

Information Technology and its Impact on the Project Success at Jordanian Construction Companies

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Abstract

Nowadays information technology has facilitated a lot of construction projects its play important roles to increase profits, decrease cost, complete tasks fast and achieve customers satisfaction at Jordanian construction companies. The study aims to identify impact of information technology (IT); in terms of its dimensions (Equipment & tools, software, networks, databases, information security, human resources skills) on project success; in terms of its dimensions (project cost, project quality, project time, customer's relationship) at Jordanian construction companies. The sample of study population consists of (89) companies represented in owner or project managers, engineers, accountants, and data entries working at construction companies/ first class/ category (A) in the capital of Amman, (267) questionnaires have been distributed and (259) questionnaires have returned. valid for statistical analysis. A valid questionnaire was retrieved for statistical analysis Results showed that relative importance's of different study variables (IT, projects' success) were all medium, with IT ranked first and projects' success ranked second. The study found that relationship between IT variable with its dimensions and the projects' success reached ($\beta=0.892$) and that ($t=61.190$) value significant at level (0.000), which proves a significant relationship between IT and the projects' success in its dimensions. The study also found that value of ($R^2 =801\%$) which means that IT with its dimensions has explained (80.1%) of variation in projects' success and its dimensions at the Jordanian construction companies. The study show's a numbers of recommendations, which include encouraging the construction projects management to adopt continuous use of advanced technological methods of software, hardware, equipment, and networks that enhance the success of construction projects, as well as working on senior management of construction projects to adopt a clear vision about the formulation and implementation of strategy needed to use advanced information technology to ensure the success of construction projects.

Keywords: Information Technology (IT), Projects' Success, Jordanian Construction Companies

Introduction

Businesses in our time face intense competition and with the increase in technological development and global change in fields, such as Internet, networks, and modern communication technologies the interest in IT has become a main requirement for projects' success. The need for project management in contemporary world is growing year after year where speed, quality, and cost control have become increasingly important in construction sector which all contributes to the success of Jordanian construction projects. The construction companies seek to obtain latest technology, especially in fields of devices and equipment, software, networks, databases, and human resources skills as well as adopting to the best practices used in construction projects management to achieve quality and customer satisfaction, develop and improve provided services, and maintaining itself and its strategic location in front of competitors in the market.

Study Importance

Scientific Importance: it stems from the importance of its variables, where IT with its dimensions (Equipment & tools, software, networks, databases, information security, and human resources skills) considers one of the important administrative concepts that researchers see the need to study; due to its importance in projects' success with its dimensions (project cost, project quality, project time, and customer's relationship).

Practical Importance: it lies in the research environment of study and the possibility of Jordanian construction companies to benefit from its results, in regard to IT concept and project success in Jordanian construction companies.

Study Objectives: it aims mainly to

- Identify the impact of IT with its dimensions (Equipment & tools, software, networks, databases, information security, human resources skills) on projects' success with their dimensions (project cost, project quality, project time, and customer's relationship) at Jordanian construction companies.
- Identify the relative importance level of IT and project success at Jordanian construction companies.

Study Problems

This study seeks to examine the success of Jordanian construction companies that enables them to increase their impact, effectiveness, and efficiency in achieving goals, and the ability to work within IT dimensions represented in Equipment & tools, software, networks, human resources skills, and information security. The study will also focus on projects success concept at Jordanian construction companies and the impact of IT with its dimensions on achieving project success with its dimensions. Based on the above, researchers can identify study problem with the following main question:

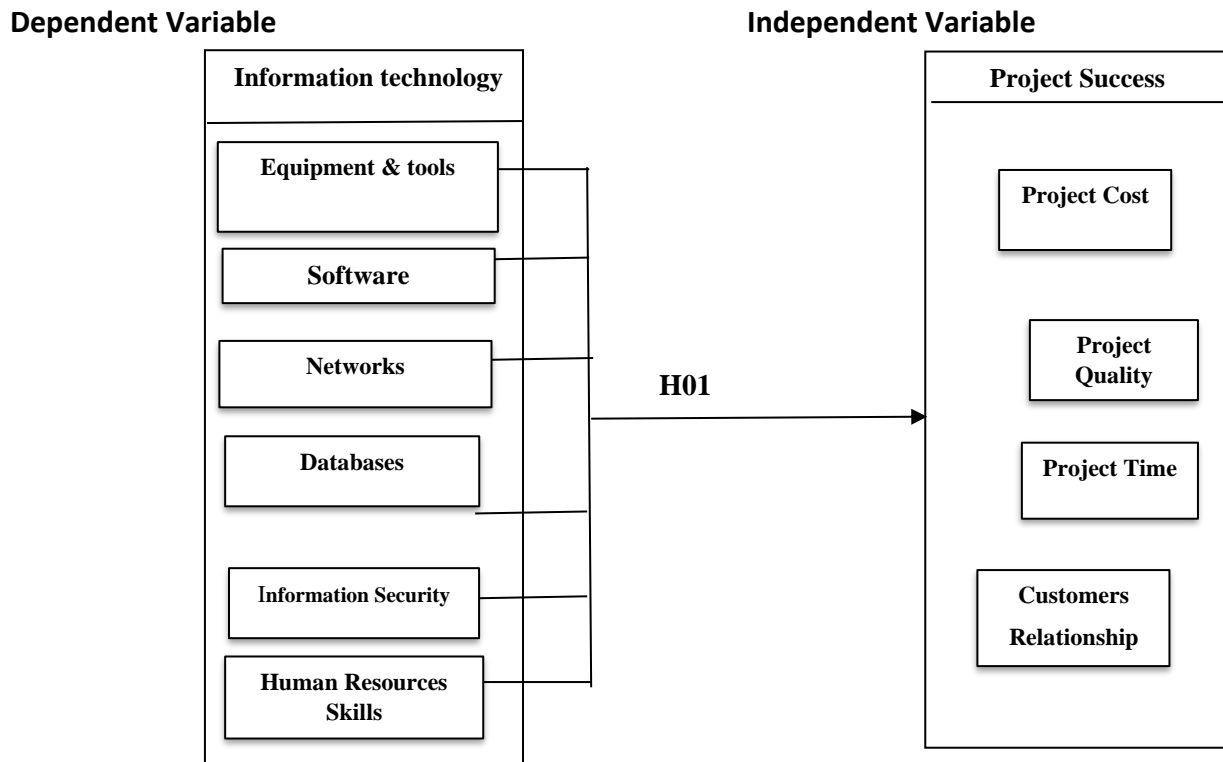
"What is the impact of IT with its dimensions on projects' success with its dimensions at Jordanian construction companies?"

