make the nation free from their reliance on the oil part. Saudi Arabia is getting ready for the privatization of the economy overall. The Kingdoms' point is to build the present GDP from the private part from 45% to 65%.

The nation is driving towards privatization of numerous open substances inside the medicinal services, administrations and vitality part. The object is to draw in outside financial specialists to put and take advantage of the market by beginning a business in Saudi Arabia.

Saudi Arabia's Public Investments Fund (PIF) is a sovereign riches support claimed by KSA. This entity was established for contributing assets for the benefit of Saudi Arabia's government. There are roughly 200 ventures and 20 of these are recorded on the Saudi Stock Exchange Tadawul. PIF gives medium- and long-term credits to vast scale government and private mechanical undertakings. PIF is arranging a task in the northwestern district – NEOM, which centers on creating key financial parts, for example, biotech, vitality, versatility and advanced science, which will help the certainty of speculators hoping to work together in KSA.

2. United Arab Emirates (UAE)*:* In excess of twenty-one percent of 2018 spending plan was assigned to top construction ventures. Numerous construction ventures are in the pipeline, for example, the extension of Al Maktoum International Airport. The development plan executed in two stages throughout the following six to eight years. When the development is finished, the airplane terminal will probably deal with in excess of 220 million travelers every year. Development on the principal period of airplane terminal extension started in mid-2017 and was completed by end 2018. Development of the second stage will initiate toward the begin 2020 and is evaluated to be finished in 2022. Dubai Metro is in the development of a rail from Nakheel Harbor station to the forthcoming Expo 2020 Dubai.

Preliminary of the new Dubai Metro is relied upon to begin in the final quarter of 2019, with traveler benefits because of start on 20 May 2020, five months in front of opening of the Dubai Expo 2020. Abu Dhabi metro venture will be 131 kilometers in length and incorporates the 18-kilometer underground Metro line. Stage 1 of the system ought to be finished by 2020. These tasks will positively affect the economy in general as new open doors are made, organizations are ending up considerably more pulled in towards setting up a business in UAE and thus there will be expanded work openings in the market.

3. Kuwait: Kuwait is centering towards the construction and transport ventures. Kuwait Metro has been affirmed with the principle intend to improve and redesign infrastructural offices that will fulfill current guidelines which will affect decidedly on the personal satisfaction. There will be more than 1,500 openings for work at the activity stage and this undertaking alone will essentially diminish the rate of traffic blockage all through the city. Kuwait is considered as the monetarily most grounded in the whole GCC district. Kuwait is concentrating on open and private associations to carry privatization into the market and become more grounded with development advancements. Additionally, this will end up being an engaging business sector including the construction sector for remote organizations hoping to grow or setup a business in Kuwait

4. Bahrain: Bahrain's government is concentrating on the construction of a light rail transport (LRT) arrange in the nation intending to facilitate the traffic issues between the urban areas. The undertaking is a piece of Bahrain's public transport masterplan 2030. The task will incorporate 105 kilometers of rail organize, with 20 train stations including an airplane terminal station and is relied upon to convey 43,000 travelers for every hour. LRT will be actualized in a staged way and is relied upon to rouse individuals to extend and set up a business in Bahrain [8].

5. Oman: Oman's market is still generally, little in any case, as of late the air terminal began its development intends to adjust and include new facilities. Through this the construction venture, Muscat International Airport will currently can deal with 12 million travellers for every annum. The nation is infusing more endeavours to improve medicinal services, training, and the travel industry, which is reflected in beginning new construction ventures identified with these sectors [8].

