# INVESTIGATING FACTORS AFFECTING SOFTWARE MAINTENANCE IN E-COMMERCE COMPANIES IN JORDAN

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**Submitted in Partial Fulfilment of the Requirements of the Degree of Doctor of Philosophy, October 2015**

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# Acknowledgements

First of all, praise and thanks be to Almighty Allah. Then, I would like to thank my father and mother who have prayed for me, and supported me during my study period. My heartfelt thanks go to my lovely wife, Ameera, my son, Karm and my daughter, Aline who accompanied me on this journey, a journey full of ambition, hope, difficulties and challenges … May Allah bless them.

I am grateful to my brothers and sisters and their families, for the support, encouragement, and patience. I would also like to thank all my uncles and my friends in Jordan and the UK for standing by me.

Special thanks go to Professor Haifa Takruri-Rizk for her assistance, advice and valuable recommendations.

Also, to Professor Grahame Cooper, thank you for help and suggestions.

To the e-commerce companies in Jordan, thank you for corporation.

Last, but not least, to Al-Hussein Bin Talal University, thanks for the scholarship, which allowed me to pursue my PhD.

# List of Publications

**The following papers have been published**

Salameen, R., Takruri-Rizk, H., & Cooper, C. (2015). A preliminary study of software maintenance in e-commerce companies in Jordan. *Journal of Multidisciplinary Engineering Science and Technology (JMEST),* 2374-2381.

Salameen, R., Takruri-Rizk, H. (2015). Investigating of the factors affecting software maintenance in e-commerce companies in Jordan. *Salford Postgraduate Annual Research Conference (SPARC).*

**The following papers under review**

Salameen, R., Takruri-Rizk, H. (2015). Developing a framework for human resource factors influencing software maintenance in e-commerce applications: a case study of e-commerce companies in Jordan.

Salameen, R., Takruri-Rizk, H. (2015). The extent of use of documentation in maintaining e-commerce applications: case study e-commerce companies in Jordan.

# List of Abbreviations

| | |
|---|---|
| AHU | Al-Hussein Bin Talal University |
| EC | Electronic Commerce |
| E-Commerce | Electronic Commerce |
| HR | Human Resources |
| HTML | Hyper Text  Markup Language |
| IEEE | Institute of Electrical and Electronic Engineers |
| IES | International Electrotechnical Commission |
| IOS | International Organization for Standardization |
| IS | Information System |
| IT | Information Technology |
| ITC | Information and Communications Technology |
| JD | Jordan Dinar |
| JO | Jordan |
| NIC | National Information Centre |
| PDTRA | Petra Development  Tourism and Region Authority |
| QoS | Quality of Service |
| QSR | Qualitative Research Software |
| SDLA | Software Development Life Cycle |
| SLA | Service Level Agreement |
| SM | Software Maintenance |
| UML | Unified Modeling Language |
| Y2K | Year 2000 Problem |

# List of Definitions

**Cash on delivery:** A type of transaction in which payment for a good is made at the time of delivery. If the purchaser does not make payment when the good is delivered, then the good will be returned to the seller.

**Conceptual Framework:** A visual or written product, one that explains, either graphically or in narrative form, the main things to be studied, the key factors, concepts, or variables and the presumed relationships among them.

**Cost-Effectiveness Analysis:** is a form of economic analysis that compares the relative costs and outcomes (effects) of two or more courses of action.

**Documentation**: Written text and/ or graphics that describes all steps of software products (e.g. requirements analysis, design, implementation, testing, regulation test, user manual).

**Electronic Commerce (EC)**: The exchange of value (i.e. goods for money) between two parties (i.e. consumer and merchant) via electronic means (i.e. internet).

**Framework:** A real or conceptual structure intended to serve as a support or guide for the building of something that expands the structure into something useful.

**Information Technology (IT)**: Anything related to computing technology, such as networking, hardware, software, the Internet, or the people that work with these technologies.

**Maintenance:** The act of keeping an entity in an existing state of repair, efficiency, or validity to preserve from failure or decline.

**NVivo:** A qualitative data analysis (QDA) computer software package produced by QSR International. It has been designed for qualitative researchers working with very rich text-based and/or multimedia information, where deep levels of analysis on small or large volumes of data are required.

**Senior Management**: A group of high level executives that actively participate in the daily supervision, planning and administrative processes required by a business to help meet its objectives. The senior management of a company is often appointed by the corporation's board of directors and approved by stockholders.

**Service-level Agreement (SLA)**: A part of a service contract where a service is formally defined. Particular aspects of the service - scope, quality, responsibilities - are agreed between

the service provider and the service user. A common feature of an SLA is a contracted delivery time (of the service or performance).

**Software Development Life Cycle:** A term used in systems engineering, information systems and software engineering to describe a process for planning, creating, testing, and deploying an information system.

**Software Maintenance**: The totality of activities required to provide cost-effective support to a software system. Activities are performed during the pre-delivery stage as well as the post-delivery stage (ISO/IEC 14764, 2006).

**Support Interface:** The activities at the interface between the maintainers, maintenance manager and stockholders.

# Abstract

The most costly phase in the software life cycle is the software maintenance phase. It consumes between 40% and 90% of a software project's budget. Software applications play an important role in e-commerce companies and the significance of software systems and their maintenance cannot be ignored. In order to improve the software maintenance process, a comprehensive understanding of the different factors involved in software maintenance in e-commerce companies is necessary. Thus, this study aims to identify and investigate the key factors that influence the software maintenance relevant to e-commerce in the country of Jordan. Furthermore, it hopes to provide a framework to address factors that affect the context described.

A preliminary study was conducted in order to gain an insight into software maintenance issues faced by e-commerce companies in Jordan and also, to obtain further details of the main study requirements, such as participant numbers.

This study adopted an interpretivist philosophy, qualitative approach. It was conducted in six e-commerce companies in Jordan. Each company was divided into two groups: Group A represents employees who work in software maintenance; Group B represents senior management of e-commerce companies. The total is 15 participants: 9 participants from Group A and 6 participants from Group B. Semi-structured face-to-face interviews, documents and archival records were selected as the data collection instruments for this study. Also, the qualitative data was analysed using NVivo software application.

The findings of the study revealed that there is an absence of systematic approach regarding work in software maintenance in e-commerce companies in Jordan. Moreover, the study contributes to knowledge regarding the key factors that affect software maintenance activities in e-commerce companies in Jordan. Twenty-three factors were identified in the study as factors that affect software maintenance and those were classified into five main categories: human resources, organisation environment, operational environment, software characteristics and external factors. Also, the research contributes new knowledge by identifying three new factors affecting software maintenance: native language, operation users, and views of people about software maintenance jobs. Furthermore, the study developed a framework for software maintenance processes in e-commerce companies in Jordan to improve the effectiveness of maintenance work and reduce the negative impact on company operation.

# Chapter One: Introduction and Background Research

# 1. Introduction

This chapter introduces the research. The background of the research will be presented, along with the rationale of the study, the purpose, the aim, objectives, and research questions. The significance and contributions of the study will be outlined; also, a brief background about the context of study is described. The chapter ends with an overview of the thesis.

## 1.1 Background

The software engineering environment has made significant progress in the software industry and yet, software inefficiency is still a major obstacle, which is why regular software maintenance is required. Although the maintenance phase is the last phase in the software life cycle, it is still a very important phase of the software engineering process (IEEE std, 1998).

Lientz et al. (1978), Abran and Maya (1995), Bennett and Rajlich (2000), Kajko-Mattsson et al. (2001), Abran et al. (2004), April and Abran (2012), Dehaghani and Hajrahimi (2013), Islam and Katiyar (2014) argue that the most important and costly phase in the software life cycle is the maintenance phase. Furthermore, maintenance software consumes most of the budget of a software project (between 40 to 90% of the total budget project) in the software life cycle, and includes all activities relating to software maintenance. Singer (1998) illustrates that two-thirds of the working time of programmers is consumed by software maintenance and the remaining working time is spent developing new systems. Pino et al. (2012) confirmed similar working time proportions in his study. Additionally, software maintenance plays an important role in the life cycle of the software project, and software maintenance includes fixing errors, improving performance and adapting a system to ensure consistency with the changes that happen in the work environment (López and Salmeron, 2012). Yongchang et al. (2011) and Islam and Katiyar (2014) note that the average cost of software maintenance is about four times that of the development cost.

Canfora et al. (2000) observe that problems in software maintenance arise from managerial and/ or technical issues, which in turn impact on the cost of software maintenance. Consequently, exploring and analysing the factors that influence the cost of maintenance can help IT managers and decision makers to reduce its cost by controlling the factors affected. However, López and Salmeron (2012) concluded that success in software maintenance can be slowed for reasons related to work environment and daily activity in companies.

Software systems require regular update to recognize the organization of the business. However, a company cannot replace the software every time there is a change, for many reasons related to high cost of software, and the scarce resources in organizations. Thus, the perfect solution is to maintain and enhance the existing software, so that there is greater attention to software maintenance rather than software replacement when a company is trying to improve and increase its business activity.

Software maintenance differs entirely from traditional maintenance in other domains of engineering. Also, the quality of software maintenance depends on quality of maintenance processes and their development process. Development plays an important role in the quality of software maintenance, and weak development leads to more errors and defects in software products (Desharnais and April, 2010). Moreover, the architecture of the system affects its maintainability. Therefore, the systems should be designed with consideration of the user requirements and IT infrastructure maintainability of the system.

Moreover, Pigoski (1996) put forward attributes that can improve the maintainability for any system. Those attributes are: reliability, understandability, testability, modularity and expandability.

**1.2 Jordanian Context**

**1.2.1 About Jordan**

Jordan is one of the Middle East countries, and the total area of Jordan is 89, 318 square kilometres with a population in 2013 of 6,388,000 (Department of Statistics, Jordan, 2013). The unit of currency, the Jordanian dinar (JD), equals around 0.93 GBP and 1.41 USD (Currency converter, October 2015). Arabic is the first and official language in Jordan and English the second language. Islam is the predominant religion.

**1.2.2 Location**

Jordan is located in the heart of the Middle East region to the northwest of Saudi Arabia and southern Syria, and to the southwest of Iraq and to the east of Israel and the West Bank. Jordan has access to the Red Sea through the city of Aqaba, located on the northern tip of the Gulf of Aqaba (Travel Centre, 2015).

### 1.2.3 E-Commerce in Jordan

The e-commerce trade growth in the last few years and the demand for using e-commerce has increased significantly. The number of e-commerce companies in Jordan, according to the last statistics in 2012, is above twenty and the figure is rising (E-Commerce in Jordan, 2012).

### 1.2.4 National Information Center

The National Information Centre (NIC) was established in 1993, and they seek to help the information technology sector in logistics information, and also provide website domain services. NIC is responsible for setting Jordan's information policies and strategy for all IT sectors (El-Khalilia and Damen, 2008).

Further information about the research context will explain in chapter three.

### 1.3 The Rationale for the Study

A great deal of research has been conducted on software maintenance and much of that research has focused on the fact that software maintenance takes a large portion of the budget of any software project (Lientz et al., 1978; Abran and Maya, 1995; Bennett and Rajlich, 2000; Kajko-Mattsson et al., 2001; Abran et al., 2004; April and Abran, 2012; Dehaghani and Hajrahimi, 2013). However, there is no such research about software maintenance in Jordan, which is reasonably advanced in information technology.

This research seeks to address the problems in software maintenance and its effect on developing e-commerce companies in Jordan. It will look at ways of reducing the cost of software maintenance without affecting its effectiveness and also, to try to understand the different factors that affect software maintenance for e-commerce companies in Jordan.

Additionally, it is widely believed that the development of software maintenance can help increase the investments in the area of software products, maintenance and an e-commerce application, consequently giving an incentive to develop the economy in Jordan. This is in line with the recommendations of his Majesty King Abdullah II when he met the ICT sector in 15 April 2015. The recommendation focused on developing the Information and Communications Technology (ICT) sector to support the national economy (Importance of Telecommunications Sector, 2015).

Also, the culture in an Arab country affects the choice of software application that is used in e-commerce companies for the reasons below:

➢ The mother tongue is Arabic, which means some portions of the system should be translated into Arabic.

➢ The payment method in e-commerce companies in Jordan differs from other countries; the primary payment method used in e-commerce companies in Jordan is "cash on delivery" (preliminary study findings).

The reasons above justify some differences in software applications used in e-commerce companies in Arab countries in general, particularly in Jordan. Therefore, the study will focus on software maintenance in Jordan, a specific environment implementing e-commerce. Moreover, there is a lack of similar studies in Arab countries and especially those applicable to Jordanian e-commerce.

### 1.3.1 Personal Interest

An author's strong interest in the topic and answering the research questions can counteract the inevitable interference from work, family obligations and procrastination (Maxwell, 1996).

The researcher is a Jordanian citizen and the empirical case studies will be conducted in Jordan. The researcher worked as a lecturer in schools affiliated to the Ministry of Education in Jordan, from February 2004 until March 2009 in parallel with a lecturer position at Al-Hussain Bin Talal University, Jordan, on a part time basis. He has a background in the subject of software maintenance support, and has worked in the software maintenance department in Petra Development Region Authority (PDTRA) since 2009. This meets Maxwell's (1996) point that a research topic chosen within the researcher's experience and background is preferable.

The researcher believes, through his experiences and background, that there is a problem with software maintenance, particularly in Jordan.

All of the above reasons justify the need for the present study.

## 1.4 Research Outline

### 1.4.1 Research Aim

This study aims to identify and investigate the key factors that influence the software maintenance relevant to e-commerce companies in the country of Jordan. Furthermore, it hopes to propose a framework to address factors that affect the context described.

### 1.4.2 Research Objectives

To meet the aim of the research and to answer the research questions, four objectives were formulated as follows:

- To review the relevant literature on software maintenance in order to understand software maintenance models, processes, practices, and the factors, which influence the software maintenance.
- To conduct an empirical study within the e-commerce companies in Jordan in order to understand the factors influencing the cost-effectiveness of software maintenance.
- To explore how and why these factors influence the software maintenance in Jordanian e-commerce companies.
- To propose a framework to address the factors that influence software maintenance activities in e-commerce companies in Jordan.

### 1.4.3 Research Questions

In order to achieve the research aims, three research questions were raised:

- What are the internal and external factors that affect the efficiency of software maintenance within the context described?

- How do these factors influence the effectiveness of software maintenance in the described context?

- Why do these factors influence the software maintenance in e-commerce companies in Jordan?

**1.5 Significance of Study**

This study is considered to be significant for several reasons :

- It addresses an important subject that is software maintenance (April et al., 2004; Dehaghani and Hajrahimi, 2013; Islam and Katiyar, 2014; Prodan and Prodan, 2014).

- The study provides an insight concerning software maintenance. In addition, it provides up to date relevant information and knowledge, which many in the information technology sector are not aware of (e-commerce companies in Arab countries and particularly in Jordan).

- The study provides users with an up to date software maintenance model, techniques and cost effective approaches that save users effort, money and time.

- The study seeks to identify the internal and external factors that influence software maintenance in one of the most vital sectors in Jordan at this time, namely e-commerce companies in Jordan.

- The possibility of benefitting from the results of this study in improving software maintenance activities in other e-commerce companies in Jordan.

- Applies to other countries in the Middle East.

**1.6 Major Contributions to Knowledge**

- This study fills a gap in relevant literature due to the scarcity of studies in the field of system maintenance in Jordan, and develops a better understanding of the problems of software maintenance in e-commerce companies in Jordan.

- The major part of the study was devoted to examining the problem of system maintenance in e-commerce in Jordan in an attempt to reduce the factors that negatively impact the effectiveness of software maintenance.

- This study has made another contribution to knowledge by emphasizing a number of factors that affect software maintenance such as human resources, software characteristics, organisational environment, operational environment and external factors.

- The study identified some unique factors influencing the software maintenance in e-commerce companies in the Jordanian context. Furthermore, the critical point of this study is to reveal the principles of system maintenance in Jordanian e-commerce companies.

- This study has generated a framework to deal with software maintenance activities and practices in e-commerce companies, and the framework helps to keep cost-effectiveness and save effort in software maintenance.

Consequently, the study plays an educational role by providing the information technology sector in Jordan with valuable knowledge relevant to software maintenance in e-commerce application, which is still in the early stages in Jordan.

## 1.7 Research Process

As mentioned previously the aim of the research is to identify and investigate the key factors that influence the software maintenance relevant to e-commerce in the country of Jordan. Furthermore, it hopes to propose a framework to address factors that affect the context described. In order to achieve this aim and objectives the researcher begins with the literature review to identify the factors affecting software maintenance and to understanding research methodology.

The present research will be conducted in e-commerce companies in Jordan. To prepare the companies for the main study and to clarify the picture about the problems in software maintenance in e-commerce companies a preliminary study has been conducted.

The researcher adopts a qualitative method to collect the data, and two sources were used: face-to-face interviews, documents and archival records. NVivo software is used to analyse the qualitative data and the findings from the data analysis are discussed in light of the literature. The final phase of the present research is conclusions and recommendation. Figure 1.1 below shows the research process.

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┌─────────────────────────────────────┐
│ Investigating factors affecting     │
│ software maintenance in e-commerce  │
│ companies in Jordan.                │
└─────────────────────────────────────┘
                 ↓
┌─────────────────────────────────────┐
│ Develop research aim, objectives,   │
│ and question(s).                    │
└─────────────────────────────────────┘
                 ↓
┌─────────────────────────────────────┐
│ Literature review                   │
│   • Identify factors that affect    │
│     software maintenance            │
│   • Research methodology            │
└─────────────────────────────────────┘
                 ↓
┌─────────────────────────────────────┐
│ Conduct preliminary study           │
└─────────────────────────────────────┘
                 ↓
┌─────────────────────────────────────┐
│ Review the aim, objectives,         │
│ question(s) and methodology of      │
│ the research                        │
└─────────────────────────────────────┘
                 ↓
┌─────────────────────────────────────┐
│ Collect data using qualitative      │
│ method                              │
└─────────────────────────────────────┘
           ↓              ↓
┌──────────────────┐  ┌──────────────────┐
│ Documents and    │  │ Semi-structure   │
│ archival records │  │ interviews       │
└──────────────────┘  └──────────────────┘
                 ↓
┌─────────────────────────────────────┐
│ Analyse data (use NVivo software)   │
└─────────────────────────────────────┘
                 ↓
┌─────────────────────────────────────┐
│ Discuss the findings in light of    │
│ literature                          │
└─────────────────────────────────────┘
                 ↓
┌─────────────────────────────────────┐
│ Propose framework                   │
└─────────────────────────────────────┘
                 ↓
┌─────────────────────────────────────┐
│ Conclusions, contributions,         │
│ limitations and recommendations     │
└─────────────────────────────────────┘
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Figure 1.1: Research Process.

## 1.8 Structure of the Thesis

To accomplish the research aim in section 1.4.1 and research objectives in section 1.4.2, the thesis will be divided into eight chapters as follows:

- **Chapter One: Introduction and Background of Research**

  The chapter introduces the research, its background and the need for it, and the research aim, objectives, questions, and major contribution to knowledge. The design and methodology of research are outlined.

- **Chapter Two: Literature Review**

  The literature review relates to software maintenance, the concepts and the aim of software maintenance, factors affecting software maintenance, and the software maintenance in e-commerce companies. The components of e-commerce application are outlined. The conceptual framework for the study is presented.