Study Hypotheses

H01: "There is no statistically significant impact at the significant level ($\alpha \leq 0.05$) for IT in terms of its dimensions (Equipment & tools, software, networks, databases, information security, and human resources skills) on project success in terms of its dimensions (project cost, project

quality, project time, and customers’ relationship) at the Jordanian construction companies", as shown in the following study model

Figure 1
Study Model



Source: Designed by researchers based on the following references

Independent Variable: (Hazier & Render, 2011; Giuseppe & Londoli, 2008; Al-Zoubi et al., 2013; Qandilji & Al-Samurai, 2012; Yassin & Al-Alaq, 2012; Al-Wadi, 2011; Bdeir, 2010; Al-Khafaf, 2021).

Dependent Variable: (Winch, 2011; Pinto, 2013; Smith & Job Ling, 2014; Allen, 2015; Alnuaimiet et al., 2019; Cunha, 2014; Mastrogiacomo, 2014; Meredith Mantel, 2012; McCarty, 2017; Mesquida, 2014; Singh, 2020; Chen et al., 2018; Eid, 2013; Kerzner, 2015; Jumaa, 2008; Hassan & Yaqoub, 2018; Khader et al., 2018; Khalaf, 2018; Najm, 2013; Al-Othman, 2017; Al-Mahyawi & Al-Waeli, 2018; Al-Rabawi, 2020; Dahlias & Anbar, 2017; Radwan, 2012; Aishouni, 2014; Al-Ali, 2009; Dudin, 2012; Al-Fatlawi, 2015).

Study Terminology

- **Information Technology (IT):** it’s a collection of hardware, equipment, software, networks, databases, information security, and human resources skills for Jordanian construction companies used to communicate in a network framework with other devices and human to obtain information at required speed and accuracy.
- **Project Success:** it’s a process that project excels in it by producing or providing a unique product or service that requires a high efficiency level of human resources

skills. The successful project seeks to achieve its goals accurately within cost and time constraints and to ensure that outputs are provided within required quality and desired specifications to meet customer satisfaction.

Study Limits

- Objective Limits: it's limited to verifying IT in its dimensions (Equipment & tools, software, networks, databases, human resources skills, and information security) in project success with its dimensions (project cost, project quality, project time, and customer relationship) in the Jordanian construction companies.
- Temporal Limits: it's represented in the expected time period for completion of this study.
- Human Limits: it's limited to project owner/manager, engineers, accountants, and data entry workers at the Jordanian construction companies.
- Spatial Limits: it's limited to first class category (A) employees at the Jordanian construction companies.

Theoretical Frame and Previous Studies

Theoretical Framework

Information Technology (IT) Concept

Technology refers to the possibility of implementing advanced and modern scientific methods, which often described by new developments in processes or production, as well as the scientific progress that affect various activities used in it (Salmi, 2017, 4), while (Turban, 2018, 19) defined IT as the technological aspect of information system; which represented in hardware, software, databases, networks and communications used to receive, process, modify, store, and retrieve data.

IT Dimensions

IT plays a fundamental and important role in organizations and projects through the cooperation of elements that formulate basic dimensions of it, where many specialists agree on a set of basic components of IT, the most important are:

- Software

It's all educational groups of information processing and can be classified into operating system software which manages and supports computer system operations and work as programs to perform direct processing for personal use of end users; such as payroll, processing, manufacturing software, and other programs such as computer design software (CAD) (Hazier & Render 2011, 282-283). They are systems and programs that operate hardware and devices which contain data, information, and knowledge as well as determining operations performs by these devices (Al-Najjar, 2022, 58).

- Equipment & Tools

It's an electronic device directed to accept, process, store, and display data; where due to the diversity, difference, and development of businesses there has been a diversity in different computers (Al-Zoubi, et, al., 2013, 11). It includes devices, hardware, and materials to be used in data processing which don't only include devices such as a computer, printer, keyboard, etc. but also include the possibility of updating it periodically to keep pace with the continuous changes and needs in facility (Al-Najjar, 2022, 58).

- Networks

It's a network of computers connected to each other by high-speed communication channels used by a large number of people in different places. It's a communication media that distribute data and information between several sites in written, audio, or visual form (McKweon, 2015, 7).

- Databases

It's a set of interconnected data and information for the purpose of providing users' requirements (Elmasri, 2021, 38). Data considers an essential part of organization's assets, which must be seen as a resource that must be organized and managed efficiently, and includes all the IT components necessary for the facility to serve end-users. The data resources management also must be an integrated part with organization's strategy and needs (Al-Najjar, 2022, 59).

- Information Security

It's a controlling process on the safety, security, and confidentiality of information by project team due to the connection between information and competitive advantage, as well as determining who deals with this information and data according to project work nature and the validity of information access (Mesquida, 2014). Information security is maintaining data privacy and protecting important data associated with patents and technology ownership, where Internet considers the most dangerous on information security by enabling unauthorized persons to access valuable data, errors in dealing with implementation, and wrong entry. The team must secure physical protection of data, information, software, encryption, and monitoring system to prevent data breaching and to ensure the success of project objectives and information access (Al-Nsour, 2019).

- Human Resources Skills

The human resource plays great importance in organizations, where in IT its importance seems obvious in management and operation of information system, and may outweigh the importance of other physical requirements (Edmondson & Harvey, 2018).

Project Success

Project Success Concept

The current era is witnessing a development in construction sector and number of huge and complex projects is increasing day by day, where the major problem that accompanies it lies in the increase in its duration and establishment costs; as estimated in their budget. The controlling and following up on these projects is very difficult and important, which requires great effort by those in charge of managing them to ensure there is no deviation from their duration and cost prescribed in the basic plans, and perhaps the issue of controlling projects in term of its costs is very important to guarantee their successes (Shaaban, 2012, 27).

(Saqr, 2021, 2) indicates that a successful project may require manpower at a distinguished efficiency level as well as good training, communication with others, and provision of detailed reports on all achievements made during the project implementation. All of the above will be done under certain and predetermined criteria that contribute to the identification of all those concerned about project and in charge of it. The successful project is one that meets three international criteria for success, which are the implementation of project within specified schedule, achievement of quality objectives sought by the project

team and those involve with it, and the completion of project within framework of agreed budget outline (Al-Ali, 2016, 470).

Dimensions of Project Success

There are four objectives of project: the start and end of project, the cost represented in optimal utilization of resources without compromising quality, the performance represented in implementing project as planned with the aim of satisfying customers and achieving their expectations within planned order, appropriate quality in timely manner, and excellence represented in doing something convincing to customers (Theeb, 2017, 66).

-Project Cost

One of the most important factors for organization success is the ability to objectively estimate projects cost and adapt to variables of external environment, which in turn will be affected by many elements and requirements of the competitive environment. The concept of cost used to describe activities methods related to using resources in a way that increases the value provided to customers and achieves goals of organization (Hassan & Yaqoub, 2018). The cost management is a completion of project management triple constraint represented in cost, schedule, and scope where each one of those must be completed in order to complete the project in a timely manner and within available budget. Organizations must achieve the project cost goals by achieving all expectations of clients; therefore, the project must be completed within assigned budget approved by the concerned people (Meredith & Mantel, 2012, 297).