6. Qatar: Qatar currently displays apparently the biggest undiscovered business open door for universal organizations who are hoping to supply a market that has a critical need to source construction items. Laid out in the "Qatari National Vision 2030" and upheld by significant government speculation, billions of dollars are being filled the development of real business, retail, private, accommodation, transportation, relaxation and amusement extends in anticipation of FIFA World Cup 2022 and the more extensive 2030 Vision. A choice of a portion of the top undertakings' construction projects include Doha metro project - Phase 1 cost $18 billion design and execution of a metro line spanning 85 kilometres and construction of 37 underground stations - Phase 1. These lines are expected to be open to the public by 2020. Msheireb Downtown Doha (MDD) development project**,** cost $6 billion. Development of Msheireb Downtown Doha (Formerly Heart of Doha City) mixed-use scheme comprising several districts, including a residential and mixed-use quarter, a retail quarter, a heritage quarter and a commercial area [9].

1.4.2 Construction Challenges in the GCC

According to Deloitte [3] there are many challenges that are encountered in the GCC construction industry. Some of these challenges are as follows:

Bad cost estimation: For example, each project needs to have a valid cost estimate to determine if it is viable or not, under reported estimates of project cost could result in increasing the attractiveness for approving the project, in such a scenario the project investor would only know the true cost estimate once the project is at an advanced stage. The project owner would then have to decide whether to stop the project and lose what had already been spent, continue with the project and fund the additional cost, or try and understand what mitigation plans could be put in place to control the project cost and perhaps compromise the original design. Unbalanced bids for lump sum contracts and for which an award is made to the contractors who submit the lowest bid for the project: The bid price assumes that the project scope on certain items will be changed significantly and this can be due to knowledge that the design is incomplete; accordingly, the pricing of individual bill of quantities (BOQ) items can be calculated to maximize the increase in price for items known to be linked to expected design changes.

Absence of a documented change management process with the appropriate approval levels could result in approving unsubstantiated change orders and/or over-paying change orders: This process should be aligned with other related processes, such as analyzing schedule delays and granting time extensions, as well as those relating to contract notifications, project communications and document management. The absence of the appropriate project documentation and communication might reduce the chances

for voiding unsubstantiated changes. Often project owners will give verbal instructions for change orders and the written instructions will only follow much later.

The lack of capturing and documenting a project's data: Communication and records could potentially also be misleading, with the absence of a real-time and the correct data, will increase the risk that project owners and contractors may make the wrong decisions, which could severely delay the progress and harm the project. It can be claimed that all these problems and challenges can be solved or at least be mitigated by using Information and communications technology (ICT) solutions, in the following section some ICT approaches and methods will be presented as well as its benefit

1.5 Information Technology in the Construction Industry

IT in the construction projects emerged from two fields. The first was related to the use of computers for creating drawings, making structural analysis, and carrying out time and cost calculations. The second was concerned with the use of computers to classify, store and manage the construction information [10].

In this section, the definition of IT and some approaches to IT implementation in the construction projects as well as its benefits are discussed.

Information technology (IT) is a technology that "uses computers to gather, process, store, protect, and transfer information. It is common to use the term Information and communications technology (ICT) interchangeably because it is unimaginable to work on a computer which is not connected to the network" [11]. Figure 1.1 shows the major components of ICT and how information flows through a medium of communication.