- **Chapter Three: Jordan Context**

  The chapter provides information about the context of Jordan where the study was conducted. It also provides information about e-commerce companies in Jordan and an overview of the universities in Jordan that teach the field of computers.

- **Chapter Four: Research Methodology**

  The chapter is divided into two sections: the first section is the preliminary study and the second section is the research methodology.
  Section one provides the preliminary study overview, aim, and objectives.
  Section two provides the research philosophy, approach, strategies, data methods, and discusses the justification of the research approach of the study. The pilot studies are described and the interview protocols adopted in the field study are explained.

- **Chapter Five: Research Findings**

  The chapter begins by describing the descriptive data of the participants. Then, it provides the findings of the empirical study, which is conducted in six e-commerce companies in Jordan. The findings include the data from two methods that have been

adopted in the present research, namely the interviews and documents and archival records.

- **Chapter Six: Data Analysis and Discussion**

The chapter presents the analysis of the findings of the semi-structured face-to-face interviews and available documents and archival records in e-commerce companies in Jordan. Moreover, the chapter highlights the findings with related literature in chapter two. Also, it includes a summary of the key findings arising from the analysis of the data.

- **Chapter Seven: Proposed Framework**

The chapter presents a proposed framework aiming to improve the software maintenance activities in e-commerce companies in Jordan. The proposed framework includes five sub-frameworks.

- **Chapter Eight**: **Conclusion, Contributions, Recommendations and Limitations.**

The chapter provides the conclusion of the study, and the contributions to knowledge, as well as the recommendations to practices, decision makers and ideas for further research in the software maintenance field, particularly in e-commerce. Finally, the limitations of the study are presented.

## 1.9 Chapter Summary

In this chapter the problems of the study and the rationale of the study have been discussed. Also, the research aim, research objectives and research questions have been outlined and the research process has been presented. A brief background about the context has been described and the structure of the thesis explained. The next chapter, the literature review, will present a background about software maintenance, the reasons for doing maintenance to the systems and it will highlight the factors that affect software maintenance.

# Chapter Two: Literature Review

## 2. Introduction

Over the past forty years, software maintenance has become an important part of the software life cycle and still until today it is the most important phase in the software development life cycle (SDLC), as has been inferred by numerous studies (Nasir and Abbasi, 2010; Islam and Katiyar, 2014; Prodan and Prodan, 2014; Grant and Cordy, 2014; Samart and Prompoon, 2014; Mengning et al., 2015).

This chapter will present the background of e-commerce systems and the web-site model. Also, the chapter will give an insight into software maintenance and review the concepts, models and categories of it. Furthermore, it will highlight the factors that affect software maintenance. Finally, the chapter will explain the main reasons for maintenance and lastly, the conceptual framework of the study will be presented.

### 2.1 Electronic Commerce System

The electronic commerce (EC) system has a heterogeneous software environment in terms of its software, hardware, and database. It is a system to deal with financial matters in business functions.

Jackson (2015, p.6) defines e-commerce as: *"the type of business that delivers services and products over electronic based systems through marketing, distribution, buying, and selling". Alternatively,* Saleh (2002, p.303) *defines electronic commerce as "the exchange of value (i.e. goods for money) between two parties (i.e. consumer and merchant) via electronic means (i.e. internet)".*

The EC is a new advanced technology related to trade. Benefits of e-commerce include: the speed of the internet, the security in payment methods, time to deliver, and high security communication over the internet, which all play an important role in its widespread acceptance. EC business terms of sale and the components of EC (software, database, hardware, network, and communication) are very important features for business continuity. These features help to achieve the success of EC operations, such as availability, security, and high performance (Saleh, 2002).

### 2.1.1 Components of E-Commerce Systems

Jackson (2015) stressed that one of the global challenges in e-commerce business is designing an electronic infrastructure to support online business. Successful e-commerce applications must include high-speed connections to network, enterprise server software, and web server software as well as a server operating system (Stair and Reynolds, 2012).

Furthermore, Storey et al. (2000) reported that e-commerce systems are dynamic and change quickly. Those changes are needed in the e-commerce industry as well. Furthermore, the e-commerce industry is a mix of products and services including:

- Hardware (e.g. routers, firewalls, switches, servers, and workstations);
- Software products (e.g. Java development environments, EDI applications, and browsers, HTML editors, and middleware software/ service);
- Network (e.g. wireless, cable, satellite network); and
- Transmutation networks (e.g. internet, private networks).

On the other hand, Di Sciascio et al. (2003) argue that the problems in websites arise from three components: hardware, software and network issues. These components require constant maintenance to continue the work of the website. To ensure high performance of the website its administrator should give attention to all these components.

One of the most important tips to keep the e-commerce website at the front is to keep it from the viruses and security risks that affect business processes. Furthermore, it requires regular maintenance to prevent problems in the future and to obtain the latest technology (Hibu Company, 2014).

The present research will be focused on one of the components of the website, which is software, and in particular on its maintenance.

### 2.2 Web Application

Dennis et al. (2014) noted that the dynamic content systems such as web 2.0 require on-going maintenance and that leads to an increase in the efforts of software maintenance.

Offutt (2002) put forward seven criteria for the success of web applications, namely reliability, usability, security, availability, scalability, maintainability, and time to market.

These attributes can lead to the success of any web application and they affect all issues related to it.

Lee and Jefferson (2005) further explained the characteristics of software maintenance efforts in web-based applications. They compared it with other applications in software applications in previous studies on software maintenance. Their empirical study was conducted using a Java web-based administrative application in the e-Government. The study found that the amount of work required using the Java system is similar to that required when using other systems. This is because similar software maintenance techniques are used.

### 2.2.1 Web Sites Model (Technology Changes)

The goal of this section is to give a background about website models of the past and present. Offutt (2002) states that technology changes rapidly and significantly, and the web application should deal with the change. In the past websites were used to email, files, newsgroups, and chat rooms, but now websites have become more interactive with the users. Also, the websites include many types of businesses interacting with users. The rapid changes make an impact on software engineering to deal with this change.

In the past websites were created by a single webmaster using HTML, JavaScript, and simple CGI scripts. Figure 2.1 shows the structure of the early websites. As a client-server, the computer (client) acted as a web browser as the users used to visit the website via the server, and the web server sent a file (HTML) to the client. This model faced many problems such as security, high traffic, maintainability, and limited functionality.
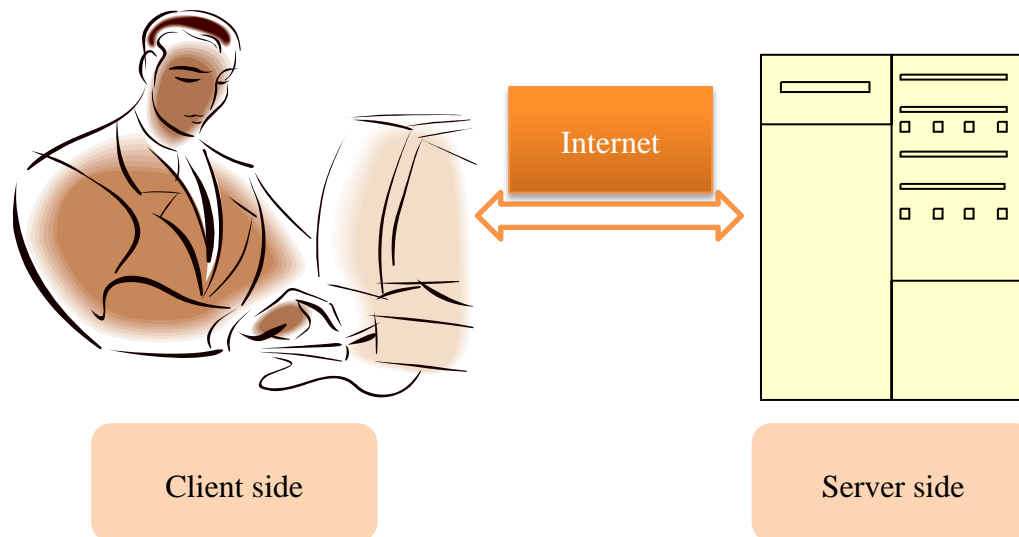
Figure 2.1: Structure of early websites client-server model (N-tier model)

Source: Offutt (2002).

Current website changes are compared with those in the past. Now, websites are becoming more interactive and provide e-commerce applications (business-to-customer, business-to-business). So, the structures of websites have changed to deal with the changes.

Figure 2.2 illustrates the change of the structure. What is new in the structure is the middleware, which is the software that handles communication between application server and database server. Moreover, sometimes there may be more than one application server and database server.

These changes have led to more security, functionality, scalability, maintainability of the website. Indeed, the team of websites must include manager, programmers, network administrators, graphics designer, security experts, marketer, and others. This team uses diverse technologies including several varieties of Java, HTML, JavaScript, XML, UML, and many others.
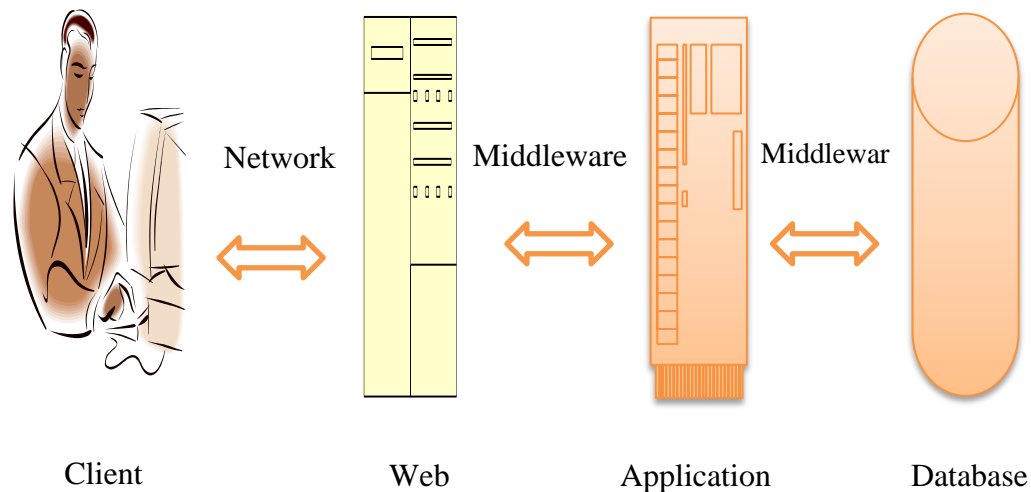
Figure 2.2: Modern websites generally follow an N-tier model.

Source: Offutt (2002).

## 2.3 Definitions of Software Maintenance

The known meaning of maintenance is to keep things working or running when it breaks down to be repaired and put back to work. Many principles define maintenance as keeping work running when things go wrong and fixing the problem to get work back in order. The expression 'maintenance', when connected to software, presumes a meaning entirely different from the principle in any other industry (Villavicencio, 2014). When we are talking about software maintenance, there is a difference in the meaning. According to Islam and Katiyar (2014), maintenance is the actions taken when a product does not function properly. Indeed, in the existing literature numerous definitions of software maintenance have been presented over the last years. Definitions vary mostly in determining the beginning of the maintenance process, whether it is after or before delivery of the product. Below some of the software maintenance definitions will be referred to.

Mamone (1994, p.75) defined software maintenance as "*any modification of a software product, after its delivery, to correct errors, improve performance or other attributes, or the action of adapting the product to a changing environment*".

Also, IEEE standard (IEEE Std 1219, 1998, p.4) for software maintenance defined software maintenance as "*the process of modifying a software system or component after delivery to correct faults, improve performances or other attributes, or adapt to a changed environment*".

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De Souza et al. (2005) noted that software maintenance is traditionally defined as any modification made on a system after its delivery.

The definitions of Mamone (1994), IEEE Std 1219 (1998) and De Souza et al. (2005) means maintenance starts with the delivery of the system to the customer or client. Indeed, the maintenance seeks to fix errors and bugs that occur along the lifetime of software operation and improve performance to adapt to the business environment.

On the other hand, Pigoski (1996, p.82) defines software maintenance as "*the totality of activities required to provide cost-effective support to a software system. Activities are performed during the pre-delivery stage as well as the post-delivery stage. Pre-delivery activities include planning for post-delivery operations, supportability, and logistics determination. Post-delivery activities include software modification, training, and operating a help desk*". This definition is consistent with the ISO standard of software life-cycle and software maintenance approach.

According to ISO/ IEC 14764 (2006, p.4), software maintenance is defined as:

*"The totality of activities required to provide cost-effective support to a software system. Activities are performed during the pre-delivery stage as well as the post-delivery stage"*.

ISO/ IEC 14764 (2006) concluded that the pre-delivery means planning for post-delivery activity and operations, and post-delivery included training for products, maintainability, the help desk, and software modification.

Indeed, many authors considered that maintenance should start before the delivery of the software product (pre-delivery). Schneidewind (1987) considered that the causes of problems that make maintenance difficult and complicated begin maintenance after delivery of software.

Furthermore, Osborne and Chikofsky (1990) stressed that more attention should be given to system life cycle approach for controlling and managing all activity related to software systems toward improved maintenance. On the other hand, Bennett and Rajlich (2000) argue that the objective of maintenance is to modify the existing software product while preserving its integrity.

After discussing the definitions of software maintenance, it is clear that software maintenance activities include all activities related to improving or fixing errors in the

software, and each activity should start in the early phases of the software development life cycle as long as the software is in service. So, based on all previous definitions of software maintenance, the present research will adopt the software maintenance definition of ISO/ IEC 14764 (2006) and Pigoski (1996). The definition is comprehensive of all software maintenance activities, and it includes the planning for post-delivery activity in pre-delivery. The planning includes maintainability, software modification, and training for products, which meets the aim of the study (cf. 1.4.1).

## 2.4 Categories of Software Maintenance

Canfora et al. (2000); Nasir and Abbasi (2010); Floris and Harald (2010); Prodan and Prodan (2014); Grant and Cordy (2014) and Islam and Katiyar (2014) consider that the maintenance phenomenon is the most important in the software system life cycle. Moreover, several studies have referred to the phenomenon and the side effects that relate to software engineering (Lientz and Swanson, 1980; Abran and Nguyenkim, 1993; IEEE Std, 1998; ISO/IEC 14764, 2006; López and Salmeron, 2012). These studies have classified categories for software maintenance activities. The classification of software maintenance into categories could help people who are working in software maintenance to deal with maintenance activities. On the other hand, splitting maintenance into categories increases the evidence that the software maintenance not only simply corrects and fixes errors, but that "maintenance" means many activities "pre" and "post" delivery of the software.

### 2.4.1 Lientz and Swanson Categories

Lientz and Swanson (1980) divide maintenance activities into three classifications: c*orrective*, *adaptive*, and *perfective* maintenance.

- Corrective maintenance: includes all activities to fix errors or mistakes in the software product after delivery.
- Adaptive maintenance: modification of software system to make sure it is working when a new change occurs in a work environment such as, new hardware, operating system, DBMS, network.
- Perfective maintenance: refers to changes that arise from user requests, improving performance and maintainability, improving usability, improving ease of use (López and Salmeron, 2012).

### 2.4.2 IEEE Std Categories

IEEE Std (1998) redefines the categories of Lientz and Swanson (1980), which are corrective, adaptive, and perfective maintenance, and they add the classification of emergency maintenance as a fourth category. The IEEE Std (1998) categories are as follows:

- Corrective maintenance: reactive modification of a software product performed after delivery to correct discovered faults.
- Adaptive maintenance: modification of a software product performed after delivery to keep a computer program usable in a changed or changing environment.
- Perfective maintenance: modification of a software product performed after delivery to improve performance or maintainability.
- Emergency maintenance: unscheduled corrective maintenance performed to keep a system operational.

Consequently, from the fourth classification "Emergency maintenance" we conclude that software maintenance can be scheduled or unscheduled. Furthermore, Abran and Nguyenkim (1993) mentioned another category – "user support" - in response to user requests for their IT training needs. This support helps to better understand the system and reduces the problems, which occur from inefficient software use.

### 2.4.3 ISO/IEC 14764 Categories

The ISO/IEC 14764 (2006) proposed four categories of software maintenance. These types are grouped together into two groups Correction and Enhancement as shown in Figure 2.3 below.

1. Correction: correct errors when they occur and reduce potential errors in the future:
   - Corrective maintenance: scheduled modification required when errors occur in software products to correct errors.
   - Preventive maintenance: to address the potential errors, which may occur in the future in software products and planning for correction before they become operational faults.

Also, in correction classification there is a sub-classification that is *emergency maintenance*: is an unscheduled modification to keep a system running temporarily until the corrective maintenance is finished and corrects the errors.

2. Enhancement (noun correction): to enhance software products, user request, documentation, and improve maintainability. Two types of enhancement are proposed:

- Adaptive: performed to make a system usable in a changed environment, e g. - new platform, system requirements, government policy, new system interface requirements.

- Perfective: improve a system in order to provide a new functionality, improve maintainability, user request modification, and to modify existing documentation.
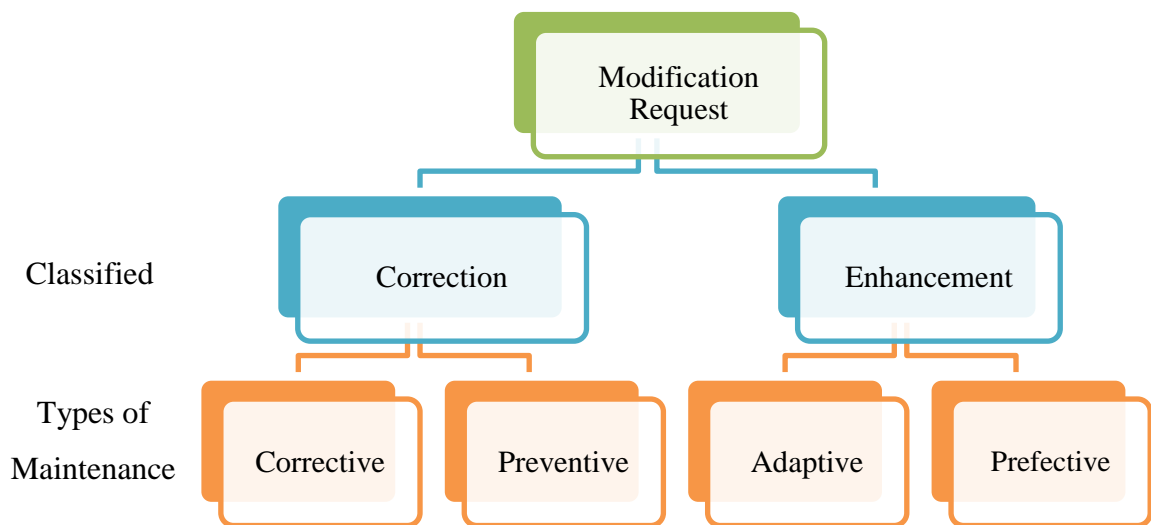


Figure 2.3: Software maintenance classifications

Source: ISO/IEC 14764 (2006, p. 4).

Abran et al. (2004) report that the understanding of different classifications of software maintenance can help the software engineer in estimating the cost of software maintenance. Estimating cost is a very important planning aspect of software maintenance, so software engineers must have prior knowledge of these classifications.

**2.5 Software Maintenance Process**

Software maintenance processes are the activities and tasks for the life cycle of software maintenance. This helps to modify existing software when problems occur or modification is required of software products.