-Project Quality

Today, quality has become one of the most important factors for achieving competitive advantage, where increasing demand for quality from customers has made many organizations realize that they have to provide high quality services to stay competitive (Radwan, 2012, 14-15). The project quality management considers one thing that project management concerned with as a sign of good organization and quality of decisions, where interest in project quality has increased during the boom of economic activity in many world countries (Serrador & Turner, 2015).

-Project Time

The administrative work is an activity that seeks to achieve goals in light of available capabilities and circumstances, whereas the achievement of objectives linked to a specific timetable and plan. The required results can only be reached successfully within commitment to required time limits, where administrative work requires effort and thinking at the planning, directing, organizing, and controlling stages (Alzahrani & Emsley, 2013, 318). Vaisanen and Sahito (2017) emphasizes that time has a precious value in the technology era and rapid development, where it considers one of the manifestations of modern life and its good investment are noble and high-end goals on individuals or organizations level.

-Customers Relationships

It's possible to say that customers are the most important asset in organizations and that success and survival of companies depend on its customers (Eid, 2013, 69). The Customers relationship consider one of the most important issues related to all types of businesses, which is justified by the philosophy of customer guidance and basic principles for

continuous improvement of modern companies. The customer satisfaction is the feedback that helps to identify customers' preferences and expectations, where satisfaction considers the basic criterion for performance (Grigoroudis & Siskos, 2010, 1).

Previous Studies

The study of Ghalib and Al-Bakri (2022) reached a set of results, the most important indicates that small projects should take advantage of its available capabilities in the field of communications and websites by following the experiences of local or external successful projects to reduce error margins and adopt a sound scientific approach in small projects of Baghdad.

The study of Al-Kubaisi and Kamal (2022) about professional project management using (PMBOK) methodology reached a set of results, the most important indicates that electronic project management evaluation system provides accurate information to decision-makers because it's a knowledge-rich information base that help in the decision-making processes and can take corrective actions any time to reduce abnormalities in each group of project management processes.

The study of Bilir (2022) found that customer satisfaction has a critical role in project success along with the iron triangle that depends on (CSF) context represented in cost, budget, and scope. The senior management support, teamwork, and active planning consider crucial factors in IT projects of Turkey and lie in ensuring that projects are well focused and avoid wasting effort and resources in less important areas.

The study of Ogbeide et al (2022) on road projects in Nigeria found that successful project need to minimized delays in completion and completed it on time by predicting and identifying possible delay problems in the early stages of project, therefore diagnosing causes of delays to identify and implement the most appropriate economic decisions and provide the best preventive measures that involve active staff participation through team contribution, improved knowledge sharing, and management reviews.

The study of Roslon (2022) related to supported construction projects using artificial intelligence in Poland found that project success depends on aspects related to cost, time, and quality or meeting requirements; from the standpoint of contractors. Study found that high level of customers and their satisfaction has a positive impact on winning new contracts and significantly reduces the likelihood of getting involved in harmful disputes and incurring additional costs.

The study by LaKhdari and Ben Jeddou (2021) found that using ICT saves cost and time, enhances work skills, reduces production costs, and increases productivity of inputs which represent dimensions of project success in the Arab Maghreb countries.

The study of Blasem and Hassan (2020) found an interest of project management to search for suitable alternatives to the raw materials used in project achievement with a lower environmental impact, the impact of company's senior management to completed it on time, and the presence of project management interest in scheduling and planning to ensure its completion within specified time in the Oil Projects Company / East Baghdad field.

The study of Al-Nsour (2019) found that attitudes of workers in IT projects came at a high significance level and their attitudes to the performance improvement dimensions of project plan implementation came also at high significant degree. The study indicates a clear statistical significant impact on improving performance of project plan implementation whenever using IT in the construction projects management at Salt Governorate of Jordan.

Study Methodology

Study Nature and Type: it's an applied study in nature, descriptive in terms of purpose where it will test the impact between variables, and it's a quantitative in terms of mechanism and procedures (Saunders et al., 2007). It considered an unplanned research because it is conducted in the natural environment of Jordanian construction companies (Al-Najjar et al., 2020, 53-56).

Adopted Strategy: researchers relied on survey/ sampling strategy of first -class construction companies/ category A for the purposes of representing study population.

Study Population: it's represented in all (89) companies operating in the construction field/ first class/ category A in the capital of Amman/Jordan.

Study Sample: researchers relied on the equal random stratified sample method of construction companies for the purposes of representing study population, where researchers distributed (3) questionnaires for each company, and accordingly the size of study sample become (267) questionnaires dispersed on Jordanian construction companies and recovered (259) valid for analysis.

Analysis Unit: the inspection unit consisted of a project owner/manager, engineer, accountant, and data entry persons working in the construction companies/first-class/ category A in the capital of Amman/ Jordan.

Data Collection Methods: This study has relied on the descriptive analytical approach that suits study model by collecting necessary data from owners of construction companies who represent the study society, where study focused on two sources for data collection, which are:

Secondary Data

Researchers viewed secondary sources represented in the relevant Arab and foreign references, periodicals, reports, and researches which dealt with study variables and their dimensions, where researchers adopted data documentation based on (American Psychological Association (APA) system, 2020).

Primary Data

Researchers relied on the questionnaire to collect primary data, which was prepared specifically for the study in order to address analytical aspects of study topic, where questionnaire included a number of items that reflect study variables and its dimensions; in a way that cover both of independent variable (information technology) and dependent variable (project success). Table (1) shows the population and sample of study

Table 1

Study population & sample

Number	Company Name	Number	Company Name
1	Ali Karim & Son Company	46	Arab Technical Construction Company
2	Dar Al Khebra Contracting Company	47	Steel Structures Company W.L.L
3	Khalifa International Contracting Company	48	Civil Engineering Company W.L.L
4	Mohamed Ahmed Abu Aisha & Brothers Contracting Company	49	Mahmoud Ali Mahmoud Hammoudeh Heirs Co.
5	National Engineering & Contracting Co.	50	Haddadeen Engineering Contracting Company
6	Masenat Engineering & Contracting Company	51	MAG Engineering & Contracting Company
7	General Contracting Company	52	Jurf Contracting Company W.L.L.
8	Zakaria Saleh Al Tarawneh Contracting Co., W.L.L	53	National Construction Company W.L.L
9	Jordan Economic Development and Trade Co.	54	Hussein Attia & Sons Co. W.L.L
10	Haymur Cousins & Partner Company W.L.L	55	Abu Shuraikh Company for Roads & excavations
11	Engineering Projects Company	56	Engineering World Construction & Contracting Company
12	Al Shawani General Contracting Co., W.L.L	57	Mohammed Al Rawashdeh & Sons Company
13	Habash / Deir Contracting Company, W.L.L.	58	Mohammed & Khalaf Company
14	Construction Company for Contracting & Construction Works	59	Mohammed & Aref Salma Al Kooz & Partners Company
15	Saleem & Waleed Al Shalabi & Partners co.	60	Khalil Ishak Mohammed Al-Fakhoury Heirs Co.
16	Madanat Contracting Company	61	Al-Qurnah & Salamah Company
17	Toukan Contracting & Trading Company	62	Ali Maher Jarrar & Partners Company
18	General Machinery Company	63	Atef, Farris & Magadha Kawar Company
19	United Projects Company	64	Al-Tabbaa Construction Contracting Co., W.L.L.
20	Al Emaar Contracting Company W.L.L.	65	Al-Hawari Contracting Company W.L.L
21	Khaled Marqa Est. for Electromechanical Contracting	66	Dirar Al-Sarayreh & Sons Company
22	Ismail Al-Harsh & Partners Company	67	Al Masar United Contracting Co. W.L.L.