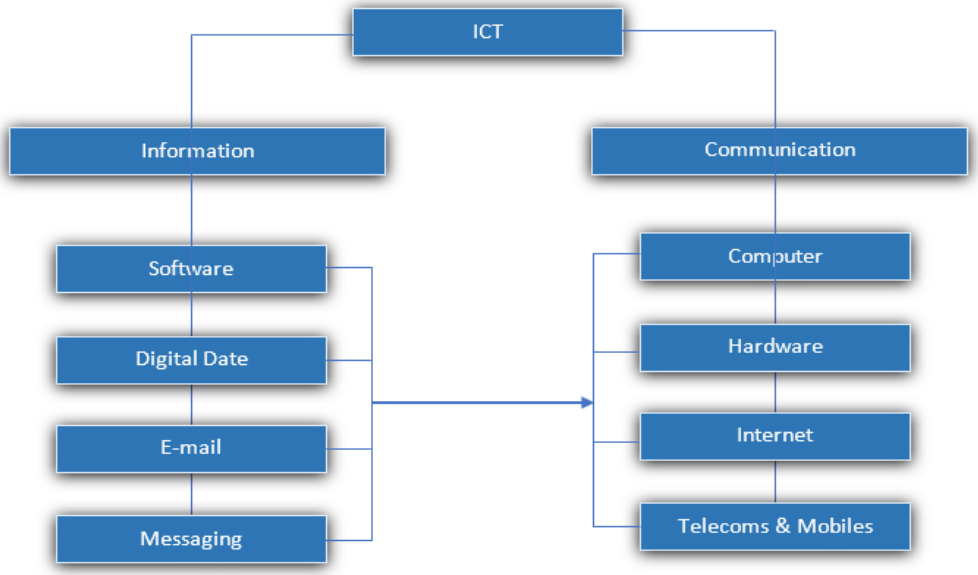

Figure 1.1 ICT and its components [12]

Adwan and Al-Soufi [46] reviewed the literature about using ICT in the construction projects during the period 1996-2016. Eleven (11) categories of ICT applications were identified: BIM based ICT applications, modelling based ICT applications, computer based Training ICT applications, decision based ICT applications, mobile, wireless & tracking based ICT applications, miscellaneous ICT applications, knowledge management based ICT applications, virtual based ICT applications, project management based ICT applications, simulation based ICT applications, and web-based ICT applications.

1.5.1 Obstacles to Information Technology (IT) Adoption

Studies on obstacles, barriers, and challenges of adopting ICT in the construction projects are varied. Some are on specific area of ICT while some considered all aspects of ICT as a whole. Since Building Information Modelling (BIM) is a trend in the construction industry, it is not strange to find that several researches have been conducted to identify its barriers rather than stating ICT in general.

Table (1.1) outlines various obstacles in construction projects identified in literature. Obstacles that hold similar meanings have been merged, and those that are limited to a specific type of ICT tool and can be generalized to other ICT tools are taken in account. Obstacles that are related to the nature of a specific ICT program and cannot be generalized are eliminated

Table 1.1 Obstacles from the Literature Review

Individual obstacles		Source	Summary
1	Lack of demand and lack of top management support	(AL - Btoush & Haron, [13], (Hamadaa, Harona, Zakiriaa & Humadab, [14], (Kushwaha, [15], (Samuelson & Björk, [16], (Bosch-Sijtsema, Isaksson, Lennartsson & Linderoth, [17]	Individual in construction project make no demand for full IT adoption and management does not initiate of support and IT adoption in construction projects
2	Resistance to change	(AL - Btoush & Haron, [13], (Hamadaa, Harona, Zakiriaa & Humadab, [14], (Kushwaha, [15], (Ahmed, [18], (Soon Ern, Kasim, Nasid Masrom & Kai Chen, [19], (Alaghbandrad, Asnaashari & Preece, [20], (Bosch-Sijtsema, Isaksson, Lennartsson & Linderoth, [17], (Adriaanse, Voordijk & Dewulf, [22]	Individual involved in construction project resist change from what they are already using to new advance IT software's
3	The capital to invest	(AL - Btoush & Haron, [13], (Kushwaha, [15], (Sardroud, [21], Adriaanse, Voordijk & Dewulf, [22]	Most project do not have enough financial, manpower and skill need for IT adoption
4	Lack of training staff to new technology	(AL - Btoush & Haron, [13], (Kushwaha, [15], Akinbile & Oni, [23] (Alaghbandrad, Asnaashari & Preece, [20]	Trained staff that understands new IT technology are lacking
5	Return on investment	(AL - Btoush & Haron[13], (Kushwaha, [15], (Ozumba & Shakantu, [24], Akinbile & Oni, [23] (Alaghbandrad, Asnaashari & Preece, [20], (Sardroud, [21]), (Kasim & Ern, [25]	Most organizations fear that resources invested might be wasted