Mallikarjuna et al. (2014) stress that software modification becomes complex and costly with the large size of software product. Therefore, he notes four tasks of modification process, which could reduce the complexity of modification. Figure 2.4 shows the main four tasks and the relationship between the tasks.
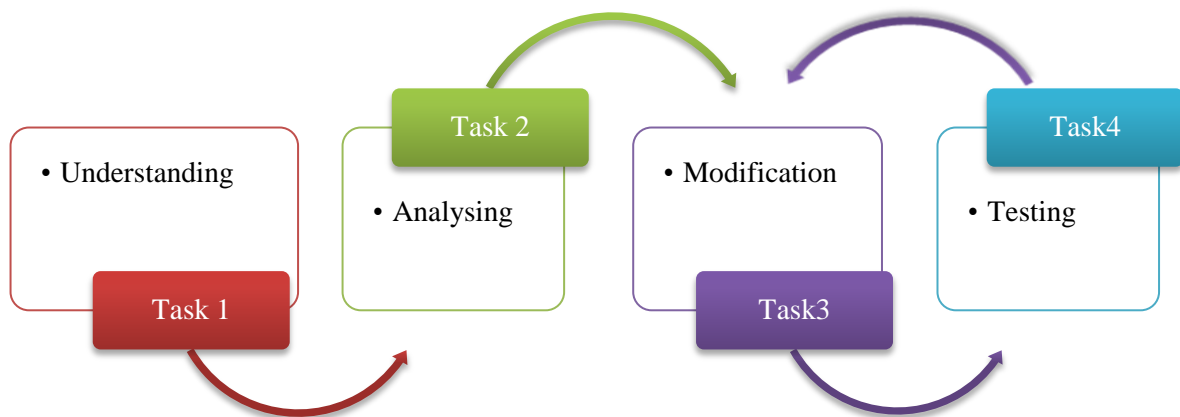


Figure 2.4: Software maintenance process.

Source: Mallikarjuna et al. (2014, p.1485)

1. System understanding: is a process of comprehending the functions of the system and the relationship between system components. This task is considered as an essential base for inspecting and modifying a software product.
2. System analysis: is one of the very important tasks in the software maintenance process that concerns classifying the required modifications to correct, enhance, or adopt the system.
3. System modification: is the task of changing and correcting the inspected functions within the software product.
4. System testing: is different from normal tests. It just considers testing changes, which are done in the system modification task and the side effects in the other functions in the system. The main aim of system testing is to validate whether the modification change has achieved the goals of maintenance.

Furthermore, Islam and Katiyar (2014) stressed the Testing Quality, which means the effective testing strategy adopted from software engineering to reduce the errors in the system. Testing quality helps to reduce the effort in the maintenance.

**2.5.1 IEEE Software Maintenance Process**

IEEE 1219 standard puts forward seven phases of the software maintenance process (IEEE 1219, 1998). Figure 2.5 shows the IEEE standard process.
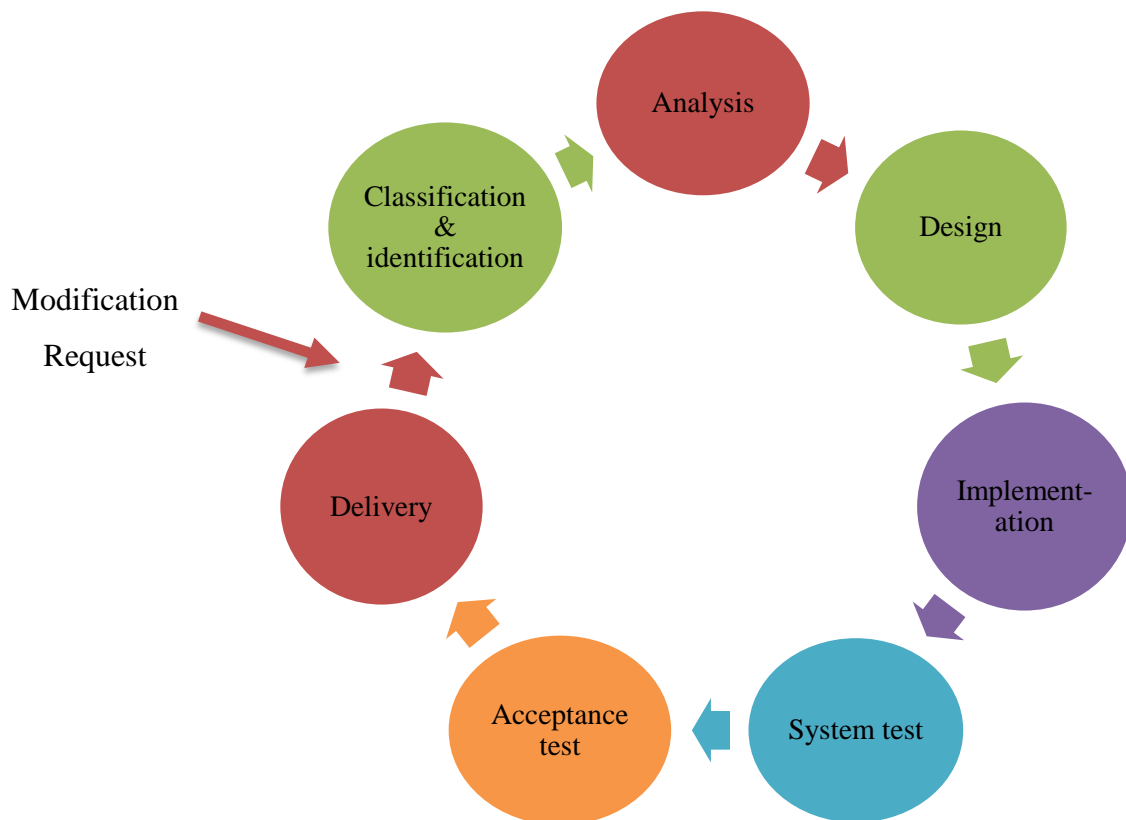


Figure 2.5: IEEE 1219-98 Maintenance process activities.

Source: IEEE 1219(1998).

The phases are:

a) **Problem/ modification identification, classification, and prioritization**: in this phase the software request and modification are identified and given a prioritization number. Then, the modification request classification of IEEE1219 (1998) categorizes software maintenance into corrective, adaptive, perfective maintenance, and emergency maintenance.

b) **Analysis***:* this phase analyses the initially presented ideas so that a design can then be based on the analyzed issues for the next phases in the software maintenance process: design, implementation, testing, and delivery.

c) **Design:** in this phase the output of the analysis phase, the documentation of the whole project and the existing database shall be used to design the modifications of the system. The output of the design phase is used as input for the next phase.

d) **Implementation***:* in this phase, all output from design phase, the documentation, and the current source code (comments and databases) shall be used to implement a system.

e*)* **Regression/system testing:** the input of this phase includes Test-readiness review report, documentation, and updated system. This is to ensure that the modified code does not introduce new errors that did not exist before the beginning of the maintenance process.

 f) **Acceptance testing***:* testing generally involves running a suite of tests on the completed system. Developers, clients, customers, or third parties are involved in acceptance testing. The acceptance test occurs to ensure that the modification has been done and was satisfactory to the customer.

g) **Delivery***:* this phase determines the requirements for delivery of the new version of the system after modification.


**2.5.2 ISO Software Maintenance Process**

ISO/ IEC 12207 proposed six activities, which can control the software maintenance process. Also, these activities are necessary to modify and enhance existing software and preserve the continuity of work. Figure 2.6 shows the activities of the software maintenance process related to ISO Standard:
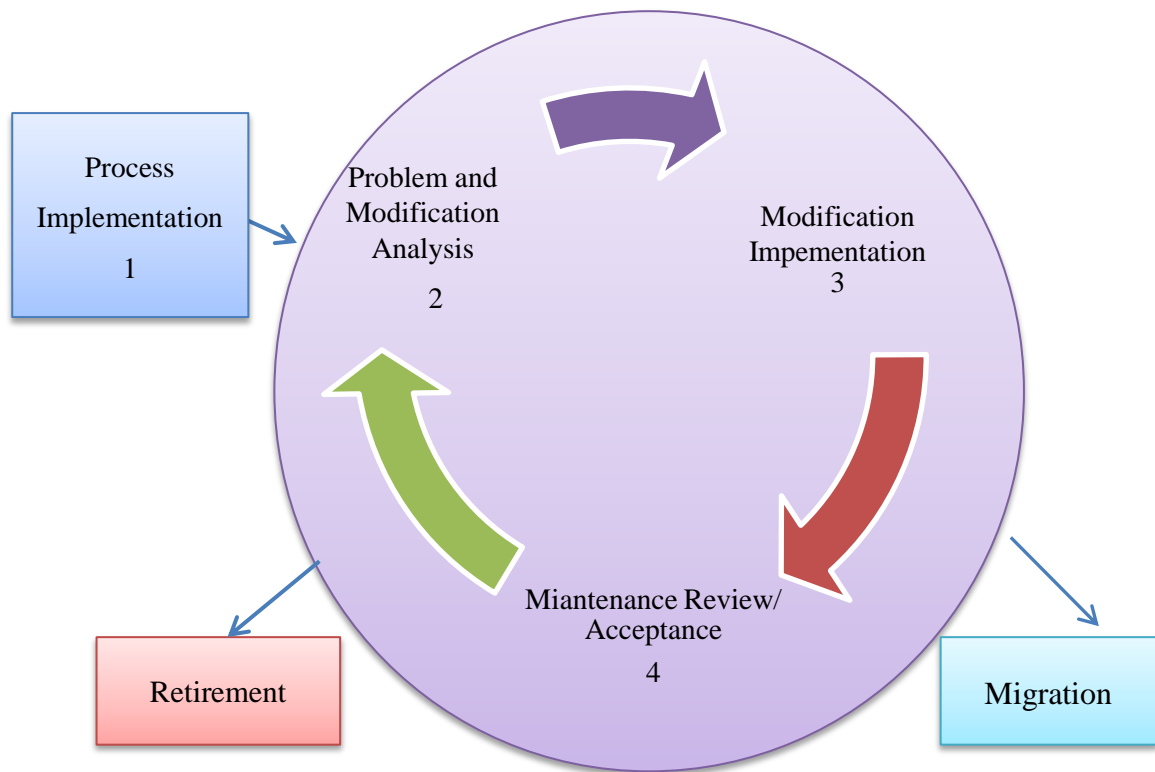
Figure 2.6: ISO/ IEC 14764 Software maintenance process.

Source: ISO/ IEC 14764 (2006, p.6).

a) **Process Implementation**: during the initial implementations, maintainers start plans for maintenance process, training, measurement, user feedback, configuration management, transition, project management, and how to accomplish maintenance process. They develop a strategy for performing maintenance. Maintainers collect information about software like documents, problem reports, and request modifications.

b) **Problem and Modification Analysis**: these activities are established after software transition, when they need modification. During the modification, the maintainers should analyse modification requests or problem reports and their impact on the existing software and on the organisation. Also, the analysis must carefully look at the types of maintenance, cost and time to modify, and impact on performance; for example security, continuity, safety.

Moreover, the maintainers in this process develop different options for implementing the modifications, and analyse the impact for each of the options on the software and hardware used in the organisations.

The problem and modification analysis depend on the output of the process implementation phase. At the end of this phase the maintainer is able to generate the following points:

- Impact analysis (initial priority, problem evaluation, classification of the type of maintenance). Also, the impact analysis is required from the software maintainer before doing maintenance, with a full analysis about potential impacts of the change or update on the existing system (Nasir and Abbasi, 2010).
- Updated documentation (Software documentation, test strategy).
- Recommended option.
- Approved modification.

c) **Modification Implementation:** in the modification implementation phase, activity of the maintainer transfers from analysis and plans the modification of the software product to develop and test modification. The maintainer should have information about modification documentation, problem reports or modification requests, and the baseline (system architecture, modification request, source code).

The most important output Modification Implementation includes:

- Updated test plans and procedures.
- Modified source code.
- Test reporting.
- Updated documentation (updated modification records, analysis report, requirement, and test plan).
- Measures.

d) **Maintenance Review/ Acceptance**: the input of this activity is the modification test, and modified software.

The maintenance review/acceptance activity reviews the input to ensure that modification of the systems is conducted correctly, and modifications are based on good evidence of need in the working environment.

The output of maintenance review: the major outputs of maintenance review activity are accepted modifications and those modification suggestions which have been rejected due to lack of evidence, and a software qualification test report.

e) **Migration***:* a system may be run in another environment during its life. Thus, they need to be modified to work in the new environment, and to this end the migration activity phase modifies a system to allow it to run in the new environment and to ensure a smooth transition to the new environment.

It is important in migration activity to verify and maintain old data when migrating to and planning for a new environment. Thus, the development of a migration plan is important for the successful transition to migration. This should include details about support for the new environment in the future, migration execution and variation, and data relating to both the old and new environments.

Many tasks should be performed by the maintainer in migration activities:

- Perform a site survey.
- Install the equipment and software.
- Collect and analyse data from old and new environments.
- Run the software under parallel control with the old software.
- Operational training about new software products.
- Archive the old data and software in a safe place.
- Identify potential risk.
- Document any updated changes.

 f) **Retirement:** once the software becomes redundant and does not achieve its objectives, it must be retired. An analysis should be performed to make the decision to retire a software product.

An economic analysis should take place to make the decision to retire a software product or replace it by a new software product. The retirement maintainer should archive and maintain the old data and software product.  Analysis should determine if it is cost effective to:

- Move to a new technology or new software product.
- To facilitate the maintenance.
- Maintenance become difficult.
- Develop a new product to achieve modality or standardization.

**2.6 Software Maintenance Process Models**

**2.6.1 Quickly Modify Model**

According to Basili (1990) and Grubb and Takang (2003), the name of the model "Quickly" came from the methods that are dealing with the errors in software maintenance. This means the maintainer seeks to correct the errors in software maintenance as soon as possible, without reviewing the potential risks or the change effect to another component in the system.

This model is appropriate in the short term because the problems are solved quickly, but in the long term it is expensive because they damage the structure of the system. So, depending on quickly modifying the model in the maintenance process will affect the structure of the system, and also the structure for maintainability. Moreover, the documents get updated often after fixing errors if there is time.

Figure 2.7 shows the process of software maintenance at quickly modify model.
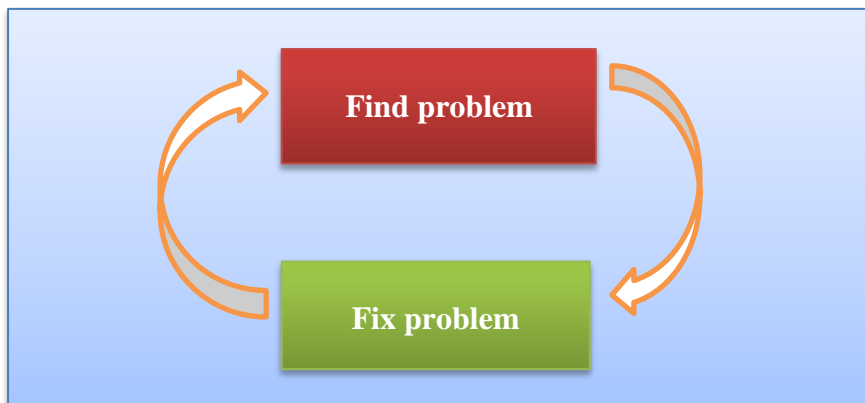


Figure 2.7: Quickly modify model.
 Source: Grubb and Takang (2003, p.70).

Usually, this model occurs when there is no time to review the documents or delay in solving problems affects the business process of the organization. Indeed, it is an unreliable model, especially in software maintenance. Also, the documents are updated and often after fixed errors if they have time.

## 2.6.2 Iterative- Enhancement Model

According to Basili (1990), Iterative – enhancement is used in an environment where the system is not understood and the developer does not have more knowledge about the system.

The model assumes the system has a completed and consistent set of documents describing the system. Also, the organization can analyse the exist system.

The phases of the proposal model have similar phases to the software development model but it is suited to software maintenance (See Figure 2.8). The documents are updated directly after updating any phase in the Software Maintenance Life Cycle (SMLC).
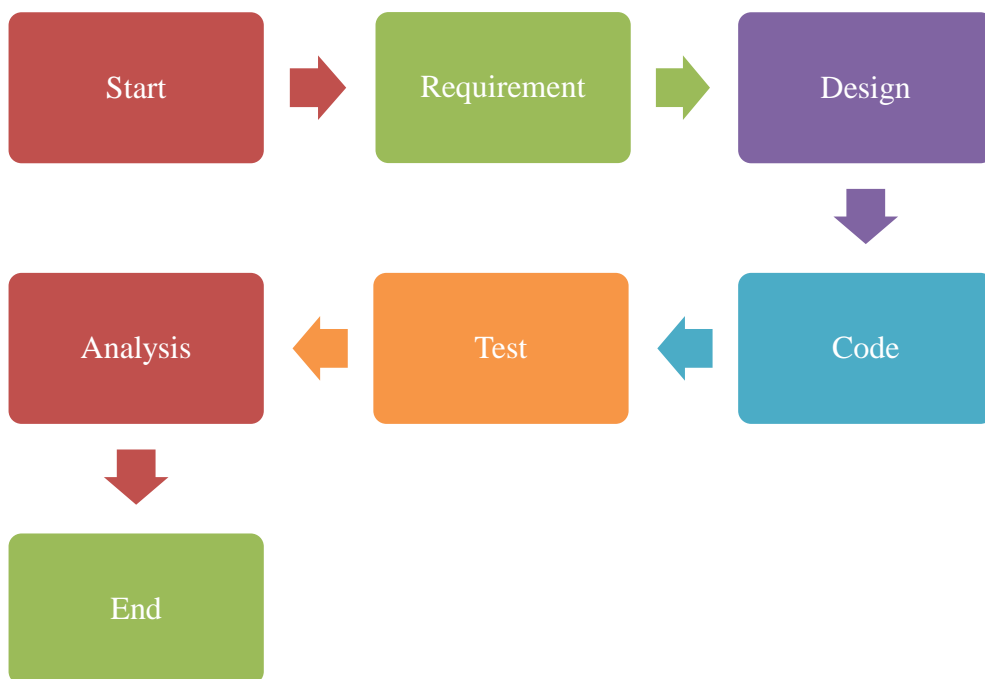


Figure 2.8: Iterative- enhancement model.

 Source: Basili (1990, p.20).

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## 2.7 Software Maintenance and Software Development

The development and maintenance are closely connected; usually, the developers prepare for the software maintenance when they are developing the product.

Chapin et al. (2001) define "development" as creation of the software from scratch, starting through the software life cycle from the initial requirement phase until the software is released. Grubb and Takang (2003, p.6) define maintenance as "*the act of keeping an entity in an existing state of repair, efficiency, or validity to preserve from failure or decline*".

On the other hand**,** the process of software maintenance as previously defined starts after delivery of the software product and continues to the end, until the software is made redundant by the end user.

Mikkonen and Systä (2014) report that despite the fact that maintenance consumes approximately 70% and the development 30% from the budget of software projects, there is a strong relationship between developing and maintaining the software, and it is impossible to separate them. Niessink and Van Vliet (2000) state that there is a difference between software maintenance and software development from a service point of view, and it is important for the IT department to know the target for each one. Software maintenance is service related to any tools providing service to software, whereas software development seeks to develop a product and any tools and functions related to developing software. Service quality is assessed by two facts: the output of the service and, the method of service delivery whilst the software maintenance starts after the software is developed.