23	Al Mohandas Contracting Company W.L.L	68	Al Makhtarah General Contracting Co. W.L.L.
24	Tayseer Abu Arja & Partners Company	69	Al Wajeeh Construction Contracting Co.
25	Saab Al , Hyari & Partners Company	70	Salem Khamees Al-Maghariba & Sons Co.
26	Omega Contracting Company, W.L.L	71	Mahmoud Khaled & Partner Company
27	Yousef Ahmed Al-Bustanji & Brothers Co.	72	Samah Contracting Company, W.L.L
28	Babylon Contracting Company, W.L.L	73	Al-Tuff Contracting
29	Ahmed & Mahmoud Al-Yaqoub Company	74	Sufyan Al-Nasser & Sons Company
30	Al-Saket & Al-Alawzi Company	75	Darwish Bseiso & Partners Company
31	Dijlah Construction Contracting Establishment Company, W.L.L	76	Fahd Al-Halasa & Jawhar Kaboushi Co.
32	Qahtan Haddadin & Partners Co., W.L.L	77	Sadeen Contracting & Construction Works Jordanian Company
33	Essam Al-Huwaidi & Fareed Hatter Co.	78	Al-Montaser Engineering Contracting Co. W.L.L
34	Al-Arroba Crushers & Contracting Co., W.L.L	79	Arab Towers Contracting Co., W.L.L.C
35	National Construction Company/ Al Bayt Contracting Company	80	Mohamed Yousef Ahmed Al-Qamouk & Partner Co.
36	Gareeb Nino & Partners co.	81	Arab International Construction & Contracting Co.
37	Hussein Miqdadi & Partner Company	82	Azmi Al-Zuriqat & Partners Company
38	Al-Wajeeh Construction Contracting Co. W.L.L	83	Sabri Farah International Est. Co., W.L.L
39	Bab Al-Sharq Contracting Company, W.L.L	84	Arab Anbat Construction Contracting Co., W.L.L
40	Essa Haddadin & Partners Co., W.L.L	85	Tarkeebat Construction Contracting Co. W.L.L
41	Mahmoud Al-Saffareeni Contracting Est.	86	Maysar Yousef Farhan Taha & Partners Co.
42	Aryaf Construction Contracting Co., W.L.L	87	Dirar Al-Sarayreh & Sons Company
43	Faaz Construction Contracting Co., W.L.L	88	Al-Masar Al-Mutahidah for Contracting co.
44	Essa Jared Al-Tarawneh Contracting Co.	89	Marwan Ahmed Al-Kurdi Company

45	Engineering Group Co. for Construction & Technology		
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Source: Jordanian Contractors Association, 2022, <http://jcca.org.jo/FindContractor.aspx>

Data Analysis and Hypothesis Testing

Data Analysis

Personal and Job Characteristics

It shows in table (2) below

Table 2

Personal and Job characteristics

Variable	Class	Frequencies	%
Gender	Male	145	56.0
	Female	114	44.0
Age Class	less than 30 yrs.	62	23.9
	30 yrs. - less than 40 yrs.	117	45.2
	40 yrs. - less than 50 yrs.	63	24.3
	50 yrs. and more	17	6.6
Years of Experience	less than 5 yrs.	46	17.8
	5 yrs. - less than 10 yrs.	82	31.7
	10 yrs. - less than 15 yrs.	75	29.0
	15 yrs. and more	56	21.6
Job Title	Accountant	39	15.1
	Data Entry	53	20.5
	Project Manager	64	24.7
	engineer	103	39.8
Qualification	College Diploma or less	31	12.0
	Bachelor	167	64.5
	Master	49	18.9
	Ph.D.	12	4.6

Table (2) shows the personal and job characteristics of study sample, where it indicates a convergence between males and females in construction companies, with an increase in the percentage of males at (56.0%) compared to females with (44.0%), which an indication that construction companies attract employees with competencies and experience regardless of gender. It was also found that majority of sample members are youth, where the age group (30 yrs.-less than 40 yrs.) formed (45.2%) as a largest while the group (less than 30 yrs.) constituted (23.9%). However, sample members were distributed among all experience categories with a relative increase in (5 yrs.-less than 10 yrs.), which amounted to (31.7%) and indicated that respondents have the required experience to work. The sample members were also distributed on all job titles, with a relative increase for the category (engineer) of (39.8%)

which aligns with the nature and needs of construction work. Finally, the sample members owned academic qualifications with bachelor category as the largest at (64.5%).

Study Variables Description

Table (3) shows the description of different study variables.

Table 3

Variables description

Variable	Dimensions	Mean	Relative Importance
Information Technology		3.400	Moderate
	Software	3.391	Moderate
	Equipment & tools	3.453	Moderate
	Networks	3.399	Moderate
	Databases	3.438	Moderate
	Data Security	3.384	Moderate
	Human Resources Skills	3.337	Moderate
Project Success		3.393	Moderate
	Project Cost	3.409	Moderate
	Project Quality	3.332	Moderate
	Project Time	3.424	Moderate
	Customers Relationship	3.406	Moderate

Table (3) shows that relative importance of the two variables of study model (information technology, project success) was medium and the same for all their sub-dimensions, which indicates that attitudes of the sample members towards these variables were not at high importance, and that interest in IT needs greater attention from management. Despite the mean convergence of sample members' responses on dimensions of (information technology) variable but the mean of (human resources skills) dimension was the lowest with (3.337), which indicate that respondents are not convinced about the workers' skills in construction companies to support IT in it.

In addition, the evaluation of projects' success through importance of its dimensions by management is still not agreed on its high importance by sample members, especially since the dimension (project quality) was the last; in terms of arithmetic mean value for sample members' approvals, which confirms that respondents believe management doesn't support project success and their dimensions, especially that quality needs direct management support.

Study Model Tests (Hair et al., 2017).

Testing Measurement Outer Model: its goal is to achieve validity and reliability

-Validity: it's the ability to measure what is required, or the ability of a measurement instrument to achieve its intended purpose.