6	High cost of software and hardware	(Hamadaa, Harona, Zakiriaa & Humadab, [14], (Kushwaha,[15], (Ahmed, [18], (Soon Ern, Kasim, Nasid Masrom & Kai Chen, [19] , Akinbile & Oni, [23] (Samuelson & Björk, [16], (Bosch-Sijtsema, Isaksson, Lennartsson & Linderoth, [17], (Adriaanse, Voordijk & Dewulf, [22]	Lack of resources to meet the high cost of IT software's
7	High cost of training	(Hamadaa, Harona, Zakiriaa & Humadab, [14], (Ahmed, [18], (Soon Ern, Kasim, Nasid Masrom & Kai Chen, [19] , (Kasim & Ern, [25]	Training staff will result to expanded budget
8	Lack of skilled staff	(Hamadaa, Harona, Zakiriaa & Humadab, [14], (Kushwaha, [15], (Ahmed, [18], (Ozumba & Shakantu, [24], (Kasim & Ern, [25], (Adriaanse, Voordijk & Dewulf, [22]	Lack of knowledgeable employees impedes IT adoption
9	Lack of awareness	(Hamadaa, Harona, Zakiriaa & Humadab, [14], (Ozumba & Shakantu, [24], (Adriaanse, Voordijk & Dewulf, [22]	Not knowing the current issues in ICT technology reduces the chance of IT adoption
10	Lack of support from government	(Hamadaa, Harona, Zakiriaa & Humadab, [14], (Kushwaha, [15],	Lack of concerning for developing industrial infrastructure that aid business growth can hinder IT adoption
11	Legal and regulations issues	(Hamadaa, Harona, Zakiriaa & Humadab, [14], (Ahmed, [18], (Ozumba & Shakantu, [24], (Alaghbandrad, Asnaashari & Preece, [20]	Sustained legal and restriction laws can inhibit some IT software's from being implemented
12	Conservative attitude of professionals	(Soon Ern, Kasim, Nasid Masrom & Kai Chen, [19], (Samuelson & Björk, [16], (Kasim & Ern, [25]	Lack of embracing new technology from professional in the management hinders IT adoption
13	Benefits are not tangible	(Hamadaa, Harona, Zakiriaa & Humadab, [14], (Ahmed, [18],	Lack of immediate reward hinders IT adoption

		(Ozumba & Shakantu, [24], (Bosch-Sijtsema, Isaksson, Lennartsson & Linderoth, [17]	
14	Lack of supply chain	(Kushwaha, [15], (Ahmed, [18], (Ozumba & Shakantu, [24], (Bosch-Sijtsema, Isaksson, Lennartsson & Linderoth, [17]	Inadequate transport mechanism hinders IT adoption
15	Complexity of software	(Ahmed, [18], (Alaghbandrad, Asnaashari & Preece, [20], (Bosch-Sijtsema, Isaksson, Lennartsson & Linderoth, [17]	Incompatibility of software's can hinder software adoption
16	Absence of standards	(Ahmed, [18], (Ozumba & Shakantu, [24], (Alaghbandrad, Asnaashari & Preece, [20], (Samuelson & Björk, [16], (Adriaanse, Voordijk & Dewulf, [22].	Lack of established standards and protocols can prevent IT adoption
17	Product liability risks	(Ahmed, [18], (Sardroud, [21], (Kasim & Ern, [25], (Adriaanse, Voordijk & Dewulf, [22]	The risk associated with IT software can hinder IT adoption
18	Lack of time to train or to invest in ICT	(Ahmed, [18], (Samuelson & Björk, [16], (Kasim & Ern, [25], (Adriaanse, Voordijk & Dewulf, [22]	Investment in innovation and training is a prerequisite for proper IT adoption
19	Frequent power failure	(Ahmed, [18], Akinbile & Oni, [23]	Lack constant energy supply which may damage IT software can hinder IT adoption
20	Poor internet connectivity	(Ahmed, [18], (Ozumba & Shakantu, [24]	When internet connections are poor or un-available, IT adoption become impossible
21	Cost of specialist software too high	(Soon Ern, Kasim, Nasid Masrom & Kai Chen, 2017),	High cost of installation and maintenance can hinder IT adoption