On the other hand, Robillard et al. (2007) state that there are different processes between software maintenance and software development as in the maintenance process we require activity processes, which are not used in the development process. Maintainers in software engineering need to understand the existing system and analyse it in depth, so that they can improve the software product.

However, (Chapin, 2000; Kajko-Mattsson, 2000; Chapin et al., 2001) concluded that we cannot ignore the relationship between development and software life cycle to define maintenance. They have some similarities in their scope, understanding process and categories of maintenance.

Chapin (1999), states that by planning to apply software maintenance the early phase in the development phase of software lifecycle could help to reduce the cost and time for software

maintenance, and also improving the maintainer's skills can improve the quality of maintenance work. Furthermore, Sommerville (2007) argues that changing the system after delivery is expensive because the maintainer spends a lot of time understanding the system, and to analyse the impact and effect of the change request. Therefore, planning for the maintenance early in the development phase can reduce the time consumption to understand the system in the maintenance phase. Moreover, using software engineering techniques like object oriented and configuration management leads to reduction in software maintenance costs.

On average, the cost of software maintenance is about 4 times that of the development cost (Yongchang et al., 2001; Islam and Katiyar, 2014).

Sommerville (2007) states that there is a strong relationship between the development phase and the maintenance phase. Giving more attention and expending more effort in the development phase produces a maintainable system. Figure 2.9 shows how development cost decreases the maintenance cost. System 1 uses an extra $25.000 to make the system more maintainable. The result from two scenarios in system 1 and system 2 shows a saving of $100.000 in maintenance costs over the lifetime of the system. That shows that giving more attention to making a maintainable system in the development phase could bring about a decrease in time and cost to maintain the system in the future.
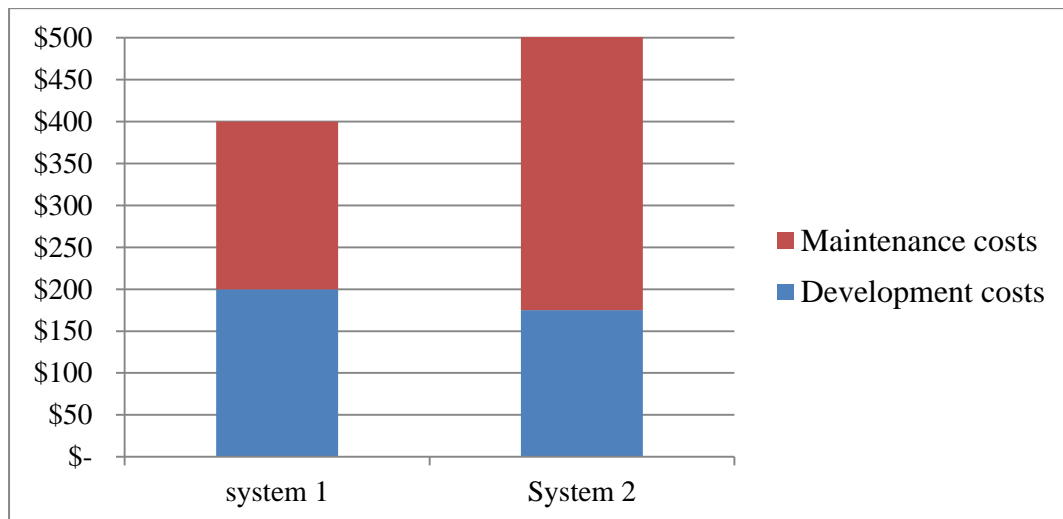


Figure 2.9: Development and Maintenance cost

Source: Sommerville (2007, p.495)

Based on the dissection above, there is a strong relationship between software development and software maintenance, while the average cost of software maintenance is about 4 times the cost of development. Indeed, planning early in the development phase for software maintenance will reduce the effort, time, and cost of software maintenance during the software lifecycle (SDLA).

## 2.8 Software Maintenance Cost

Many scholars mention about the high cost of software maintenance during the software lifecycle (SDLS). According to IEEE standard the three primary elements, which relate to increasing the cost of software maintenance, are documentation, communication and coordination, and testing (IEEE Std, 1998).

Al-Najjar (2007) report that, the greatest challenge facing the software organisation is the high cost of software maintenance, and he described maintenance as the "necessary evil". In general, maintenance has been regarded as a cost centre. Also, Stojanov et al. (2013) and De Guzmán et al. (2015) stressed that the software maintenance phase is the most time and cost consuming in the software lifecycle (SDLS).

On the other hand, Li et al. (2010), argue that the amount of software maintenance work varies from one company to another and between two projects in the same company as well. Moreover, improved process classification schema to classify defects could reduce the effort of the maintenance. They also concluded that most of the costs were influenced by the size of software, complexity of the system, domain knowledge, tools, processes supporting software maintenance, and maintainers' experience.

Floris and Harald (2010) reported that the cost of software maintenance increases yearly, starting around 40% in the year 1970 and reaching 90% in the year 2009, showing that main software systems become hard to maintain over time. Figure 2.10 shows the cost of software maintenance between the years 1970 to 2009.
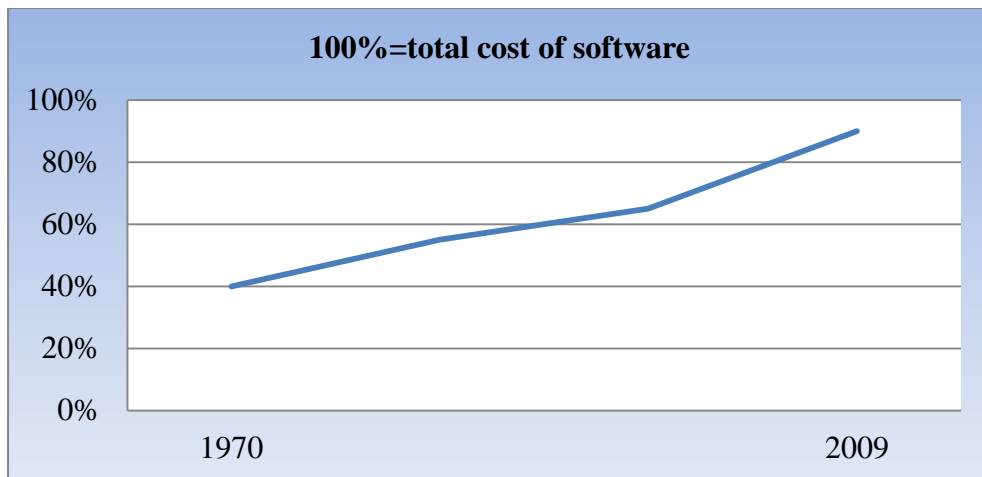
Figure 2.10: Development of software maintenance costs as percentage of total cost.

Source: Floris and Harald (2010, p.1).

On the other hand, Dehaghani and Hajrahimi (2013) reported that the whole life of the software mainly includes two phases: phase one is production and phase two is maintenance. Indeed, maintenance consumes the largest portion of the budget of software, consuming 90% of the whole budget. Meanwhile the knowledge of factors influences software maintenance, helping to reduce the cost of maintenance by controlling the factors. Moreover, Islam and Katiyar (2014) stressed that software maintenance costs 90% of the budget of the software project. Also, Prodan and Prodan (2014) report that the software maintenance phase consumes between 50% to 80 % of the total budget of the software project.

### 2.8.1 Software Maintenance Cost Estimation

Islam and Katiyar (2014) stressed the significance of accurate cost estimation in software project can be used to determine what resources are required and used in the project. Also, it can more easily manage the real resources used in the project.

Estimating the cost of software maintenance is very important in organisations to avoid high costs of software maintenance in the future. It is one of the biggest problems and one of the most costly areas connected with computers, for example Nokia company, spent around 75 million Euros solving computer problems for Y2K (Nasir and Abbasi, 2010).

Islam and Katiyar (2014) developed software maintenance cost estimation models, and these models help to improve the impact of maintenance cost factors, through controlling the factors influencing software maintenance and leads to increasing the cost and impact in the

software maintenance process. The developed model is based on COCOMO II model and uses fourth generation language environment.

## 2.9 Why is Software Maintenance Required?

Singh and Tripathi (2015) report that as software grows in size the complexity and the challenges in maintaining the software increase too. Large size software includes many functions and many users will use the software, so that is increase the effort at the maintenance.

Nasir and Abbasi (2010) report that the high cost of software maintenance is the major problem facing any software development and maintenance organisations, and they also stressed that a good software maintenance process leads to reducing the cost of software maintenance and making it more easily manageable through controlling the factors that affect software maintenance tasks. However, maintaining software is not an easy task, as it requires more attention from the management system in the organisation.

Islam and Katiyar (2014) argue that a long-life system needs more maintenance than a shorter one. In a short life span system we can ignore the some errors in the system but in a long-life span system we cannot.

Further, Grubb and Takang (2003) state that the maintenance activities aimed to keep a system in operation include fixing bugs, recovering from failure, and dealing with changing operating system and hardware.

In this respect, Abran et al. (2004) indicate that the major reasons to conduct the maintenance process is to ensure that the system continues working without any bugs, and to ensure that the system achieves user requirements. Maintenance must be performed in order to:

- Correct faults and bugs;
- Improve and enhance the design;
- Implement enhancements;
- Interface with other systems (internal or external);
- Adapt system so that different platforms, hardware, software, system features, and telecommunications can be used;
- Migrate legacy software; and
- Retire software.

Moreover, Bennett and Rajlich (2000) confirm that the maintenance is very important for all software applications for many reasons:

- The change and modification of software must be reliable and quick, otherwise the business opportunities could be lost.
- Change and modification of software is required over the life of the business system.

Similarly, Midha et al. (2010) report that the software maintenance is required for four reasons, which are: to fix bugs, to add new features in the system, improve performance of the system, and/ or to adapt to a changed environment. Further, changes in environment support (hardware, network) affect software and lead to changing the software to fit with the changing in the environment (Ren et al., 2011).

Zhang and Versteeg (2013) argue that in almost all software organisations the most important activity in maintenance is bug fixing. The possibility to predict bug-fixing time can help to estimate maintenance effort and improve the maintenance services in software projects.

From the previous discussion, we can summarise the reasons for doing software maintenance as below:

- To ensure that the system continues to work without errors;
- To correct faults and bugs;
- To adapt the system in a new environment;
- To change hardware, software, or/ and operating system; and
- To add new functions to the system.

On the other hand, Cortellessa et al. (2015) reported that managing software after deployment is very complex due to the changes in requirements after launching the software. So, software maintenance is not just fixing bugs in the system, but includes new requirements in the system.

## 2.10 Source of Problems in Software Maintenance

Islam and Katiyar (2014) reported that there are different types of application areas, and the software application is affected by the characteristics of the area of work. April and Abran (2012) stressed that software maintenance is not just a technical issue, but one that needs better management input from the organisation/ company managers. Indeed, the main source of problems in software maintenance can be summarised in a single clause that is most

software organisations do not have any defined processes for software maintenance activities in their works. Also, he added that for the last forty years many software process models have been provided and suggested but none of them have been widely accepted as yet.

Furthermore, Polo et al. (2002) indicate that the problems of software maintenance are coming from the management process (managerial processes) and technical process. Furthermore, most organizations do not systematically and consistently maintain a system. Also, most companies use big application systems written in old language like COBLE/CICS, DB2 and it is difficult for unqualified persons to use the code, due to the complexity of the language. Ren et al. (2011) divided the factors that affect software maintenance into two groups: technical factors (integrity of maintenance, adaptability maintenance, etc.) and non-technical factors (application experience, staff stability, support environment, etc.).

Regarding the source of problems in software maintenance, Benaroch (2013) noted in his study that the software maintenance is affected by two issues; the first one is system attributes like size of the system, age, etc., and the second attribute is personal attributes like number of maintainers, location, etc. He further argues that the personal attributes are more significant in software maintenance activities.

Moreover, Islam and Katiyar (2014) discuss the term "Technology Newness", reporting that technology rapidly changes and these changes increase the potential risks in software maintenance through increasing the effort in software maintenance to keep the system up-to-date with new technology.

## 2.11 Factors Affect Software Maintenance

Pahl (2004) reported that the reason for changes in software might be internal factors or unexpected external factors. Maintenance is very difficult, because there are many factors (internal and external) that affect software maintenance (Mamone, 1994; Sherer, 1995; Niessink and Van Vliet, 2000; Bennett and Rajlich, 2000; Polo et al., 2002) including:

- Lack of documentation, sometimes software was updated without updating the documentation.
- System not designed for maintenance or modification.
- Problems with the code itself; it is difficult to track an unfamiliar code.

- The software maintenance depends on the language, which a programmer used to programme the system; high-level language is easier for the maintenance and tracking of bugs in the code.
- Lack of qualified people who worked in the IT sector.
- Lack of communication between employees and management.
- Poor knowledge about the nature and process of software maintenance, both at user and maintenance engineer level.

According to Sommerville (2007), many factors affect the software maintenance process and help in increasing the cost and complexity in software maintenance. Some of these factors are:

- Software development stability: the development team after finishing the development of the system work on the new system. The maintenance being transmitted to another team, which does not have any background about the system also needs more time to understand the system.
- Maintenance staff skills: often staff are unfamiliar with the system domain and sometimes cannot deal with the old system, which was written in old languages.
- Contractual responsibility: sometimes the company using software makes a contract to maintain the system separately with the system development contract. So, they face problems in maintaining the developed system, increasing the effort to understand the system and increasing the maintenance cost.
- Programme structure: sometimes the systems have been developed without using software engineering techniques. Also, they have a lack of system structure and documentation, which cause difficulty in understanding.
- Programme age: sometimes, taking a long time to finding the right versions of system components to change. This is because old systems have not been subjected to configuration management.

Moreover, Sommerville argues that the first three reasons above have faced the organisation when considering the development and maintenance systems as separate activities.

On the other hand, Singer (1998) has outlined some important points about software maintenance that focus on work practices in organizations to improve the effectiveness of software maintenance, five "truths" which contribute to maintaining the system:

- Software maintenance engineers and employees are experts in the system they are maintaining.

- The source code is the most important resource of information about the system. Hence, if the source code of software is available, we can dispense the consultation of another person to aid the maintenance. Moreover, Niessink and Van Vliet (2000) reports the existence of more than 100 billion lines of code in the world. Approximately 80% of them are unstructured, patched, and poor documents. Also, to guarantee continuous operation of the system, we must make sure some tasks are done like correcting errors (system must be free from errors), meeting the requirements of the users, and fitting with the environment change.

- Documentation of changes/ needs is crucial to succeed with software maintenance and for understanding the system in the future. Problems occur when the software is updated without updating the record/ documentation.

- Maintenance control systems are very important for the organization and the user, and they allow users to track the changes in the system when there is a change in software version, and serve as important information to organizations about bugs and errors.

- Reproduction of problems and/ or problem scenarios are important resources for solving problems- scenarios, leading to better understanding of the problems and of the code. A thorough understanding of the code makes it easier to resolve technical software problems.

### 2.11.1 Factors Affecting Software Maintenance Related to Human Resources

An organization maturity term refers to the level and the quality of the organization. High-level organizations have expert teams and seek to improve the skills of staff to deal with development and maintenance of the system (Islam and Katiyar, 2014). Despite advances in technology and major shifts in the economy, human resources remain an organization's most valuable resource (Saraswathy et al., 2011).

Foster (2014) stressed that in any organisation human resource management is the most important management and human resource management in information technology gives the same attention and support as in any other organisation. People who work in the software project require people to administer it, they need someone to direct the employees in the

work and to organise the work in the IT directorate such as employees backup, maintenance tasks, and distribution of tasks between employees.

In respect of human attitude, the motivation of the maintenance team in the work helps to deliver better results in the software maintenance. Actually, the "*maintainer must build a good relationship with all suppliers and manage them professionally to achieve satisfactory performance*" (Nasir and Abbasi, 2010. p.2).

However, Kalboneh et al. (2015) reported that availability of skills and experience of employees are one of the challenges that face the Jordanian industrial companies in adopting e-commerce. (cf. 6.1)

### 2.11.1.1 Expertise in Software Maintenance

ISO/IEC 14764 (2006, p.38) states that "*the two most popular approaches to estimating resources for software maintenance are the use of parametric models and the use of experience*".

Swanson and Beath (1989), point out that the basic problem in software maintenance is the lack of qualified and experienced staff. One third of the people doing maintenance are students and two-thirds are new appointees without experience. Moreover, Pigoski (1996) confirms that between 60% to 80% of new staff appointments have no experience. Also, many organizations assign huge numbers of people to solving problems in maintenance, and unfortunately, those people are not qualified and work without documents, so exchange of and tracking systems become more difficult and takes more time, and the problem is magnified when they leave the companies or the maintenance department (Polo et al., 2002). These studies are all more than twelve years old, and no doubt this field has made great strides in improvements since these findings were made.

Sneed and Opferkuch (2008) showed that software maintainers' experience is very important in software maintenance and plays an important role in reducing the time, effort, and cost for software maintenance. Often, there is a lack of clear practice and domain knowledge so poor technical expertise in software maintenance leads to increased errors and more likelihood of new errors, which then affects the development of software maintenance. In order to improve efficacy of software maintainers, there should be more software maintenance training in this industry.

Furthermore, Islam and Katiyar (2014) affirm the significance of experts in software maintenance work, noting that the experiences of employees in software maintenance positively affect maintenance activity.

On the other hand, Rashid et al. (2011); Ren et al. (2011) and Pagano et al. (2012) noted that keeping the original developers who developed the system to do maintenance of the same system leads to fixing errors and/ or changes in the system more quickly and that leads to reducing the cost of the maintenance. (cf. 6.1.1)

**2.11.1.2 Skills of Employees**

Galar et al. (2011) and Agrawal et al. (2012) stressed about the significance of training activities to develop employees in software maintenance. The HR plays an important role in the success of the software projects. So, the senior management should make sure the employees have requisite knowledge and skills required to do their job (Agrawal et al., 2012). Moreover, Nasir and Abbasi (2010); Islam and Katiyar (2014) stressed that one of the factors affecting software maintenance is a lack of understanding the system in the software maintenance team. To avoid this problem the maintainer must know how the system works and developed before starting work. Indeed, the maintainer uses the majority of their time understanding the system before starting work.

Colomo-Palacios et al. (2013) reported that the quality of the software product and the services depend substantially on the knowledge and skills applied by software engineers at work. At the same time, human aspects are one of the main problems facing the software engineering industry. Indeed, inefficiencies in software product and service come from a lack of adequate software engineers'.

April and Abran (2012) noted that there is a lack of training plans from management to employees who work in software maintenance. Training is considered very important for employees to improve their skills and knowledge in the field of work. Indeed, the training should be about understanding the software adopted in the organisation and how to maintain it.

According to Agrawal et al. (2012) and Islam and Katiyar (2014), the software maintenance team plays an important role in software maintenance activity. So it requires a lot of training in the field of software products and maintenance to ensure they are familiar with the software and how to maintain it. It is very difficult for the maintainer to maintain a system,

which is developed by another person, so to solve this problem the maintainer must understand the structure of the system and the functionality of the system before starting to maintain the system. Moreover the operator users must have full training about using the system before dealing with the system to avoid any errors in use and unsatisfactory experience from the user (Nasir and Abbasi, 2010). (cf. 6.1.2)

### 2.11.1.3 Employees Turnover

Colomo-Palacios et al. (2013) stressed there is a lack of established careers in software engineering. Yang et al. (2008) report that the turnover and expertise play an important role in software maintenance and productivity. High turnover rate tends to slow down software maintenance productivity, and they recommended addressing these factors when making planning decisions. Moreover, knowing these factors help project managers to make distribution effort plans more reasonable. Furthermore, the turnover of employees increases the effort and cost of software maintenance (Islam and Katiyar, 2014).