-Reliability: it's the ability of instrument to measure the required goal under different conditions, where measurement model test divided into two parts:

- Convergent Validity
 - Discriminate Validity

Testing Convergent Validity: it includes three tests (Hair et al., 2017).

- Individual item reliability for questions, which must be greater than (0.70).
 - Composite reliability (CR), which must be greater than (0.70).

- Average Variance Extracted (AVE), which must be greater than (0.50).

Figure (2) shows the different saturations of questions while table (4) shows indicators summary for the three convergent validity elements of measurement model.

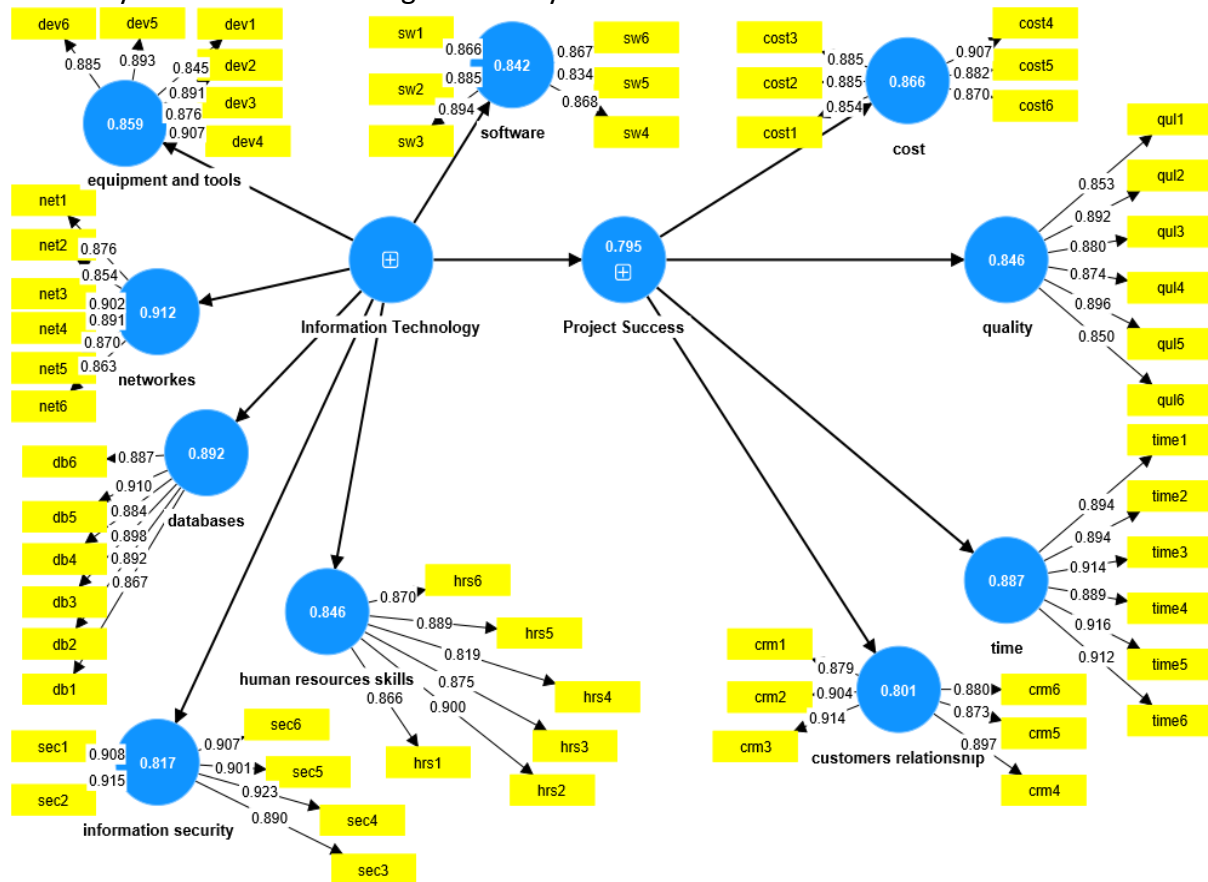


Figure 2
Different saturations of questions

Table 4
Testing measurement model (outer model)/ convergent validity

Construct	Item	Factor Loading	Cornbach Alpha	CR		AVE
				Rho_a	Rho_c	
Software	Q1	0.866	0.935	0.936	0.949	0.755
	Q2	0.885				
	Q3	0.894				
	Q4	0.868				
	Q5	0.834				
	Q6	0.867				
Equipment & tools	Q1	0.845	0.943	0.944	0.955	0.780
	Q2	0.891				
	Q3	0.876				
	Q4	0.907				
	Q5	0.893				
	Q6	0.885				
Networks	Q1	0.876	0.939	0.940	0.952	0.768
	Q2	0.854				

	Q3	0.902				
	Q4	0.891				
	Q5	0.870				
	Q6	0.863				
Databases	Q1	0.867	0.947	0.948	0.958	0.792
	Q2	0.892				
	Q3	0.898				
	Q4	0.884				
	Q5	0.910				
	Q6	0.887				
Information Security	Q1	0.908	0.957	0.957	0.966	0.824
	Q2	0.915				
	Q3	0.890				
	Q4	0.923				
	Q5	0.901				
	Q6	0.907				
Human Resources Skills	Q1	0.866	0.936	0.938	0.949	0.757
	Q2	0.900				
	Q3	0.875				
	Q4	0.819				
	Q5	0.889				
	Q6	0.870				
Project Costs	Q1	0.854	0.942	0.942	0.954	0.775
	Q2	0.885				
	Q3	0.885				
	Q4	0.907				
	Q5	0.882				
	Q6	0.870				
Project Quality	Q1	0.853	0.938	0.939	0.951	0.765
	Q2	0.892				
	Q3	0.880				
	Q4	0.874				
	Q5	0.896				
	Q6	0.850				
Project Time	Q1	0.894	0.955	0.955	0.964	0.816
	Q2	0.894				
	Q3	0.914				
	Q4	0.889				
	Q5	0.916				
	Q6	0.912				
Customers relationship	Q1	0.880	0.948	0.948	0.959	0.794
	Q2	0.904				
	Q3	0.914				
	Q4	0.897				
	Q5	0.873				
	Q6	0.880				

It shows from table (4) the following

- All loading factors values were greater than (0.80) and consider acceptable for statistical analysis purposes and indicate convergence validity in the measurement model (Hair et al., 2017, 138).
- All Cornbach Alpha values for variables were between (0.935–0.957) which are greater than (0.70) and indicate good reliability and convergent validity in the measurement model (Hair et al., 2017, 138).
- All CR values of variables were above (0.70) which confirm the convergence validity in measurement model (Hair et al., 2017, 144).
- All calculated mean variance values (AVE) for variables were greater than (0.50) which all statistically acceptable and confirm the convergence validity of measurement model (Hair et al., 2017, 138).