		Akinbile & Oni, [23]	
22	Security issues	(Ozumba & Shakantu, [24], Akinbile & Oni, [23] (Samuelson & Björk, [16],	Lack of information protect strategies can hinder IT adoption
23	ICT infrastructure	(Ozumba & Shakantu, [24], (Alaghbandrad, Asnaashari & Preece, [20], (Samuelson & Björk, [16], (Sardroud, [21], (Adriaanse, Voordijk & Dewulf, [22]	IT adoption requires a comprehensive ICT implementation
24	Interoperability	(Ozumba & Shakantu, [24], (Samuelson & Björk, [16], (Bosch-Sijtsema, Isaksson, Lennartsson & Linderoth, [17], (Adriaanse, Voordijk & Dewulf, [22]	Compatibility of existing software
25	Lack of technical support	(Ozumba & Shakantu, [24]	Support to staff training enhances the chance of establishing a strong technical team to handle IT adoption
26	Fear of mass job losses in the industry	Akinbile & Oni, [23]	IT adoption leads to employee's job loss as computer can perform better than individuals in speed and accuracy
27	Difficulty to measure the benefits	(Samuelson & Björk, [16], Sardroud, [21]	Lack of visible and immediate benefits
28	Takes a long time to learn	(Bosch-Sijtsema, Isaksson, Lennartsson & Linderoth, [17], (Kasim & Ern, [25]	Long training duration may be considered as time wasted
29	Expensive operating and maintenance costs	(Bosch-Sijtsema, Isaksson, Lennartsson & Linderoth, [17], (Sardroud, [21], (Kasim & Ern, [25]	Lack of budget to facilitate constant maintenance.
30	Lack of economical assessment	(Sardroud, [21]	When the economic benefits of IT are not properly measured, its adoption may be hindered
31	Lack of understanding	(Sardroud, [21]	Understanding between professional on technology adoption is necessary

32	Immaturity levels of some ICT tools	(Sardroud, [21]	Compatibility of existing tools
33	No innovative culture	(Sardroud, [21], (Kasim & Ern, [25]	Lack of organization technology innovation culture
34	Difficult to integrate and combine	(Sardroud, [21], (Kasim & Ern, [25]	Compatibility of software's
35	Lack of successful evidence	(Sardroud, [21]	Lack of frequency of adoption in similar organizations
36	Lack of flexibility and adaptability	(Sardroud, [21], (Kasim & Ern, [25]	Lack proper environment for IT adoption
37	No market information	(Kasim & Ern, [25], (Sardroud, [21],	Lack of information on the available IT software's relevant to the industry
38	Availability of contractual arrangements about ICT use	(Adriaanse, Voordijk & Dewulf, [22]	Lack of information on strategies to adopt IT
39	Clarity of procedural agreements	(Adriaanse, Voordijk & Dewulf, [22]	Lack of information on standard and protocols of IT adoption

1.5.2 Benefits of using Collaborative ICT system

Ahuja, Yang, & Shankar [47] mentioned the benefits of using collaborative ICT system in the building project management based on the previous literature and discussion with experts from the industry as well as with academics, the identified perceived benefits are categorized under four groups as following:

- Benefits related to project completion as per the estimated time & budget, such as less time spent in query and approval process, reduced risk of errors and rework on projects, a complete log of all communications maintained for tracking purposes and reduced administrative costs of document handling and distribution to multiple parties.
- Benefits related to effective team management such as effective collaboration, coordination, communication between project team members, and effective joint decision-making.
- Benefits related to effective use of technology such as reduced hard copy storage of documents/drawings, flow of accurate information, improved capability of the system to cross-reference to other correspondence, and multi-locational availability of information.
- Benefits related to the increased organizational efficiency such as the increase in the overall organizational efficiency, better information assessment, management within the organization, and useful information compiled and disseminated to other projects.