Floris and Harald (2010) emphasised the effect of people leaving or retiring who have a strong knowledge and experience of the system of software maintenance for this further increases the cost of software maintenance in that new people have to be trained. Moreover, systems tend to become increasingly complex.

On the other hand, Rashid et al. (2011) observed that there is a high employee turnover within the IT support department in the organisation. This leads to greater challenges in software maintenance activities. (cf. 6.1.3)

### 2.11.1.4 Domain Knowledge

According to Pigoski (1996) and Pfleeger (2001) (cited in Anquetil et al. 2007), there is an increase from 40% to 60% of software maintenance effort used for understanding the system. Also, Koskinen et al. (2004) report that software maintainers need useful information about the software before starting maintenance to avoid side effects occurring from changes in the software. It is recommended that the information the maintainers need should be decided beforehand so as to collect that information before starting maintenance.

Serna and Serna (2014) acknowledge the significance of knowledge management in making software maintenance easier and facilitating work software maintainers. They stressed the importance of having a method to detect existing sources and their location in the company.

Anquetil et al. (2007) affirmed that most challenges in software maintenance are the lack of domain knowledge. The knowledge should include comprehensive information about the system such as the software process used, technical detail of programing language(s) used in the application, system architecture, the way the system interacts with its environment, how the portions of the system fit together, how the system integrates with another system, requirements of the system, and requirements for updating the system and any information that helps in software maintenance in the environment. The knowledge comes from multiple sources such as documents, experience, and source code. Lack of knowledge increases the cost and complexity of the software maintenance; it also increases the effort in understanding the system. Indeed, the problems with domain knowledge worsen when employee turnover increases. Therefore, they suggest that the model to save knowledge is useful in the software maintenance. The suggestion is based on gathering all information about the software and techniques to solve the problem of lack of knowledge in software maintenance.

Grubb and Takang (2003) state that the lack of domain knowledge affects the software maintenance. The lack of domain knowledge may mean the maintainer/ programmer make changes to software without knowing the effects on other portions of the system (the ripple effects). The problems are compounded when the documents are incomplete or non-existent. (cf. 6.1.4)

**2.11.2 Factors Affecting Software Maintenance Related to Organisational Environment**

**2.11.2.1 Management**

In the maintenance phase the major aim is to provide cost-effective software during the time of running the system. Quality and productivity are the responsibility of management, hopefully allowing for greater efficiency and increased business profits (Canfora et al., 2000).

El-Khalili and Dema (2006) report that management is a key success factor in any software development process. Moreover, the maintenance management plays an important role in the monitoring of business activities (Kamsu-Foguem, 2014). (cf. 6.2.1)

Thayer (1997) and Weihrich (2000) put forward five functions of the management as shown in Figure 2.11. The functions are planning, organizing, staffing, leading, and controlling.

- Planning: selecting missions and vision to achieve the goal of the organization as well as making decisions of types of activities required to achieve missions and visions and making predictions about the future.

- Organizing: the function of the management is to identify the intentional structure role for people to fill in an organization to achieve her goal. This aids in determining the responsibilities and needed authority.

- Staffing: planning for career and giving more attention to the workforce in the organization to increase the efficiency through training, improving knowledge and skills.

- Leading: working environment and assessing the motivation of people to achieve organization goals.

- Controlling: the measuring and correcting of activities to ensure that they meet the goals and improve the plans of the organization.