The above results of convergent validity indicators confirm the availability of convergent validity in the measurement model tests.

Testing Discriminate Validity: it consists of two parts of tests (Hair et al., 2017)

- **Cross Loading Variables.**

It shows from table (5) loading of variables and their correlation with each other.

A. Independent Variable: Information Technology (IT)

Table 5

Discriminate Validity / Heterotrait- Monotrait (HTMT) ratio of independent variable dimensions

	Equipment & Tools	Software	Information Security	Networks	Databases	Human Resources Skills
Equipment & Tools	0.883					
Software	0.858	0.869				
Information Security	0.772	0.760	0.908			
Networks	0.871	0.867	0.831	0.876		
Databases	0.843	0.824	0.852	0.895	0.890	
Human Resources Skills	0.817	0.807	0.812	0.850	0.840	0.890

It shows from table (5) that correlation between the sub-variables of independent variable IT between equipment and tools with itself came to (0.883), which is higher than correlation between the rest of variables, and for software with itself it amounted to (0.869), which is higher than all correlations with the rest of variables while for information security with itself it reached (0.908), which is higher than correlations to all other variables but for networks with themselves it came to (0.876), which is higher than correlations with the rest of variables; other than databases which came to (0.895) but still very close to it. The interconnection of databases with themselves came to (0.890), which is higher than correlation with other sub-variables; except for networks which came to (0.895), but still very

close to them. Finally, the interconnections of HR skills with itself reach (0.890) which is higher than all correlations with other variables of the independent variable IT.

The above analysis confirms discriminatory validity of measurement model for sub-variables of independent variable/ IT Hair et al (2017) as shown in table (6) below.

Table 6

Discriminatory validity for sub-questions of independent variable IT, cross loadings

Independent Variable	Software	Equipment & Tools	Networks	Databases	Information Security	Human Resources Skills
Software						
sw1	0.866	0.743	0.721	0.697	0.605	0.693
sw2	0.885	0.776	0.766	0.709	0.675	0.709
sw3	0.894	0.791	0.768	0.719	0.664	0.71
sw4	0.868	0.733	0.771	0.742	0.628	0.709
sw5	0.834	0.702	0.726	0.726	0.649	0.661
sw6	0.867	0.726	0.769	0.707	0.74	0.725
Equipment and Tools						
dve1	0.754	0.845	0.725	0.703	0.677	0.687
dev2	0.766	0.891	0.775	0.765	0.663	0.729
dev3	0.772	0.876	0.781	0.707	0.717	0.726
dev4	0.787	0.907	0.799	0.779	0.694	0.728
dev5	0.718	0.893	0.76	0.75	0.665	0.709
dev6	0.747	0.885	0.775	0.759	0.673	0.751
Networks						
net1	0.772	0.798	0.876	0.778	0.72	0.769
net2	0.725	0.722	0.854	0.754	0.676	0.749
net3	0.787	0.774	0.902	0.795	0.737	0.757
net4	0.747	0.791	0.891	0.793	0.719	0.743
net5	0.759	0.721	0.87	0.787	0.774	0.741
net6	0.767	0.773	0.863	0.796	0.738	0.709
Databases						
db1	0.723	0.746	0.779	0.867	0.752	0.758
db2	0.746	0.757	0.796	0.892	0.723	0.703
db3	0.714	0.752	0.785	0.898	0.767	0.731
db4	0.745	0.759	0.795	0.884	0.748	0.754
db5	0.764	0.759	0.823	0.91	0.77	0.779
db6	0.708	0.726	0.8	0.887	0.787	0.756

Information Security						
sec1	0.686	0.698	0.731	0.754	0.908	0.738
sec2	0.676	0.712	0.75	0.793	0.915	0.742
sec3	0.715	0.707	0.788	0.835	0.89	0.749
sec4	0.682	0.699	0.755	0.751	0.923	0.746
sec5	0.685	0.692	0.746	0.743	0.901	0.707
sec6	0.695	0.693	0.752	0.759	0.907	0.739
Human Resources Skills						
hrs1	0.738	0.743	0.738	0.723	0.76	0.866
hrs2	0.731	0.766	0.783	0.763	0.704	0.9
hrs3	0.738	0.723	0.785	0.78	0.693	0.875
hrs4	0.601	0.606	0.658	0.645	0.625	0.819
hrs5	0.677	0.704	0.716	0.725	0.703	0.889
hrs6	0.718	0.715	0.75	0.739	0.747	0.87

It shows from table (6) that all software questions came higher than if it were placed in another variable from the sub-independent variable/ IT, where it noticed that first question of software with its variable came to (0.866), which is higher than if it was placed in any other variables. Results also found that all questions of equipment & tools came higher than if it were placed in another variable from sub-independent variable/ IT, where it noticed that first question of equipment & tools with its variable came to (0.845), which is higher than if it were placed in any other variables.

Results in table (6) showed that all questions of networks came higher than if it were placed in another variable from the sub-dependent variable/ IT, where it noticed that first question of networks with its variable came to (0.876), which is higher than if it was placed in any other variables. Results also found that all database questions came higher than if it were placed in another variable from the sub-independent variable/ IT, where it noticed that first question of databases with its variables came to (0.867), which is higher than if it were placed in any other variables.

Results of table (6) showed that all information security questions came higher than if it were placed in another variable from the sub-dependent variable/ IT, where it noticed that first question of information security with its variables came to (0.908), which is higher than if it were placed in any other variables. Results also indicated that all questions of human resources skills came higher than if it were placed in another variable from the sub-independent variable/ IT, where it noticed that first question of human resources skills with its variables came to (0.866), which is higher than if it were placed in any other variables. The above analysis confirms discriminatory validity of measurement model for sub-variables of independent variable/ IT (Hair et al., 2017).

B. Dependent Variable: Project Success

Table 7

Discriminatory validity/ Heterotrait- Monotrait (HTMT) ratio for dimensions of dependent variable/ project success

	Customers Relationship	Project Costs	Project Quality	Project Time
Customers Relationship	0.891			
Project Costs	0.718	0.880		
Project Quality	0.831	0.813	0.874	
Project Time	0.790	0.874	0.780	0.903

It shows from table (7) that correlation between the sub-variables of dependent variable project success came between customers relationship with themselves to (0.891), which is higher than correlation between the rests of other sub-variables while the project cost with itself came to (0.880), which is higher than correlation between the rests of other sub-variables; whereas the correlation of project quality with itself came to (0.874), which is higher than correlation between the rests of other sub-variables.