2. Material and methods

2.1 Qualitative Data

Exploratory sequential mixed research method as shown in figure (3.1) was used for the qualitative data collection Creswell [48]; Dillman, [49].

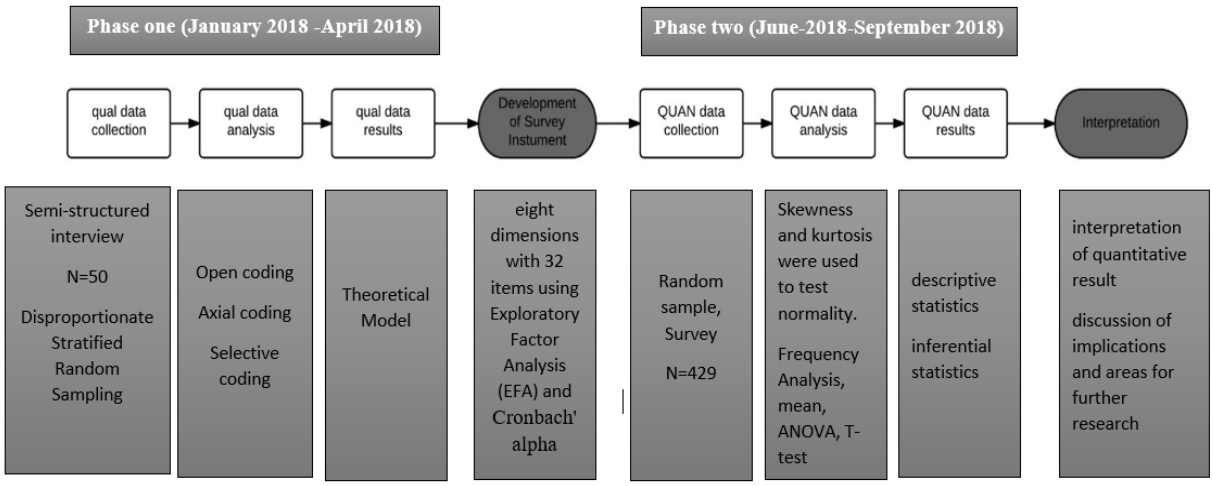

Figure 2.1 Exploratory Sequential Mixed Methods Design

The first phase of the data collection utilized a semi structured face- to- face interviews via skype for a period of three (3) months with 50 executive directors/managers, project managers, engineers and specialists working in the field of construction projects (design, execution) in the GCC countries. Disproportionate stratified random sampling was utilized to determine the sample size per each country within the GCC table (2.1).

Table 2.1 Qualitative Sample Size

Country	Number of respondents	Percentage
Saudi Arabic	17	34%
UAE	15	31%
Qatar	8	16%
Kuwait	4	8%
Oman	4	8%
Bahrain	2	4%
Total	50	100 %

Conversations were recorded and transcribe and analyzed. Three (3) themes emerged after analyzing the qualitative data using grounded theory analysis (Table 2.2)

Table 2.2 Qualitative data themes and Categories

Themes		
Technology context	Organizational context	Contextual factors
Categories: 1. cost 2. comprehension 3. complexity 4. ICT tools reliability and interoperability	Categories 1. Nature of construction project 2. Organization culture 3. awareness 4. Lack of skilled staff and training	Categories 1. organization type (contractor , consultant and owner), 2. Project type (design or execution), 3. GCC countries and individual experience.

2.2 Quantitative study.

Following the exploratory sequential mixed method approach [50] , a quantitative study was further conducted to establish significance differences by ranking of the eight (8) categories (independent variables) based on the type of organization client (owner), contractor, and consultant.