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                          ┌──────────────┐
                          │  Management  │
                          └──────────────┘
   ┌──────────┬──────────┬───────┴───────┬──────────┬──────────┐
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│Planning │ │Organizing│ │Staffinig│ │ Leading │ │Controlling│
└─────────┘ └─────────┘ └─────────┘ └─────────┘ └─────────┘
```
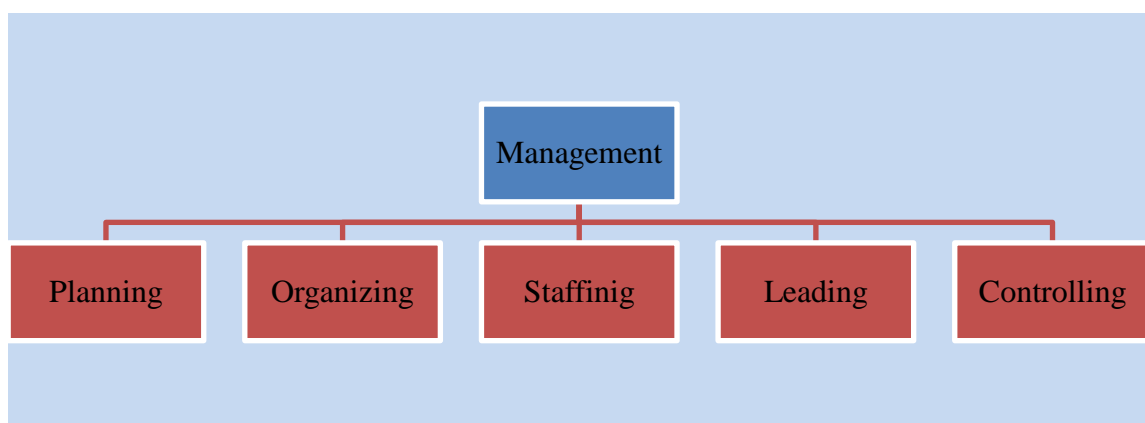
Figure 2.11: The function of project management

Source: Chang (2002).

### 2.11.2.2 Collaboration between Team Members

Gupta and Fernandez (2011, p.185) state that, "*while advanced collaboration tools are available in the market, feedback from organizations suggests a suboptimal use and insufficient value leveraged from these tools. Collaboration between team members in software projects is essential for ensuring the team meets all its goals.*"

Similarly, Fagerholm et al. (2014) report about the significance of the software team working in the software environment. Improved performance of the team in the overall development process requires integration of team spirit, team identify, and communication between the team. Further, Wei et al. (2014) in their study observed that, social presence and politeness tactics help to build and maintain strong relationships among group members in the work. Moreover, Lanubile et al. (2010) stated that people play an important role in the software engineering industry. So, software engineering involves people collaborating to develop better software. Collaboration becomes difficult especially across time zones and without face-to-face meetings with people in the software engineering industry. Therefore, information technology (IT) human resources are gaining importance in today's changing and more and more competitive environment (López-Fernández et al., 2010).

On the other hand, Gewaltig and Cannon (2014) noted that often new software is developed quickly by individuals or small teams. So in these cases, there is the potential of failure to achieve the requirements and it is hard to pretend that the results of software are right. (cf. 6.2.1.2 and cf. 6.2.1.3)

### 2.11.2.3 Standards in Software Maintenance

There are different types of application areas, and the software application is affected by the characteristics of the area of work. Moreover, whenever there is complexity in interfacing of the components in the system maintenance becomes more complex and more expensive (Islam and Katiyar, 2014).

Today, software has become larger in size and more complex. Large size of software requires great teams of specialised people to build the software. Standards therefore are necessary in order to determine common approaches. Furthermore, a standard allows harmonisation practices among different countries. Standards include language, documentation, methods, test plans and error reporting (Rata, 2014). Moreover, April and Abran (2012) reported that it is necessary to use standards in software maintenance to improve software maintenance activities. Software maintenance requires specific domains and is sometimes linked to other software organisations, so that it needs specific terminology and standards to communicate to other software organisations. Robillard et al. (2007) argue that the standards are very important to every organization using software to customize its maintenance process.

Indeed, in software engineering there are many standards involved in managing software quality and to mitigate the risk(s) in software maintenance. Standards can help to reduce the

risks in software maintenance, for example ISO 9001 helps organizations to understand the quality process, and ISO/IEC deals with tasks to maintain and develop software products, as previously mentioned standards help to mitigate risk. Table 2.1 shows the standards, which can help mitigate risks in software maintenance activity. (cf. 6.2.2.1)

| Table 2.1: Standards to mitigate risks in software maintenance | |
|---|---|
| Risk Management | Standards |
| **Maintenance activities**<br><br>All activities related to improving or fixing errors in the software, recovering from failure, and dealing with changing operating system and hardware (Grubb and Takang, 2003). | ISO/IEC 12207<br><br>IEEE/EIA 12207<br><br>ISO/IEC 14764<br><br>IEEE 1219<br><br>ISO/IEC 15504 |
| **Product quality**<br><br>The collection of features and characteristics of a product that contribute to its ability to meet given requirements (Robillard et al., 2007). | ISO/IEC 15939<br><br>ISO/IEC 14598<br><br>ISO 9126 |
| **Organisational**<br><br>Mean organizational structure used by an organization (ISO/IEC 90003, 2014). | ISO 9001<br><br>ISO/IEC 90003<br><br>SAE AS9100 |

Source: Robillard et al. (2007, p.683).

**2.11.3 Factors Affecting Software Maintenance Related to Software Characteristics**

**2.11.3.1 Documentation**

Nanz (2011) defines documentation as written description that has an official status or authority and may be used as evidence. Poor documentation leads to increasing the errors and reducing efficiency in every phase of software products.

Moreover, April and Abran (2012) emphasised about the significance of use of documentation by the maintainer in their daily work, as it should be complete and up to date.

According to Garousi et al. (2015), software documentation is very important in software development and software maintenance tasks. Software documentation is classified into two categories: technical documentation or non-technical documentation. In general, the type of documents used in development or maintenance phases depend on information practitioners' needs.

One of the greatest challenges faced by the maintainers when maintaining the software is the lack of up-to-date documentation (Dean and McCune, 1983).

Moreover, Grubb and Takang (2003) state that the software is often modified without updating the documentation or it is not existent. The major problem is when the maintainers are maintaining programmes written by others.

Lo et al. (2008) argue that challenges of software maintenance are in updating the documents synchronously with the updated software. Ignoring the updated documents causes difficulties in software understanding, which account for up to 50% of software maintenance budget (Canfora and Cimitile, 2001). Also, Floris and Harald (2010) emphasised that lack of or incomplete documentation leads to spending a lot of time of the maintainer to understand the system maintenance. Also Ren et al. (2011) report that documentation helps the maintenance team to understand the system and review the system when they need to update or fix the bugs in the system, so if the documentation is not clear that means more effort will be taken up by the maintenance team and that leads to increasing the cost of maintenance.

Das et al. (2007) state that the documentation plays an important role in understanding the software. Improving the documentation will inevitably have an effect at the maintenance level. Also, it aids in reducing the time for fixing the errors and bugs when they occur in the software system. "Documentation" in context is defined as including anything written down

about a software system, which includes source code, communications, graphs, reports, notes, comments, and formal documentation. Indeed, useful documents should be updated (up-to-date) and contain anything helping to give information about software systems. Moreover, Islam and Katiyar (2014) argue that one of the most important factors in software maintenance is the quality of documentation. Lack of documentation leads to increasing the effort in software maintenance in tracking the errors in the system, and thus increases the cost of software maintenance. Documentation is the most important subject in software maintenance, especially when doing maintenance in legacy systems. The maintenance team loses a lot of time in the system to understand the structure of the system if there is a lack of documentation (Nasir and Abbasi, 2010).

On the other hand, the study of Lethbridge et al. (2003), reports that the maintainers often update the software without updating the documentation and do not maintain documentation. Yet, online comments are often good enough to greatly assist detailed maintenance work. Also, the study suggests that architecture and abstract documentation information is often valid without needing the updating of whole documents. Furthermore, sometimes too much documentation is not useful and results in losing time when tracking the documents and updates.

Arisholm et al. (2006) report that using unified modelling language (UML) in documentation helps the maintainers to make better changes to the existing system and saving time for maintenance. Furthermore, UML is useful when maintainers have not developed the system. Indeed, adopting UML in documentations is useful but they do consume time to update.

Indeed, many fourth generation languages are self-documenting. Poor documentation is likely to be a cause of maintenance difficulties with third generation languages (Islam and Katiyar, 2014).

According to El-Khalili and Damen (2006) study, the study conducted in software development organisation in Jordan showed a few IT employees who review their documents in development and maintenance stages. Also, the documents were not updated when updating or maintaining the product. (cf. 6.4.1.1)

## 2.11.3.2 Programing Language

Islam and Katiyar (2014) reported that one of the factors affecting software maintenance is the programing language; they argued that using fourth generation languages allow software to be developed and maintained more quickly than third generation languages. Moreover, many fourth generation languages are self-documenting. Kohli and Singh (2013) stressed that clones in open source software is easy to build the system and increase the size of the system but it leads to increasing the effort and the cost in software maintenance.

Grant and Cordy (2014) noted that although software maintenance is the last phase in the software life cycle it is the most important phase and it takes the most time. One of the reasons for making maintenance complex is source code fragments. Fully understanding the source code and code fragments helps to avoid new errors arising from misunderstanding code fragments. Furthermore, Islam and Katiyar (2014) stressed that tracking errors in an unstructured code is very difficult and complex while, if the code is built in a structured manner, that leads to reducing the effort in identifying faults. Furthermore, fixing bugs or updating the system are very complex and take up a lot of time from the software maintenance team if the code and architecture of the system are complex (Nasir and Abbasi, 2010).

Midha et al. (2010) point out that the open-source software of the source code affects software maintenance. A complex software project requires a large workforce and resources to modify and maintain. When source code is easy, it is easier to maintain it. On the other hand, when a source code is complex, the maintainers need more time to understand the source code. Indeed, the CASE (Computer Aided Software Engineering) tolls of the software programme are designed to help programmers in a huge system (Islam and Katiyar, 2014). (cf. 6.4.1.2)

## 2.11.3.3 Maintainability of the System

Sommerville (2007) argues that the software product provides service for a business. All software products have attributes affecting and reflecting the quality of software. These attributes are different from one software to another one according to application environment. Therefore, a banking system must be secure, a telephone switching must be reliable, and this applies to all software system. Table 2.2 shows the general attributes of software.

| Table 2.2: General attributes of good software | |
| --- | --- |
| Maintainability | Software should be written in such a way that it may evolve to meet a change. This is a critical attribute because software rapidly changes. |
| Dependability | Software dependability including reliability, security and safety. |
| Efficiency | Software should not use system resource i.e. memory, processor (Cpu) also efficiency includes responsiveness, processing time, and memory utilization. |
| Usability | Software must be usable. That means the user can use the software without any effects of any second part like the designer, and the software should have an appropriate user interface and adequate documentation. |

Source: Sommerville (2007, p.13)

Maintainability of the system means the ability of the system to make changes in a soft and easy manner. The changes are probably adding functionality, or meeting new business requirements, or fixing bugs. Improving the maintainability can increase availability and reduce time and effort in software maintenance process (Mallikarjuna et al., 2014).

Furthermore, Mallikarjuna et al. (2014) stressed about the high cost of software maintenance phase in software life cycle. They reported that the software maintenance phase is the most important and costly phase of the software lifecycle (SDLA), and it plays an important role in quality of software product. The software must achieve the users requirements; if the software does not achieve user requirements then blame goes to the maintenance phase in the SDLC. Also, the software maintainers must have a full knowledge about the software and maintain it before starting work in maintenance to avoid impact on quality factors of software. These quality factors include reliability, reusability, and portability.

Stojanov et al. (2013) stressed that the maintainability of the system is affected by two factors in the project: the maintenance tasks itself and the people that will perform the task. He also classified the tasks into two types: simple task related to two small changes in one model; and the other type is the complex task related to large changes in multi models in the software or requiring reconstruction of the system.

One of the challenges facing the software is shortening the delivery challenge. Achieving the quality in software products takes a long time in software engineering. So, shortening delivery times for large and complex systems without achieving the software quality affects the quality and eases changes in the system in the future (Sommerville, 2007).

Thus, Singh et al. (2009) proposed a fuzzy model that can predict the maintenance level of the software through measuring the factors that affect maintainability, and the input basis on the factors that affect software maintainability. These factors are readability of source code, documentation quality, and understandability of software. Also, the proposed model explained the relationship between these factors and how these factors affect software maintenance. Indeed, knowing these factors and measuring methods can help the organization maintenance to plan in the development stage. Moreover, it aids in developing software that is easy to maintain. (cf. 6.4.1.3)

### 2.11.4 External Factors Affect Software Maintenance

### 2.11.4.1 Software Maintenance and Education

The demand for IT workforce is increasing every year. However, the outputs of the universities do not cover the increasing demand in this area. This means the employees work in the IT sector without having any experience in this area. To reduce the effect of lack of experience in this area we should improve the skills of employees and put them on training courses (Offutt, 2002).

Canfora et al. (2000) argue that institutions deal with maintenance without any strategy. This may explain why students work in software maintenance, and new appointees have no experience. This problem is related to the fact that software maintenance is not taught in many universities. There is now a greater need than there has been in the past for universities to develop software maintenance teaching programs on their courses, and they should focus on the subject of software maintenance and maintainers' skills. There also need to be established global standards for testing the skills and knowledge of software maintainers (Sneed and Opferkuch, 2008).

However, these studies are all more than twelve years old, and no doubt this field has made great strides in improvement since these findings were made. Yet, according to Jardine and Tsang (2013) more recent study, there is still a growing demand in universities, colleges, and

professional persons about courses in maintainability, reliability, and maintainability engineering in the software field. (cf. 6.5.4)

**2.11.4.2 In-house Maintenance**

Ahmed (2006) argues that there is a strong relationship between the source of software product and the source of service maintenance provider.

The biggest challenge for the company/ organization is the in-house maintenance when the product has been developed elsewhere. This should be kept in mind at the software development stage so that it allows for the possibility of in-house maintenance. Otherwise, in-house maintenance consumes a lot of time and IT resources, which means less resources to develop a new application in the company.

Moreover, behavioral parameters play an important role in success or failure of the software project. Therefore, an In-house project manager should take into consideration the behaviour of the people and give them more attention to ensure the success of the project (Nagarajan et al., 2015). (cf. 6.5.1.1)

**2.11.4.3 Outsource Software**

Many authors defined "outsourcing" in different ways; however, the common thing between the majority of definitions is the service between the organisation and external providers:

Some outsourcing definitions are as follows:

Outsourcing may be defined as: "*the acquisition of services from external service providers*" (Grover et al., 1994, p.34). Also, Jiménez et al. (2009, p.2) define outsourcing as *"a means to contract an external organization, independently of its location, rather than developing in-house."*

On the other hand, Koskinen et al. (2015, p.137) define outsourcing as *"using factors which are external to an organization to perform its functions whereas offshore outsourcing relies on using foreign resources to perform those functions."*

In the present research the researcher takes the definition of Jiménez et al. (2009). Outsourcing means adopting software built out of the e-commerce company.

According to Ahmed (2006), many companies use software products, both large and small businesses, in various processes. Several companies outsource the software product to reduce

costs and to improve efficiency, also because the technical resources are scarce in some companies.

One of the major advantages of outsourcing is that the companies are able to focus on efficiency. Many benefits can be obtained from outsourcing this type of work, such as staff availability and skills, expertise, and low prices. Sometimes, companies depend on the outsourced companies to get the software product. One of the major risks of outsourced products is maintenance because reliable maintenance is only possible if the project has put maintenance planning in place in advance, which is not always the case.

On the other hand, Park and Kim (2005) report that there is a relationship between service quality of system and maintenance efforts. The outsourcing does not always reduce the cost of maintenance and cost of information technology. The sourcing, whether outsourced or insourced, does not directly influence the maintenance efforts. From a short–term perspective, outsourcing could have a positive effect, but from a long-term perspective it could have negative effects of system maintenance cost and management. The system age also influences the quality and maintenance efforts.

Mani et al. (2014) repot that the demand for outsource maintenance increases especially in the large applications. The companies tend to adopt outsource maintenance to ensure the system works efficiently, and furthermore in outsource maintenance there is the high possibility of getting high quality maintenance and lower price.

### 2.11.4.3.1 Risk of Maintenance Outsourcing

There are many risks of maintenance outsourcing, which should be addressed in in the project plan (Bennett and Rajlich, 2000; Ahmed, 2006), such as:

- Cost and time over-run for maintenance activities.
- Lack of expertise in company selection.
- Culture mismatch.
- Data privacy and security.
- Low quality work.
- Loss of control.
- Vague maintenance contract requirement.
- Poor communication between organisations and outsourcing company.

Many companies tend to outsource maintenance to reap the benefits and reduce the cost and effort of the maintenance, especially when the consumer company lacks in technical expertise (Jiménez et al., 2009). (cf. 6.5.1.2)

**2.11.4.4 Service Level Agreement**

According to Wu et al.(2014, p. 465), service level agreement is defined as *"a legal contract between participants to ensure that their Quality of Service (QoS) requirements are met and if any party violates the SLA terms, the defaulter has to pay penalty according to the clauses defined in the SLA".* Further, Alhamad et al. (2010, p. 606) define service level agreements (SLAs) as *"agreements signed between a service provider and other party like a service consumer, broker agent, or monitoring agent".*

If the company decided to conduct maintenance via outsourcing, many issues must be addressed in advance before starting the contract of maintenance, such as risk analysis, service level agreement (SLA) and number of outsourcing organizations. If the software product development outsourcing is in a single organization then the same organization is a good candidate for the maintenance of the same project. This practice should be recommended (Ahmed, 2006)**.**

Moreover, Bennett and Rajlich (2000) argue that the major challenge in outsourcing is the lack of relationship between the company using software (software consumer/ software user) and teams of development in vendor/ service company. Furthermore, sometimes there is a lack of initial requirements, and this leads to a lack of understanding about the maintenance needs.

The service level agreement (SLA) should justify the relationship between service company and company using the software product, this aids to reduce the dispute between outsourcing companies and software users.

In addition, McCracken (2002) states that one of the challenges of providers of outsourced service maintenance is the service level agreement (SLA). Approximately 50% of outsourcing companies provide maintenance service with a lack of prototyping and the service level agreement is not clear. The outsourcing companies spend a lot of time (sometimes more than months) to understand and assess the software before making a crucial decision to enter the contractual relationship. (cf. 6.5.2)

## 2.12 Software Maintenance Risk

Lopez and Salmeron (2002) reported that software maintenance projects have many different characteristics to other types of engineering projects. These specific characteristics may increase the errors and faults in the software project. Consequently, that means the success of the software maintenance project is not guaranteed. So, it is recommended that the risks are identified and monitored in the software maintenance process of the project before further risks occur. Furthermore, identifying risks in categories will help the software engineer to deal with the risks and avoid it in the future in the same project.