Finally, the correlation of project time with itself came to (0.903), which is higher than correlation between other sub-variables in the dependent variable. The above analysis confirms discriminatory validity of measurement model for sub-variables of dependent variable (Hair et al., 2017), as shown in table (8) below:

Table 8

Discriminatory validity for sub-variable questions of project Success/ Cross loadings

Independent Variable	Project Cost	Project Quality	Project Time	Customers Relationship
Project Cost				
cost1	0.854	0.701	0.766	0.633
cost2	0.885	0.687	0.804	0.635
cost3	0.885	0.685	0.749	0.579
cost4	0.907	0.754	0.796	0.7
cost5	0.882	0.727	0.749	0.62
cost6	0.87	0.737	0.752	0.622
Project Quality				
qul1	0.695	0.853	0.63	0.676
qul2	0.75	0.892	0.697	0.723
qul3	0.714	0.88	0.701	0.754
qul4	0.713	0.874	0.712	0.741
qul5	0.707	0.896	0.702	0.763
qul6	0.684	0.85	0.646	0.7
Project Time				
time1	0.778	0.712	0.894	0.75
time2	0.769	0.693	0.894	0.736
time3	0.799	0.694	0.914	0.708
time4	0.793	0.69	0.889	0.661
time5	0.806	0.742	0.916	0.74
time6	0.793	0.694	0.912	0.683
Customers Relationship				
crm1	0.594	0.731	0.65	0.88
crm2	0.644	0.757	0.703	0.904
crm3	0.64	0.739	0.71	0.914
crm4	0.651	0.763	0.717	0.897
crm5	0.662	0.707	0.735	0.873
crm6	0.648	0.745	0.707	0.88

It shows from table (8) that all cost questions came higher than if it were placed in another variable of the sub-variable dependent on the success of projects, where it noticed that first question of project cost with its variable came to (0.854), which is higher than if it were placed in any other variables. It was also found that all project quality questions came higher than if it were placed in another variable from dependent sub-variable project success, where it noticed that first question of project quality with itself came to (0.853), which is higher than if it was placed in any other variables.

It found from table (8) that all project time questions came higher than if it were placed in another variable from the dependent sub-variable project success, where it noticed that first question of project time with itself came to (0.894), which is higher than if it was placed in any other variables. It was also found that all questions of customer's relationship came higher than if it were placed in another variable of the dependent sub-variable project success, where it noticed that first question of customer's relationship with itself came to (0.88), which is higher than if it was placed in any other variables. The above analysis confirms discriminatory validity of measurement model for the sub-variables of dependent variable project success (Hair et al., 2017).

- Variable Correlation Tests (Root Square of AVE)

Researchers calculated (Root Square of AVE) through the excel program, where conditions require that (Root Square of AVE) value should be greater than (0.50) (Hair et al., 2017). as shown in table (9) below

Table 9

Variable Correlation (Root Square of AVE)

Construct	Root Square of AVE	Construct	Root Square of AVE
Software	0.869	Project Cost	0.880
Equipment and Tools	0.883	Project Quality	0.875
Networks	0.876	Project Time	0.903
Databases	0.890	Customers Relationship	0.891
Information Security	0.908		
Human Resources skills	0.870		

It shows from table (9) that Root Square of AVE values were greater than (0.50) which indicates the discriminatory validity of measurement model (Hair et al., 2017, 144).

Structural Model Tests (Inner Model)

Researchers made required tests to prove structural model, (Hair et al., 2017). which are:

1. Coefficient of Determination R^2
2. Impact Size f^2
3. Predictive Relevance Q^2
4. Hypotheses testing (Path Coefficient)

The following tables show results of these tests:

1. Coefficient of Determination R^2

The results of analysis show in table (10)

Table 10

Coefficient of Determination R^2 or R-Square of Endogenous Latent Variable

Construct	R^2	Adjusted R^2	Results
Project Success	0.801	0.800	High

Table (10) shows that explanatory variance values of the model explain (80.1%), which is at high level (Hair et al., 2017, 144), while table (11) shows the predictive relevance.

Table 11

Predictive relevance (Q-Square predict)

Construct	Q ² Predict
Project Success	0.800

It shows from table (11) that (predictive relevance $Q_2=0.800$), which is greater than zero and indicates the model's ability to predict (Hair et al., 2017). The above analyses confirm the correctness of structural model.

Study Hypotheses Test

The analysis of hypotheses depended on (Smart PLS4) while analysis based on (Preacher & Hayes, 2008).

Discussion of Study Hypotheses

The main hypothesis has been discussed through figure (3) and table (12) path analysis.