A survey questionnaire in five (5) Likert scale (strongly agree -5), (agree -4) (neutral- 3) (disagree - 2) (strongly disagree - 1) was hence formulated and pilot tested using the eight categories to gather data from 429 Professionals working in construction projects in the GCC countries to test the study hypothesis stated as:

Hypothesis 1: H_0: There is no significant difference in ranking cost according to the organization type.

Hypothesis 2: H_0: There is no significant difference in ranking comprehension according to the organization type.

Hypothesis 3: H_0: There is no significant difference in ranking complexity according to the organization type.

Hypothesis 4: H_0: There is no significant difference in ranking lack of skilled staff and training according to the organization type.

Hypothesis 5: H_0: There is no significant difference in ranking awareness according to the organization type.

Hypothesis 6: H_0: There is no significant difference in ranking ICT tools reliability and interoperability according to the organization type.

Hypothesis 7: H_0: There is no significant difference in ranking nature of construction project according to the organization type.

Hypothesis 8: H_0: There is no significant difference in ranking organization culture according to the organization type.

Data gathered was analyzed using descriptive and inferential statistical analysis (mean score, ANOVA,) to test the hypothesis statements. The variables were ranked accordingly.

3. Results

3.1 Descriptive analysis

Table 3.1 presents the descriptive profile of the respondent who participated in the study

Table 3.1 Profile of Respondent

Variable	Categories	Frequency	Percent %
Project Type?	Design	98	22.8
	Execution	331	77.2
	Total	429	100.0
Years of Experience	Categories	Frequency	Percent %
	Under 5	50	11.7
	5 to <10	308	71.8

	10 to <15	31	7.2
	Over 15	40	9.3
	Total	429	100.0
Work Location	Categories	Frequency	Percent %
	Saudi Arabia	175	40.8
	Bahrain	29	6.8
	UAE	129	30
	Qatar	46	10.7
	Oman	18	4.2
	Kuwait	32	7.5
	Total	429	100.0
Type of organization	Categories	Frequency	Percent %
	Owner (Client)	94	21.9
	Consultant	124	28.9
	Contractor	211	49.2
	Total	429	100.0
Type of software use at work	Categories	Frequency	Percent %
	Very rarely	41	9.6
	rarely	100	23.3
	occasionally	111	25.9
	frequently	99	23
	Very frequently	78	18.2
	Total	429	100.0

Table 3.2 Summary of Ranking of Factors (obstacles) to IT adoption

Rank	Factor (Obstacles)	Mean	SD
1	Complexity	4.27	.43228
2	Lack of skilled staff and training	4.25	.49929
3	Comprehension	4.24	.53707
4	Awareness	4.14	.56126
5	Cost	4.10	.48550
6	Organization culture	3.79	.53971
7	Nature of construction project	3.34	.42807
8	ICT tools reliability and interoperability	3.22	.41335

3.2 Hypothesis testing

Table 3.3 presents the analysis of the ranking of the variables (obstacles) according to organization: client (owner), contractor, or consultant.