On the other hand, IEEE Std (1998) illustrates that the failure in software maintenance can be product (i.e. errors in functional or testing) or process (i.e. inaccurate estimates in work and time). Risks could be coming from either product or process; thus, poor performance in either case increases cost of software product and maintenance, and also increases risk in the software maintenance project.

### 2.12.1 Risks for Management in Software Project

Sommerville (2007) argues that risk management is very important for software projects to avoid the potential risks occurring in the system in the development and operational phase. He also suggests three categories of risks that help to deal with risks in the software project. These categories are:

- Project risks: the risks affecting the resources and schedule of the software project.
- Product risks: any risks affecting the quality and performance of software products.
- Business risks: the risks affecting the organization developing the software products.

Moreover, the organization environment may affect the project risks; the most possible risks affecting the software project are staff turnover, management change, hardware, change requirements, size of the project, and technology change.

On the other hand, IEEE Std (1998) indicated that to measure a software risk, the following functions should be performed: external exposure identification, structural exposure analysis, and software failure likelihood estimation.

1. External exposure identification: there are two objectives of this function.
   - To determine the factors and actions in the environment outside of the software that affect and can contribute to loss.

- To assess the loss.

2. Structural exposure analysis: the objective of exposure analysis is to discover the source of software faults that can contribute to losses, as defined in the external exposure assessment. Exposure levels to work products can then be assigned, and potential future losses can be estimated.

3. Software failure likelihood: the major objective of failure likelihood function is to predict failure probability from work products, and collect information from the testing process about the failure and the effects on the software products.

## 2.13 Similar Studies

Below are similar studies addressing factors affecting software maintenance. All three studies below seek to address factors that affect software maintenance without proposing any real solutions to deal with these factors. The researcher of this present study, however, aims at addressing the factors affecting software maintenance in e-commerce companies and proposes solutions to reduce the impact of negative factors to give the study more significance.

Here the author will relate to the study of Li et al. (2010), research conducted in two software companies in Norway. The study shows that the size and complexity of software to be maintained, the experience of software maintenance team, and the tool process support are the factors most affecting the cost of corrective maintenance in one company, while the domain knowledge is one of the main factors affecting the cost of corrective maintenance in the other company.

The study of Agrawal et al. (2012) identifies seven human resource management challenges facing the Indian software industry: lack of professional people, the problem of managing and controlling human resources, especially in globally distributed teams, low skills of the people in the work, lack of developed HR systems and processes, high employee turnover, lack of balance between work and life, and the problems of contracting employees.

Dehaghani and Hajrahimi (2013) study was conducted in Isfahan University of medical sciences and hospital function. The study included 15 software programs related to health care centres, and the aim of the study was to identify the factors affecting software maintenance. 32 factors were found that affect software maintenance and they were classified into six groups: project, maintenance project, personnel, product, computer, computer

network. The results of the study noted that the availability of full documentation and follow up maintenance by the designer help to reduce the effort and the cost of software maintenance. The study of Dehaghani and Hajrahimi focused on multi direction in the software project; just one of the six groups found in the study has focused on software maintenance (maintenance project).

## 2.14 Conceptual Framework

Miles and Huberman (1994, p.18) defined a conceptual framework as a visual or written product, one that *"explains, either graphically or in narrative form, the main things to be studied the key factors, concepts, or variables and the presumed relationships among them"*.

Merriam (1998) stress the significance of conceptual framework and theoretical framework in research, and the framework can be considered as a guide in the research. Moreover, she noted that it is difficult to imagine a study without the conceptual or theoretical framework.

The researcher has summarized the most common factors affecting software maintenance in Table 2.3 below. The previous literature related to software and software maintenance mentioned about twenty factors that affect software maintenance in the software engineering industry. To organize the factors five categories were developed, which include and cover all twenty factors. Figure 2.12 shows the main five categories adopted in the present study.

To the best of the researcher knowledge, none of the studies address the problems of software maintenance empirically in e-commerce companies in general, and in Jordan in particular, which the present research seeks to address. Figure 2.13 show the conceptual framework adopted in the present research.

| Table 2.3: Factors that affect software maintenance. | | | | |
|---|---|---|---|---|
| **Category Num #** | **Category** | **Factors** | **Factor Component** | **Related Literature** |
| 1 | Human resources | Human resources | - Lack of employee experience in software maintenance<br><br>- Skills of maintainers<br><br>- Employee turnover<br><br>- Domain knowledge | Islam and Katiyar ( 2014); Serna and Serna (2014);  Foster (2014);  Colomo-Palacios et al. (2013); April and Abran (2012);  Agrawal et al. (2012**);**  Agrawal et al. (2012); Saraswathy et al.( 2011); Galar et al. (2011);  Rashid et al. (2011); Ren et al. (2011); Floris and Harald (2010);  Li et al. (2010); Nasir and Abbasi (2010);  Yang et al. (2008);  Sneed and  Opferkuch (2008) ;  Yang et al. (2008);` Sommerville (2007);  Anquetil et al.(2007); Grubb and Takang (2003); Bennett and Rajlich (2000)  Offutt (2002);  Polo et al .(2002); Pfleeger(2001); Canfora   et al .(2000) ; Chapin (1999);  Singer(1998); Pigoski (1996); Pigoski (1996); Beath and  Swanson, (1989). |

| 2 | Software characteristics | Product quality | <ul><li>Documentation</li><li>Quality of original system (structure, hierarchical).</li><li>Programing language.</li><li>Maintainability of the system.</li></ul> | Garousi et al. (2015); Mallikarjuna et al., (2014); Islam and Katiyar (2014); Grant and Cordy (2014); Stojanov et al. (2013); Kohli and Singh (2013); Dehaghani and Hajrahimi (2013); Ren et al.(2011); Nanz (2011); Desharnais and April(2010); Floris and Harald (2010); Li et al. (2010); Midha et al. (2010); Midha et al. (2010); Nasir and Abbasi, 2010; Singh et al. (2009); Singh et al. (2009); Lo et al (2008); Lo et al. (2008); Das et al. (2007); Sommerville (2007); Das et al. (2007); Arisholm et al. (2006); El-Khalili and Damen (2006); El-Khalili and Dema (2006); Arisholm et al. (2006); Niessink and Van Vliet (2000); Grubb and Takang (2003); Lethbridge et al. (2003); Lethbridge et al. (2003); Polo et al.(2002); Offutt (2002); Canfora and Cimitile,(2001); Canfora and Cimitile (2001); Singer (1998); Sherer, (1995); Mamone(1994); Chikofsky (1990); Schneidewind, (1987); Dean and McCune (1983); Dean and McCune(1983). |

| 3 | Organisational environment | Managerial issues | • Management support<br><br>• Communication with management.<br><br>• Communication with IT staff.<br><br>• Budget of the system and maintenance. | Fagerholm et al. (2014); Gewaltig and Cannon (2014); Kamsu-Foguem (2014); Wei et al. (2014); Gupta and Fernandez (2011); Gupta and Fernandez (2011); Lanubile et al. (2010); Fernández et al.(2010); El-Khalili and Dema (2006); Polo et al.(2002) ; Chang(2002); Niessink and Van Vliet (2000); Canfora et al.(2000); Niessink and Weihrich (2000); Thayer (1997). |
| --- | --- | --- | --- | --- |
| | | Standards and maintenance classifications | • Standard and methodology of software maintenance adopted.<br><br>• Classification of software maintenance problems. | Islam and Katiyar(2014); Rata(2014); Li et al. (2010); Lientz and Swanson ,(1980); Canfora et al. (2000); Abran and Nguyenkim (1993); IEC 12207; IEEE std (1998); ISO/IEC 14764(2006). |

| 4 | Operational environment | System reliability | • Hardware and operating system reliability<br><br>• Environment reliability. | Islam and Katiyar (2014); López and Salmeron( 2012); Ren et al. (2011); Sommerville (2007);  ISO/IEC 14764(2006); Grubb and Takang (2003);  Offutt (2002).   IEEE 1219(1998); |
|---|---|---|---|---|
| 5 | External factors | Source of software application. | • Outsource<br><br>• In-house | Koskinen et al. (2015); Mani et al. (2014);   Midha et al. (2010);   Alhamad et al. (2010); Jiménez et al. (2009); Ahmed(2006);  Park and Kim(2005); Pahl (2004); Grover et al.(1994). |
| | | Service level agreement(SLA) | • Lake of service level agreement (SLA) | Koskinen et al. (2015);   Wu et al. (2014); Jiménez et al. (2009); Ahmed (2006); McCracken (2002). |
| | | Other external factor | • Outcomes of IT students in the university | Jardine and Tsang (2013); Sneed and Opferkuch (2008); Canfora et al. (2000); Offutt (2002). |
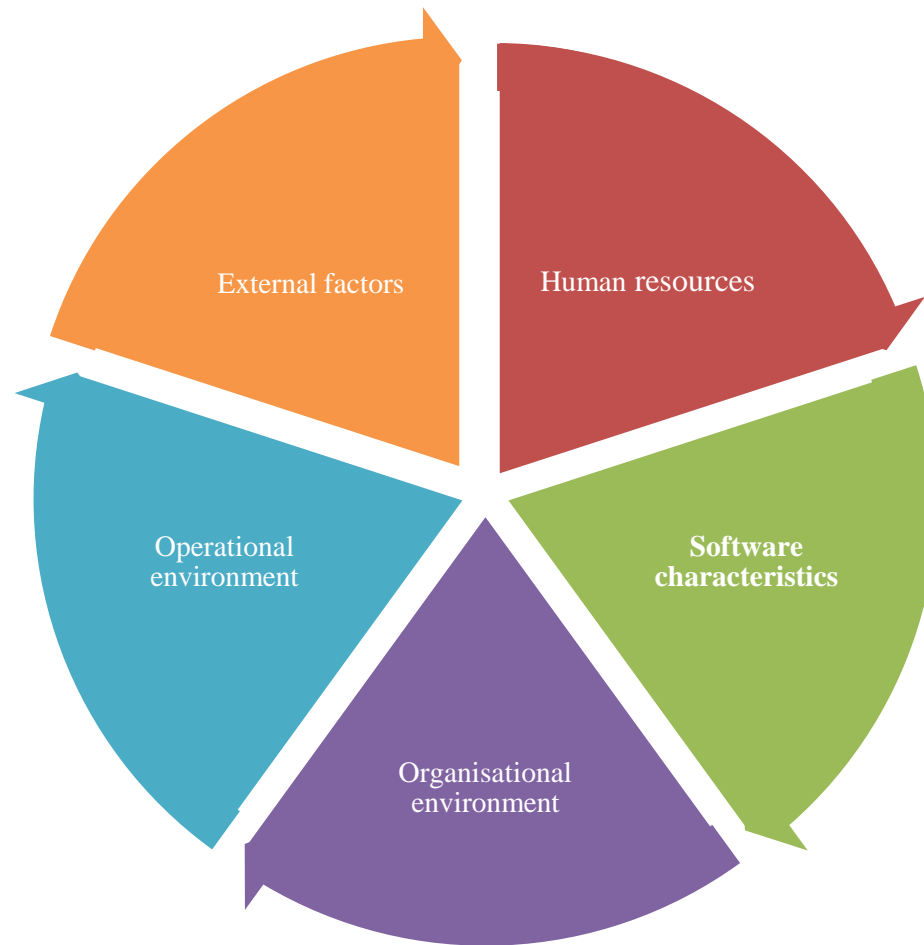
Figure 2.12: The main categories of factors affecting software maintenance.
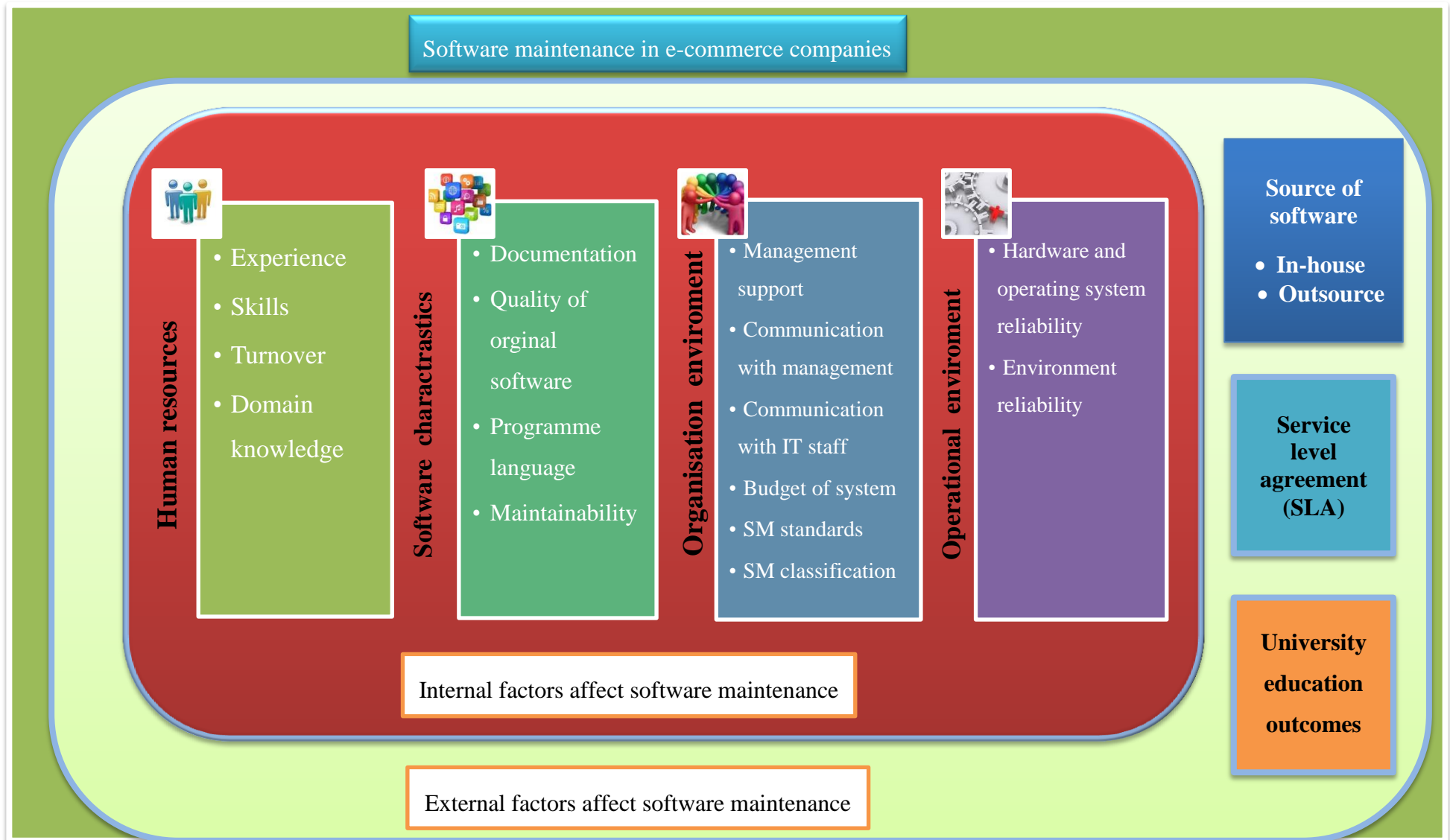
Figure 2.13: Conceptual framework for the study

## 2.15 Chapter Summary

The chapter literature review has discussed the concept, the background, the categories, the need, the model and processes for software maintenance. Likewise, the difference between software maintenance and development has been explained. Also, the reasons of software maintenance have been discussed. Furthermore, the chapter explains the structure of web-application. The factors that affected software maintenance have been discussed as well in depth. The chapter also presents and explains the conceptual framework of the study. The next chapter will present a background about Jordan where the study is conducted.

# Chapter Three: Jordan Context

### 3. Introduction

This chapter aims to provide some information about Jordan, its formal language, religion, map, population and education. The background about e-commerce in Jordan will also be presented. In addition, this chapter will highlight the most vital indicators in Jordan: trade, communication, finance and banking.

### 3.1 Background

This section will provide a background about Jordan, its official language, religion, currency, area, map and population.

### 3.1.1 About Jordan

Officially called the Hashemite Kingdom of Jordan, Jordan is a country located on the east bank of the River Jordan. Almost half of Jordan is covered by the Arabian Desert. Amman is the capital city (Department of Statistics, Jordan, 2013).

In 1945 Jordan gained independence and King Abdullah was crowned its first king. He ruled until 1951. After 1951 and until 1999, His Majesty King Hussein bin Talal ruled Jordan. Until His Majesty King Abdullah II took over on 7th February 1999 (World Atlas, 2015).

One of Jordan's greatest contributors to its economy is tourism. However, it is also renowned for its healthcare, especially within the Dead Sea area. Petra is the most famous and most visited tourist attraction owing to its long history of being founded approximately 1000 B.C. (World Atlas, 2015).

### 3.1.2 Official Language

The official language in Jordan is Arabic and English is the first foreign language (Department of Statistics, Jordan, 2013).

### 3.1.3 Official Religion

The official and the dominant religion of Jordan is Islam (Department of Statistics, Jordan, 2013). Approximately 92 percent of the Jordanian population is Sunni Muslim and 1 percent is Shi'a or Sufi. 6 percent of the population is Christian, with the majority being

Catholic or Orthodox. Other minorities include small Baha'i and Druze contingents (Berkley Center, 2015).

**3.1.4 Official Currency**

"*The country's official currency is the Jordanian Dinar, which is equal to 1000 fils, or 100 piasters. It is available in the form of paper currency of 50, 20 dinars, 10 dinars, 5dinars,1 dinar. Also, it is available in the form of coins of half a dinar categories and quarter dinars and 100 fils and 50 fils and 25 fils and ten fils and five fils*" (Government of Jordan, 2014). The Jordanian Dinar fluctuates; in October 2015 it was equal to 0. 0.93 GBP and equal to 1.41 USD (Currency Converter, 2015).

**3.1.5 The Area**

The total area of the Kingdom is approximately 89.318 kilometres square. Most of Jordan is semi-desert. Jordan relies much on the sparse rain falling over the country (Department of Statistics, Jordan, 2012). Table 3.1 shows the kingdom's area by topography.

| Table 3.1: The Kingdom's Area by Topography. | |
| --- | --- |
| **Indicator** | **Approximate area (km$^2$)** |
| Total Area of the Kingdom | 89,318 |
| Land Area | 88,778 |
| Heights | 550 |
| Plains | 10,000 |
| Rift Valley | 8,228 |
| Badia (Semi-desert) | 70,000 |
| Territorial Waters | 540 |
| Dead Sea | 446 |
| Aqaba Gulf | 94 |

Source: Department of Statistics, Jordan, (2012).

### 3.1.6 Map of Jordan

Figure 3.1 shows the map of Jordan.



Figure 3.1: Map of Jordan

Source: http://www.lib.utexas.edu/maps/middle_east_and_asia/jordan_physio-2004.jpg

### 3.1.7 Population of Jordan

The population of Jordan, according to latest statistics in 2013, is 6.53 million. Table 3.2 shows the population of the Kingdom by sex according to the years 2009 to 2013, excluding Syrian refugees.

| Table 3.2: Population of the kingdom by sex years 2009-2013 | | | | | |
|---|---|---|---|---|---|
| Year | Male (1000) | % | Female (1000) | % | Total in 1000s |
| 2009 | 3082.0 | 51.5 | 2898.0 | 48.5 | 5980.0 |
| 2010 | 3151.0 | 51.5 | 2962.0 | 48.5 | 6113.0 |
| 2011 | 3221.1 | 51.5 | 3027.9 | 48.5 | 6249.0 |
| 2012 | 3293.0 | 51.5 | 3095.0 | 48.5 | 6388.0 |
| 2013 | 3366.0 | 51.5 | 3164.0 | 48.5 | 6530.0 |

Source: Department of Statistics, Jordan Statistical Yearbook (2013).

Indicators about population in year 2013 (Department of Statistics, Yearbook, 2013):

- Percentage urban population of total population in 2013: 82.6 %.
- Population density in 2013: 73.5 Person/Km$^{2.}$

### 3.2 Education in Jordan

"*The philosophy of education in the kingdom stems out of the Jordanian constitution, the Islamic Arab civilization, the principles of the great Arab Revolt and the Jordanian national experience*" (Ministry of Education Jordan, 2015).

The educational stages in Jordan are classified as the following:

1. The pre-school (kindergarten) stage of maximum two year duration.

2. The basic education stage of ten year duration.
3. The secondary education stage of two year duration.

**3.2.1 Universities in Jordan**

The number of public universities in Jordan is (10), besides (17) universities that are private and (51) community colleges. Table 3.3 shows the public universities in Jordan. Moreover the number of students admitted to study the fields of IT at Jordanian universities in year 2013 is 4549; the fields of IT are computer science, computer information systems, networks and software engineering (Ministry of Higher Education and Scientific Research, Annual Report, 2013).

| Table 3.3: Public universities in Jordan | | |
|---|---|---|
| **University** | **Date Established** | **Location** |
| University of Jordan | 1962 | Amman |
| Yarmouk University | 1976 | Irbid |
| Mu'tah University | 1981 | Karak |
| Jordan University of Science & Technology | 1986 | Irbid |
| AL al-Bayt University | 1994 | Mafraq |
| Hashemite University | 1995 | Zarqa |
| AL-Balqa' Applied University | 1997 | Salt |
| AL-Hussein Bin Talal University | 1999 | Ma'an |
| Tafila Technical University | 2005 | Tafila |
| German Jordanian University | 2005 | Amman |

Source: Ministry of Higher Education and Scientific Research, Annual Report (2013)

## 3.3 E-Commerce in Jordan

Abdullah Al-Qudah and Ahmad (2014) reported that the government and the decision makers of Jordan supports and endorses the development in IT in various fields. Furthermore, Terzi (2011) stressed that e-commerce leads to an increase in the demand for IT jobs. Jordan's population is now ready to adopt and use technology. Moreover, the government is fully supporting e-commerce and reducing any of the barriers that face e-commerce. The study of Abbad et al. (2011), which was conducted in Jordan, showed that there are six limitations facing e-commerce in Jordan; they are: security and trust, internet, enjoyment, legal issues, and the use of technology in e-commerce. These findings are based on the views of students who are studying in universities.

On the other hand, the national e-commerce strategy report 2007-2018 (2007) showed that there are number of factors affecting the proliferation of e-commerce in Jordan. They are:

- Lack of a viable electronic payment system;
- The absence of laws that protect consumers;
- A lack of awareness from both consumers and business regarding ecommerce;
- The cost of broadband access and the cost of hardware like personal computer or mobile;
- Arbitrary changes to licenses and taxes that deter e-commerce entrepreneurs; and
- Readiness of IT sector.

Al-Khaffaf (2013) recommended focusing on the study of e-commerce in developing countries in general and specifically in Jordan. Research is needed to understand the factors that affect the e-commerce trend as knowing these factors may lead to improving the country's economy.

Based on the above discussion, the present study will address one of the issues related to e-commerce companies in Jordan and add new a contribution to knowledge by identifying the factors that affect software maintenance in e-commerce companies in Jordan, furthermore, the study seeks to propose a framework to improve the effectiveness of maintenance work and reduce the negative impact on company operation.

### 3.3.1 E-Commerce in Jordan in Figures

His Majesty King Abdullah II Message in scope of IT:

*"It is time to widen the scope of our participation in the knowledge economy from being mere isolated islands on the periphery of progress, to becoming an oasis of technology that can offer the prospect of economies of scale for those who venture to invest in our young available talent"* (Government of Jordan, 2014).

There is awareness among Jordanians regarding the importance of using e-commerce. The number of e-commerce users in 2011 was estimated at around 514,000, which constitutes around 8.2% of the total population of Jordan (Ghazal, 2012).

In addition, the volume of e-commerce in the Middle East and North Africa region is expected to reach $15 billion in 2015 (Ghazal, 2014). The volume of e-commerce in Jordan was $200 million in 2014, and had grown by approximately 30% compared to 2013. Still e-payments comprise only 5% of transactions in Jordan and 95% made in cash. Indeed, more effort needs to be made by several Jordanian banks to encourage the use of e-payments in e-commerce. The top purchases are games, apps and personal items (Ghazal, 2015).

Based on discussion above we can observe that the e-commerce companies in Jordan are growing and investment in e-commerce could improve the economy in Jordan, so the present study will help to improve the e-commerce sector in the field of software maintenance and this will enhance the economy of Jordan.

### 3.4 Trade in Jordan

This section will highlight the main indicators in the internal and external trade of Jordan in figures, according to the indicators in 2012 (Department of Statistics, Jordan Statistical Yearbook, 2013).

### 3.4.1 Internal Trade

**Basic Indicators**

- Gross output: 505031 million JD.
- Intermediate consumption: 1531 million JD.

- Value added: 45235 million JD.

- Compensation of employees: 24232 million JD.

- Taxes on production: 4431 million JD.

- Fixed capital formation: 85.7 million JD.

## 3.4.2 External Trade

**Basic Indicators**

- Exports of goods (2013): 4805.25million JD

- Imports of goods (2013): 15667.3 million JD

- Total of re-exports (2013): 812.8 million JD

- Trade balance deficit (2013): - 10049.3 million JD

- General price index of exports 2013 (1994 = 100): 247.6

- General price index of imports 2013 (1994 = 100): 365.3

## 3.5 Information and Communication

This section contains statistical data about information and technology in Jordan. It also includes indicators and ratio used. Table 3.4 shows the number of subscribers in fixed and mobile phone services in the years 2008-2013 and Table 3.5 shows the distribution of households by the ITC indicators in years 2009-2013.

| Table 3.4: Numbers of subscribers in the fixed and mobile phones services, 2008-2013. | | | | | | |
|---|---|---|---|---|---|---|
| Service | Number of Subscribers (Thousands) | | | | | |
| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
| Fixed phone (land) | 519 | 501 | 485 | 424 | 400 | 378 |
| Mobiles | 5300 | 6104 | 6620 | 7483 | 8984 | 10300 |

Source: Department of Statistics, Jordan Statistical Yearbook (2013).

| Table 3.5: Distribution of households by the ITC Indicators, 2009-2013 (Percentage). | | | | | |
|---|---|---|---|---|---|
| Indicator | 2009 | 2010 | 2011 | 2012 | 2013 |
| Fixed line | 26.0 | 21.6 | 18.5 | 14.1 | 13.9 |
| Mobile Phone | 96.5 | 97.6 | 98.1 | 98.2 | 98.5 |
| Pc or laptop | 54.3 | 56.1 | 61.2 | 57.5 | 48.5 |
| Internet | 18.4 | 21.7 | 35.4 | 47.3 | 56.8 |

Source: Department of Statistics, Jordan Statistical Yearbook (2013).

### 3.5.1 Workers in the Telecommunications

Table 3.6 shows the number of employees who worked in telecommunication sectors in the period 2006 -2012. The total number of employees in the year 2012 was 4596 employees.

| Table 3.6: Developed workers in the telecommunications sector (2006-2012) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Service | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** |
| Fixed line | 2432 | 2303 | 2212 | 2060 | 1958 | 1964 | 1900 |
| Mobile phone | 2251 | 2283 | 2079 | 2296 | 1886 | 1796 | 2143 |
| Internet | 415 | 498 | 644 | 1080 | 830 | 779 | 533 |
| Other service | 294 | 135 | 345 | 320 | 65 | 61 | 20 |
| Total | 5392 | 5219 | 5280 | 5756 | 4739 | 4600 | 4596 |

Source: Telecommunication Regulatory Commission, Yearbook (2012).

**3.6 Finance and Banking**

The Central Bank of Jordan, established in 1964, is the central bank responsible for note issues and the management of exchange reserves (Photius, 2014).