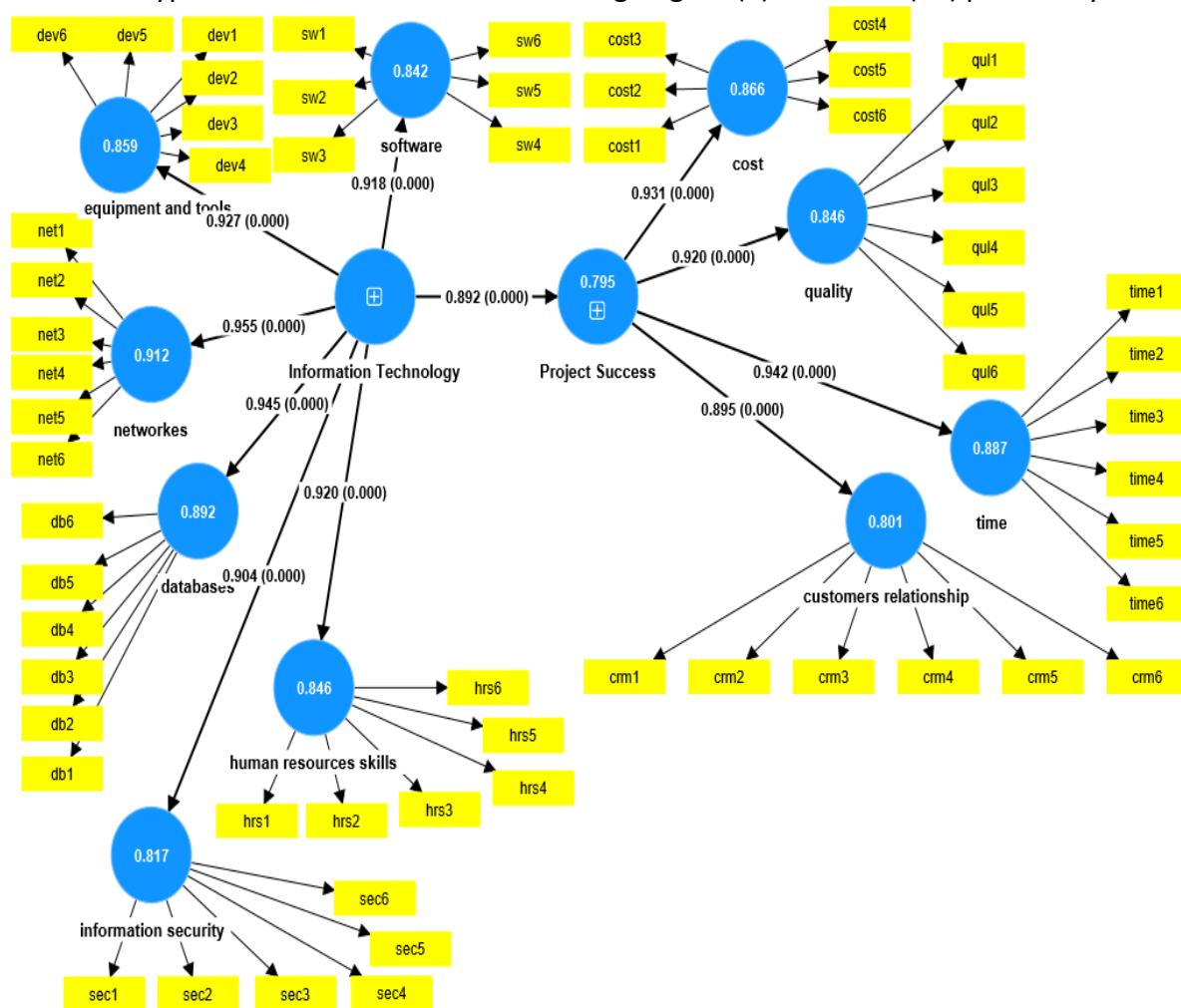


Figure 3 Path Analysis

Table 12

Path Coefficients

Path	Original Sample β	STDEV	T-Statistics	Sig.
IT-> Software	0.918	0.013	72.997	0.000
IT-> Equipment and Tools	0.927	0.013	71.311	0.000
IT-> Networks	0.955	0.007	143.663	0.000
IT-> Databases	0.945	0.010	94.44	0.000
IT-> Information Security	0.904	0.014	63.787	0.000
IT-> Human Resources Skills	0.920	0.011	81.941	0.000
IT-> Project Success	0.892	0.015	61.190	0.000

Researchers discussed the main hypothesis through overall model in figure (3) and table (12).

It shows from figure (3) and table (12) that relationship between the variable (information technology); in its dimensions and project success; in its dimensions has reached ($\beta=0.892$) and that value of ($t=61.190$) at a significant level ($Sig=0.000$), which proves that relationship between IT; in its dimensions and project success; in its dimensions is at high level and significant.

It showed that value of software coefficient reached ($\beta=0.918$) and that value of ($t=72.997$) at a significant level ($Sig=0.000$), which is less than (0.05), significant, and proves the significance of software coefficient.

It showed that value of equipment & tools coefficient reached ($\beta=0.927$) and that value of ($t=71.311$) at a significant level ($Sig=0.000$), which is less than (0.05), significant, and proves the significance of equipment & tools coefficient.

It showed that value of networks coefficient reached ($\beta=0.955$) and that value of ($t=143.663$) at a significant level ($Sig=0.000$), which is less than (0.05), significant, and proves the significance of networks coefficient.

It showed that value of databases coefficient reached ($\beta=0.945$) and that value of ($t=94.44$) at a significant level ($Sig=0.000$), which is less than (0.05), significant, and proves the significance of databases coefficient.

It showed that value of information security coefficient reached ($\beta=0.904$) and that value of ($t=63.787$) at a significant level ($Sig=0.000$), which is less than (0.05), significant, and proves the significance of information security coefficient.

It also showed that value of human resources skills coefficient reached ($\beta=0.920$) and that value of ($t=81.941$) at a significant level ($Sig=0.000$), which is less than (0.05), significant, and proves the significance of human resources skills coefficient. The above analysis proves that all paths were significant and this proves the significance of coefficient values.

It shows from figure (3) and table (10) that value of ($R^2=0.801$) which proves that IT; with its dimensions (equipment & tools, software, networks, databases, information security, and human resources skills) has explained (80.1%) from the variance in project success; with its dimensions (project cost, project quality, project time, and customer's relationship) at the Jordanian construction companies.

Based on the above analysis, researchers rejected the null hypothesis and accepted alternative hypothesis, which stated: "There is a statistically significant impact at a significant level ($\alpha < 0.05$) for information technology with its dimensions (equipment & tools, software, networks, databases, information security, and human resources skills) on the project success with its dimensions (project cost, project quality, project time, and customers relationship) at the Jordanian construction companies.

Finding and Recommendations

Results Discussion

1- The relative importance of variables: study results showed that relative importance of various study variables (information technology, project success) came all medium, where IT ranked first and project success second which indicates the interest of sample members at surveyed construction companies/ first class/ category (A) to provide the best dimensions of IT in construction projects, where technology considers one of the important mechanisms for success of construction projects.

The results of current study agreed with Al-Nsour (2019) study in the importance of using technological means and tools in project management; as it achieves optimal use of time, better quality control, and the speed in delivering important information about project management. The results also agreed with Roslon (2022) study about the high relative importance of selecting appropriate physical solutions and technology to perform work using artificial intelligence and algorithms on the success of construction projects in a public utility building on a street in Warsaw, Poland.

2- The results of hypothesis test showed a statistically significant impact at the significance level ($\alpha \leq 0.05$) for IT; in terms of its dimensions (equipment & tools, software, networks, databases, information security, and human resources skills) on the success of projects; in terms of its combined dimensions (project cost, project quality, project time, customers relationship) at the Jordanian construction companies.

The results of current study agreed with Al-Nsour (2019) study which found a clear statistically significant impact on improving the performance of project plan implementation when using IT in project management in construction companies at Salt governorate of Jordan. It agreed with the study of LaKhdari and Ben Jeddou (2021) which showed that using IT saves cost and time, enhances work skills, reduces production costs, and increases inputs productivity representing the dimensions of project success in Al-Maghreb countries. Results agreed with Bilir (2022) study which showed that customers satisfaction have crucial role on the success of projects in Turkey. Roslon (2022) also agreed that success of AI-powered projects depends on the cost, time, and quality of supported construction projects in Poland.

Recommendation

1- The need to adopt using technological methods in construction projects; due to its major role on reducing cost and time of projects, reaching right quality, and improving the relationship with customers.

2- Encouraging the management of construction projects to continuously using advanced technological means of software, hardware, equipment, tools and networks to enhance the success of construction projects.

3- Senior management in construction projects should adapt to a clear vision in the formulation and implementation of necessary strategy for using advanced IT to ensure the success of construction projects.

4- Prepare and conduct training programs for project team on using the technology in projects to improve their performance.

5- The study recommends that future studies should be directed to include other economic sectors.

Conclusion

Information technology in construction projects has improved the sharing of information among the individuals working for the company. It also plays an essential role in the success of construction projects through the optimal use of resources, reduction of time and cost, and quality control. The study found that relationship between IT variable with its dimensions and the projects' success reached ($\beta=0.892$) and that ($t=61.190$) value significant at level (0.000), which proves a significant relationship between IT and the projects' success in its dimensions. The study also found that value of ($R^2 =801\%$) which means that IT with its dimensions has explained (80.1%) of variation in projects' success and its dimensions at the Jordanian construction companies.

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