Table 3.3 ANOVA for client, contractor and consultant ranking of obstacles

Factor	Categories	No	Mean	Std. Deviation	F-value	P-value
Cost	Owner (Client)	94	4.1862	.46797	2.077	0.127
	Consultant	124	4.0524	.48690		
	Contractor	211	4.0972	.48982		
Total		429	4.1037	.48550		
Comprehension	Owner (Client)	94	4.2340	.50524	0.722	0.487
	Consultant	124	4.2903	.48829		
	Contractor	211	4.2180	.57723		
Total		429	4.2424	.53707		
Complexity	Owner (Client)	94	4.3191	.41164	1.600	0.203
	Consultant	124	4.3011	.41737		
	Contractor	211	4.2354	.44827		
Total		429	4.2727	.43228		
Lack of skilled staff and training	Owner (Client)	94	4.1631	.51673	4.046	0.018
	Consultant	124	4.2070	.48759		
	Contractor	211	4.3207	.49103		
Total		429	4.2533	.49929		
Awareness	Owner (Client)	94	4.0957	.61952	0.325	0.722
	Consultant	124	4.1559	.54505		
	Contractor	211	4.1406	.54504		
Total		429	4.1352	.56126		
ICT tools reliability and interoperability	Owner (Client)	94	3.2191	.37338	0.205	0.815
	Consultant	124	3.1968	.38253		
	Contractor	211	3.2265	.44770		
Total		429	3.2163	.41335		
Nature of construction project	Owner (Client)	94	3.3484	.43413	0.009	0.991
	Consultant	124	3.3407	.42091		
	Contractor	211	3.3448	.43152		
Total		429	3.3444	.42807		
Organization culture	Owner (Client)	94	3.8587	.55645	5.782	0.003
	Consultant	124	3.6532	.57264		
	Contractor	211	3.8402	.49879		
Total		429	3.7902	.53971		
Obstacles to information technology	Owner (Client)	94	3.8650	.17744	3.474	0.032
	Consultant	124	3.8122	.18215		
	Contractor	211	3.8602	.17309		

adoption in construction projects in GCC countries						
Total		429	3.8474	.17772		

* The level of significance at (P<0.05)

4. Discussion

4.1 Profile of the respondents

As shown in table 3.1 out of the 429 professional's sampled 77.2 % work within execution projects while 22.8% are in the design projects indicating that the respondents are well experience in the area of research study [ ]. Based on the type of organization, 49.2% are contractor, (28.9% are consultant and owner (client) are 21.9%. Within the work experience segment, 71.8% of the respondents have 5 - 10 years' experience, 11.7% has 5 years' experience and, 9.3% has over 15 years' experience and 7.2% have between 10 to less than 15 years' experience indicating that a good percentage of the respondents are actively involved in construction projects

As per project location segment about 40.8% are from Saudi Arabia, 30.1% are from UAE, 10.7% are from Qatar, 7.5% are from Kuwait, 6.8% from Bahrain and Oman 4.2%. As per frequency of using related software for work purposes: occasionally (25.9%), rarely (23.3%), very frequently (23%), always (18.2%) and very rarely (9.6%). Location profile indicate a good representation of the respondents across the GCC countries

4.2 Ranking of Factors (obstacles) to ICT adoption

As per the factors that impacted adoption of ICT in the construction projects of the GCC countries, complexity was ranked highest by the professionals (4.27) followed by lack of skilled staff and training (4.25) , comprehension (4.24), awareness (4.13), cost (4.10), organization culture (3.79) nature of construction project (3.34) and, ICT tools reliability and interoperability (3.21) respectively (Table 3.2). Complexity ranking as amongst the first obstacle impending the adoption of IT in construction indicates the many varied interrelated parts which can be operationalized in terms of differentiation and interdependency. Project technical complexity is a definite factor such as IT adoption. However, it is much easier to deal with than complex relationships and organizations protocols. Poor communication and poor use of information were seen as significant factor contributing to the complexity of a project [51]

4.3 Hypothesis testing

Similarly, analysis of variance (ANOVA) to determine the ranking of variables according to the organizational type (client (owner), contractor, or consultant in the GCC countries showed that organizations were different in ranking. Two obstacles in particular (lack of skilled staff and training and organization culture) while there were no differences in the other obstacles indicate a coherence in the obstacles amongst respondent.

Generally, the study indicated that ICT adoption in various aspect of construction project is paramount for success and sustainability (Table 3.3).

5. Conclusions

This study investigated the obstacles hindering the reasonable benefits from Information technology (IT) in the construction projects. Analysis of results indicated that there are many obstacles that impedes comprehensive adoption of information technology in the construction project of the GCC countries. These obstacles include: Complexity, Lack of skilled staff and training, Comprehension, Awareness, Cost, Organization culture, Nature of construction projects and ICT tools reliability and interoperability.

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