Below are the basic indicators about finance and banking sectors in Jordan in the years 2012 and 2013. This includes number of banks, number of insurance companies and investments in projects (Department of Statistics, Jordan Statistical Yearbook, 2013).

Basic Indicators:

- Number of banks and the monetary firms operating in the Kingdom 2012: 30.
- Number of insurance companies in the Kingdom 2012: 27.
- The volume of local investments in the projects benefitting from the Investment.
- Promotion Law 2013: 796.71 Million JD.
- The volume of foreign investments in the projects benefitting from the Investment Promotion Law 2013: 817.59 Million JD.

**3.7 Chapter Summary**

This chapter has given a background about the context of Jordan. Basically, it provides information about the area, official language, official currency, population, higher education and level of IT in Jordan, and the indicators of development in communication and trade. Also, the chapter provided a background about e-commerce in Jordan; the current situation of e-commerce, the readiness, the attention from the government and decision makers, and e-commerce strategy in Jordan. The next chapter will present in detail the methodology of the study.

# Chapter Four: Research Methodology

## 4. Introduction

"*Although many papers have been published on software development and defect prediction techniques, problem reports in real projects quite often differ from those described in the literature. Hence, there is still a need for deeper exploration of case studies from industry*" (Janczarek and Sosnowski, 2015, p.272).

Methodology refers to a systematic way to conduct research, which includes research philosophy, research strategy, and collection and analysis of data (Saunders et al., 2007). Moreover, research methodology plays an important role in conducting research (Collis and Hussey, 2009).

This chapter is divided into two sections. Section one provides the preliminary study overview, aim, and objectives. Section two provides the research philosophy, approach, strategies, interview protocol, data methods adopted and the method used to analyse the data in this study.

Furthermore, this chapter discusses the justification for choosing the particular research approach, and the philosophy of the study that the researcher adopts to achieve research aim and objective. The pilot studies are described and the interview protocols adopted in the field study are explained. It also discusses the validity, and reliability, and ethics of the study.

### 4.1 Section1: Preliminary Study

### 4.1.1 Preliminary Study Overview

A preliminary study can be defined as: "*Preliminary information is gathered by the researcher to narrow the broad problem area and to define specific problem statement*" (Uma Sekaran and Bougie, 2010, p.50). Indeed, the researcher interviews the manager and employees in e-commerce companies in Jordan to gather information about the problem because this helps to better understand the problem of the study.

The researcher conducted a preliminary study in order to get preliminary data acquisition for the area of study. During the preliminary study formal interviews were made with IT managers and senior management. Through semi structured face-to-face interviews the

researcher was able to get a general idea of the state of software maintenance in the e-commerce companies in Jordan. The researcher concluded from the findings of the preliminary study that there was complex maintenance activity in many of these companies.

The participants showed an interest in analysing and improving their maintenance activities. This led to increasing the researcher's conviction that there are real problems in e-commerce companies in Jordan, which require a deeper understanding.

### 4.1.2 Preliminary Study Aim

The main aim for the preliminary study is to prepare the companies and the researcher for the main study (which is the next stage of this research) and gather information to support the preparation of the plan for the main study.

### 4.1.3 Preliminary Study Objectives

- ➢ Check the availability of the companies for participation in the research.
- ➢ To clarify understanding of the confidentiality need and requirements of the participants, and any other considerations.
- ➢ To explore the major problems in software maintenance.
- ➢ To understand the relationships between the e-commerce companies and other kinds of companies like finance companies that relate to the e-commerce applications.
- ➢ To determine the main types of factors that affect software maintenance in organisations.
- ➢ To discover the source of software application that is used in e-commerce companies.

### 4.1.4 Population and Sample of Study

The initial population is e-commerce companies in Jordan, more specifically six participants (IT supervisors and senior managers) from six e-commerce companies in Jordan with one participant being from each company.

### 4.1.5 Companies Interested in Participating in the Main Study

The researcher has interviewed ten managers in e-commerce companies in Jordan; four companies expressed their apology for not participating in the study for confidential reasons, and six companies were interested to participate in the study.

See appendix 1 for more details about the Preliminary study, the interview questions, analysis data, findings, and conclusion.

### 4.2 Section2: Research Methodology

"*Methodology is a systematic approach or framework that is concerned with the research process from the theoretical foundation to the collection and analysis of data*" (Collis and Hussey, 2009, p. 73).

Research methodology is much more than data collection; it also means the method, and certain techniques the researcher uses to solve the research problem in a systematic way (Kothari, 2004; Saunders et al., 2007). Moreover, Collis and Hussey (2003) state that selection of research methodology should reflect the assumptions of research paradigm. So, that means the methodology of research depends on the problem of research and the aim and objectives, which the researcher seeks to achieve in the study. The next sections will discuss the research model and justification of the methodology adopted in the present research.

### 4.2.1 Type of Research

Hussey and Hussey (1997) and Collis and Hussey (2009) maintain the existence of many types of research that can be classified according to their purpose, process, logic, and outcomes. Below is a presentation of each of these types.

1. The purpose of research: the purpose of research investigates the reasons that motivate the researcher to conduct this research (why does the researcher conduct the research?)
2. The process of research: the systematic way that the researcher adopts to collect and analyse the data.

3. The logic of the research: the logic of research means whether the researcher begins from general observation to the specific (deductive) or from specific observation to general (inductive).

4. The outcomes of the research: what are the expected results, which the researcher seeks to achieve after conducting the research. This might include solving specific problems or making a general contribution to knowledge.

Table 4.1 shows the classification of the main types of research according to the purpose, process, logic, and outcomes.

| Table 4.1: Classification of the main types of research | |
|---|---|
| **Type of research** | **Basis of classification** |
| Exploratory, descriptive, analytical or predictive research. | Purpose of research |
| Qualitative or quantitative research | Process of research |
| Deductive or inductive research | Logic of research |
| Applied or basic research | Outcome of research |

Source: Collis and Hussey (2003, p.10)

Collis and Hussey (2009) categorise the research according to its purpose into four types listed below:

➢ Exploratory research: this type of research is conducted when there are a few or no earlier studies about the problem or phenomena. Essentially, exploratory research aims to look for ideas or hypotheses, rather than confirming or testing a hypothesis.

➢ Descriptive research: it provides a description of the characteristics of the phenomenon as they exist, and attempts to obtain some information about a particular problem.

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- ➢ Analytical or explanatory research: it is a continuation of descriptive research, which aims to understand the phenomena, through analysing and explaining why and how it is happening.
- ➢ Predictive research: this type of research aims to generalise from the analysis by predicting certain phenomena on the basis of hypothesised general relationships.

Furthermore, Cavana et al. (2001) and Uma Sekaran and Bougie (2013) put forward four categories related to the purpose of the study. They recommend the researcher to take into consideration the specific purpose of the research when they choose the appropriate design of the study. The categories discussed by them include:

- ➢ Exploration study: this type of research is conducted when there is little information about a problem, which results from the scarcity of studies on this particular problem. The importance of exploration studies lies in the fact that they give preliminary information about both the situation and the phenomena.

- ➢ Descriptive: it is undertaken in order to describe and understand the characteristics of the variables in a situation known to exist. Moreover, descriptive studies offer some ideas for further research.

- ➢ Hypothesis–testing: this type of research usually explains the nature of the relationships, and enhances the understanding of the relationships that exist between the variables.

- ➢ Case study: the researcher in this approach gathers information in depth about the phenomena. In this approach, the researcher can use a variety of data collecting methods.

Gronhaug and Ghauri (2005) stated that the most common types of research are exploratory, descriptive, and explanatory/causal, and that the type of research depends on the nature of the research problems.

In the present research, the aim is to identify and investigate the key factors that influence the software maintenance relevant to e- commerce companies in Jordan. So, the present

research includes both explanatory and exploratory research. Figure 4.1 shows the classification of the present research according to purpose, process, logic, and outcomes.



Figure 4.1: The classification of the present research

Source: Adapted from Collis and Hussey (2003).

### 4.2.2 Research Model

Saunders et al. (2007) suggested research model describes the process that the researcher should adopt in his research to achieve the research aim(s) through answering the research question(s). Figure 4.2 shows the research model parts, which include philosophies, approaches, strategies, choices, time horizons, techniques and procedures.
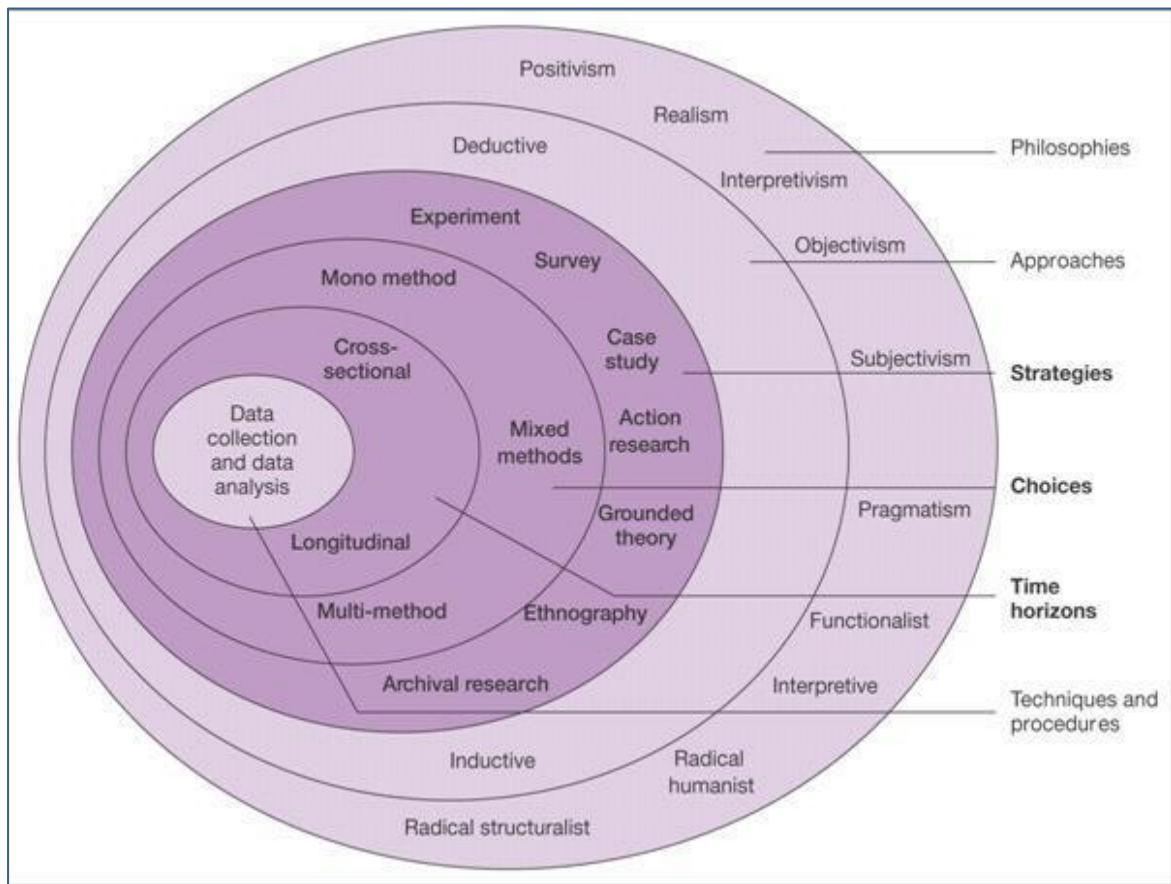


Figure 4.2: The research model.

Source: Saunders et al. (2007, p.107).

To realise the research aim and research objectives, the researcher follows a research framework (Figure 4.3, adapted from Saunders et al. (2007) research model). This framework includes research paradigm, approach, strategies, method adopted to conduct research and collecting data.

Research Philosophy

Research Approach

Data Analysis

Data collection:

- Semi- structured Interviews
- Documents and Archival records

Qualitative

Inductive and deductive

Interpretivism
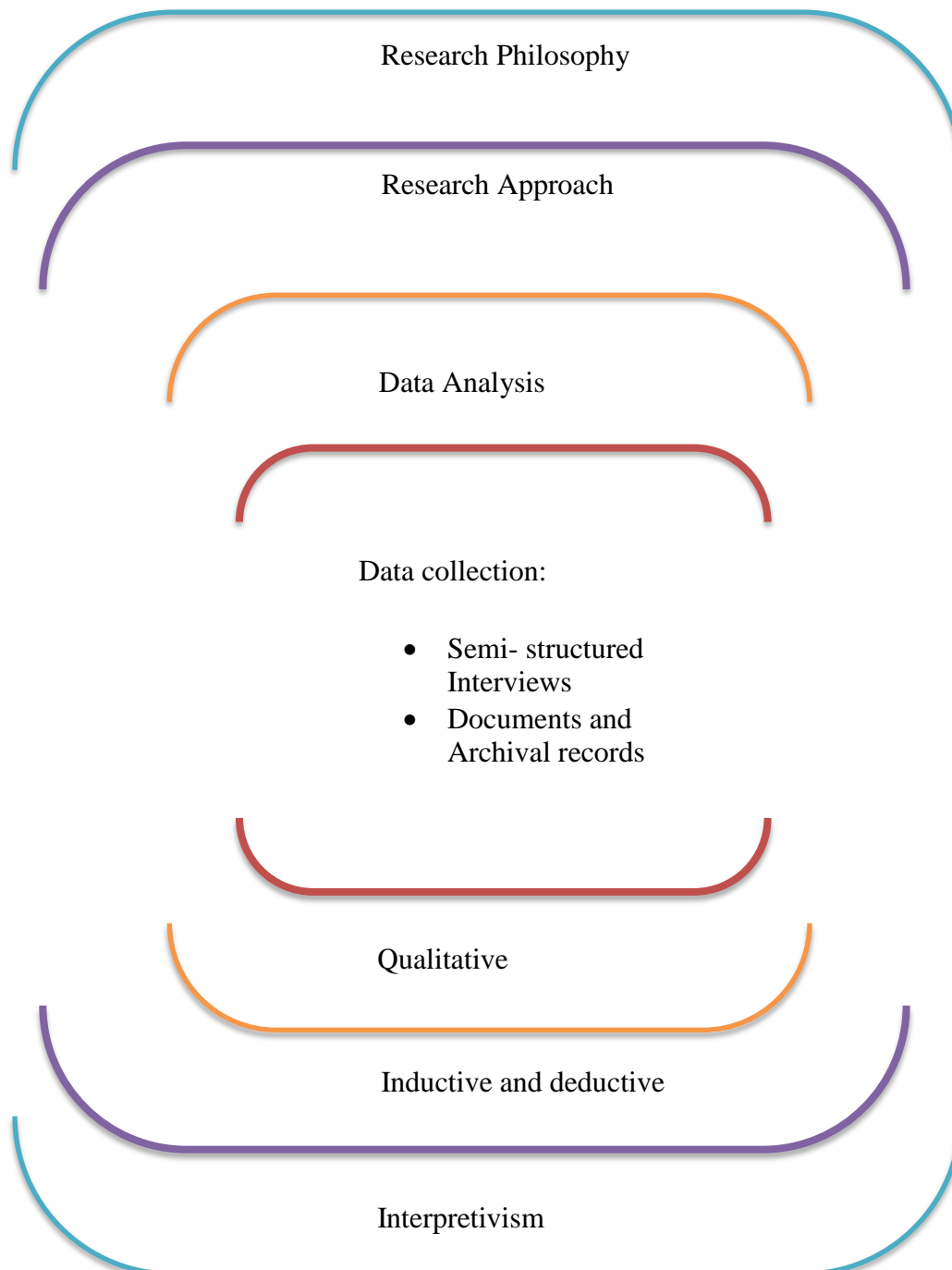
Figure 4.3: Research design framework.

Source: Adapted from Saunders et al. (2007, p.107)

### 4.2.3 Research Philosophy

*"A research paradigm is a philosophical framework that guides how scientific research should be conducted, based on people's philosophies and their assumptions about the nature of knowledge"* (Collis and Hussey, 2009, p. 55).

Oates (2005) and Saunders et al. (2012) claim that there are three main research philosophical paradigms, namely positivism, interpretivism, and critical research.

Positivist paradigms seek to prove a hypothesis and concept and seek a causal or statistical relationship. On the other hand, interpretivism tries to explore and identify factors in an organisation or social setting, and looks to understand the phenomena in the social context/ community. Critical research focuses on IT artifacts (Oates, 2005). In addition, Weber (2004) argues that in the positivist paradigm, the research object has inherent qualities that exist independently of the researcher. On the other hand, in interpretivist research, the object is interpreted in the light of the meaning structure of the person's (researcher's) lived experiences.

Collis and Hussey (2003) argue that there are two main paradigms: positivism as quantitative and phenomenological as qualitative. Moreover, the researcher should adopt one of the research paradigms in the early stage of research. *"Phenomenological paradigm is interested in understanding the human behaviour from the participants own frame reference; positivism paradigm seeks the causes of social phenomena with little regards to the subjective state of the individual"*. The phenomenological paradigm seeks to focus on the meaning while the positivism paradigm seeks to focus on measurements. Moreover, Saunders et al. (2012) argue that interpretivism is inherited from the intellectual traditions: phenomenology and symbolic interactions.

Table 4.2 shows the main features of the two paradigms of positivism and phenomenological.

| Table 4.2: Features of the Positivistic and Phenomenological paradigms | |
|---|---|
| **Positivistic paradigm** | **Phenomenological paradigm** |
| Tends to produce quantitative data | Tends to produce qualitative data |
| Concerned with hypothesis testing | Concerned with generating theories |
| Data is highly specific and precise | Data is rich and subjective |
| The location is artificial | The location is natural |
| Reliability is high | Reliability is low |
| Validity is low | Validity is high |
| Generalise from sample to population | Generalise from one setting to another |

Source: Collis and Hussey (2003, p.55).

Moreover, according to Collis and Hussey (2003) and Saunders et al. (2012), positivistic research is conducted in a laboratory environment or artificial setting to control research variables. However, in phenomenological paradigm research, the research is conducted in real life in the field of study (natural location); the researcher in this paradigm of research does not control any aspects of the phenomena.

In the case of this research, the researcher seeks to explore and identify factors in real world e-commerce companies in Jordan. The research objectives do not make any assumptions. So, the researcher decided to adopt interpretivism philosophy, because it supports the research purpose (Weber, 2004). Moreover this will also enable the researcher to interact with the organisations being studied and to understand the factors that affect software maintenance in depth.

## 4.2.4 Qualitative and Quantitative Research Approaches

There are two main research approaches: qualitative and quantitative (Yin, 1994; Bryman and Bell, 2003; Gray, 2014). Qualitative research is based on in-depth information and quantitative research on large amounts of numerical data that can be generalized (Hussey and Hussey, 1997; Gray, 2014).

Bryman and Bell (2003) state that quantitative research normally uses words rather than quantification in collecting and analysing data, while qualitative research emphasizes quantification in collected and analysed data. Table 4.3 highlights the main differences between quantitative and qualitative research strategies from principal orientation to the role of theory in relation to research, and epistemological orientation.

| Table 4.3: Fundamental differences between quantitative and qualitative research strategies | | |
|---|---|---|
| **Orientation** | **Quantitative** | **Qualitative** |
| Principal orientation to the role of theory in relation to research | Deductive; testing of theory | Inductive; generation of theory |
| Epistemological orientation | Natural science model, in particular positivism | interpretivism |

Source: Bryman and Bell (2003, p. 25)

Moreover, Cavana et al. (2001), state that methods of research are broadly classified as: quantitative and qualitative. The data in the qualitative method is based on words, and the data is collected through interviews, observations, and focus groups. On the other hand, in quantitative research, the data is based on numbers, as the data is collected through questionnaires and laboratory experimentations. Generally, positivist research concentrates on quantitative research while interpretivism and critical research are usually based on qualitative research methods.

Moreover, Collis and Hussey (2003), argue that the main data collected in the phenomenological paradigm is qualitative in order to gather data in depth about

phenomena. On the other hand, if the researcher adopts the positivism paradigm, the data collected is mainly quantitative because the data should be highly specific.

Bryman and Bell (2003) state that the qualitative research approach is often used in case study research strategy. It also uses a variety of data source methods, such as interviews and observation because these types of data source help understand the phenomena in depth. Moreover, in qualitative research the researcher is closer to the field of the study (Gray, 2014).

Furthermore, Silverman (2010) states that the researcher in qualitative data methods collects data in depth about the phenomenon of the study. The choice of approach in research, whether qualitative or quantitative, depends basically on what the researcher is trying to achieve in the study. If the researcher is interested in making numerical comparisons between some phenomenon, then the quantitative approach is the right choice. On the other hand, if the researcher seeks to understand the phenomena in depth, the qualitative method is the right choice. Table 4.4 below, as reported by Alhudaithy (2009), summarises the work done by Gronhaug and Ghauri (2005) on the weaknesses and strengths of qualitative and quantitative methods.

| Table 4.4: The strengths and weaknesses of qualitative and quantitative methods | | |
|---|---|---|
| | **Qualitative** | **Quantitative** |
| **Strengths** | <ul><li>Can be cheaper than quantitative if small scale</li><li>Can be simpler to undertake</li><li>Offers useful overview</li><li>Helpful as prelude to quantitative research</li></ul> | <ul><li>Higher level of accuracy</li><li>Provides factual information</li><li>Results more significant and focused both as to information gathered and target audience used</li><li>Margin of error can be calculated. Generalisations possible</li><li>Data are in the form of</li></ul> |

| | | numbers from precise measurement. |
|---|---|---|
| **weaknesses** | • Findings more subjective, calling for higher level of interpretative skill as data are in the form of words from documents, observations, and transcripts. <br> • Research procedures are particular and replication is difficult. <br> • Smaller sample size reducing statistical accuracy levels <br> • Greater chance of bias from respondents and through interpretation <br> • Difficult to generalise from limited cases | • Slower than qualitative <br> • Not so simple to undertake <br> • Often requires computer analysis facility <br> • Low response rates <br> • Some risk of bias <br> • Procedures are standard and replication is assumed. |

**Source:** Alhudaithy (2009, P.121).

### 4.2.4.1 Justification for Adopting a Qualitative Research Approach

The researcher in the present study adopts a qualitative research approach to study the problems and phenomenon (software maintenance) in depth. The research conducted in e-commerce companies and the responses specifically relate to the problems of research study (employees who work in software maintenance and senior management). The researcher observed when he conducted the preliminary study that, there are a relatively small number of respondents in the e-commerce companies in the Jordanian context. For this reason, the qualitative approach is more appropriate in this research and the findings are consistent with recommendations of Hussey and Hussey (1997) and Gray (2014). The qualitative research approach is suitable in small samples and quantitative approach in large samples.

## 4.2.5 Deductive and Inductive Approaches

There are two broad methods of reasoning research approach, "deductive" and "inductive", and it is very important to decide which one works best with the research problem.

Saunders et al. (2007) states that:

Deduction refers to testing a theory through the design research strategy, while inductive refers to building a theory through collected and analysed data. The results of data analysis generate a theory.

The deductive approach uses deductive reasoning to come to evaluate the research issues. This is commonly described as a top-down approach because it first looks at the wider general picture before the scope is narrowed down to the more specific details. So, in effect the process starts with a general theory so that after scrutiny, a specific hypothesis is formed. The further steps of deductive reasoning are observation and confirmation. The hypothesis is tested in this process. On the other hand, inductive reasoning is looking from bottom to top, from specific observation to generalizations and theories, and the researcher collects observation data to develop a theory or findings as a result (Creswell, 2012; Saunders et al., 2012).

Bryman and Bell (2003) stated that the deductive approach *"represents a view of the nature of the relationships between theory and research"*. The researcher gathers knowledge related to the domain of the study and adopts a hypothesis (or hypotheses). Finally, the hypothesis might be accepted or rejected. Figure 4.4 shows the process of a deductive approach.
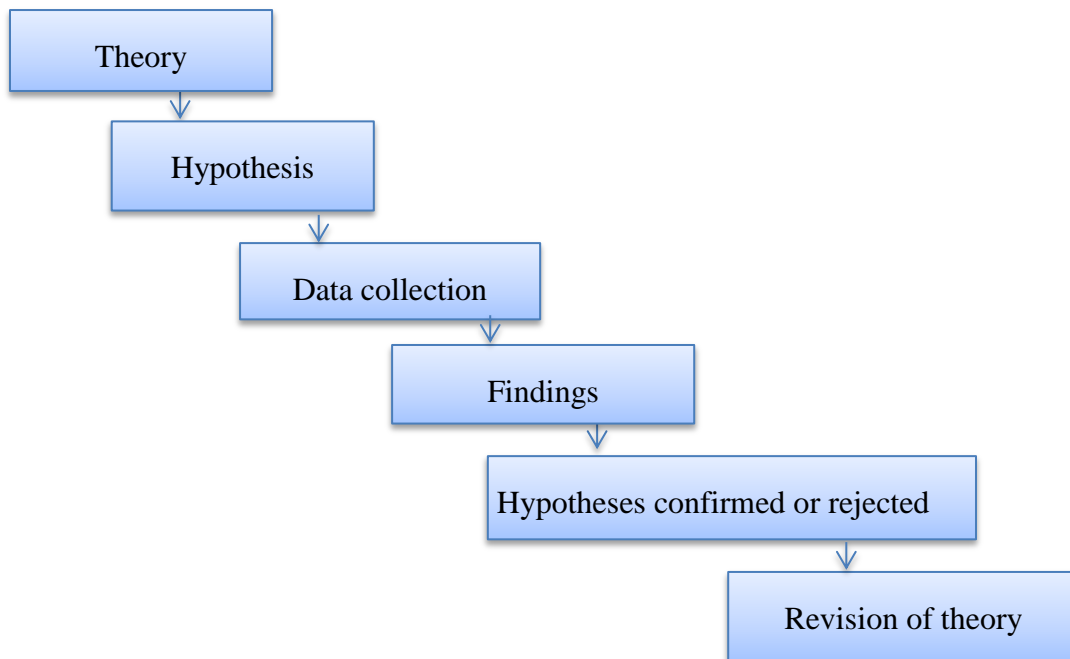
Figure 4.4: The process of deduction

Source: (Bryman and Bell, 2003, p.11)

On the other hand, the inductive research begins from specific observation and ends with the theory. Indeed, the results of inductive research are theoretical generalizations. Figure 4.5 shows the process of induction.



Figure 4.5: The process of induction

Source: Bryman and Bell (2003, p.12)

According to Cavana et al. (2001), deduction is the process in which the researcher starts with a theoretical proposition and moves to collect and analyse data to reject or accept the hypotheses. In contrast, the processes of induction research start with certain phenomena and arrive at theory.

Table 4.5 below summarizes the major differences between inductive and deductive approaches to research.

| Table 4.5: Differences between inductive and deductive | |
|---|---|
| **Deduction emphasises** | **Induction emphasises** |
| Scientific principle<br><br>Moving from theory to data | Gaining an understanding of the meanings humans attach to events |
| The need to explain causal relationships between variables | A close understanding of the research context |
| The collection of quantitative data | The collection of qualitative data |
| The application of controls to ensure validity of data | A more flexible structure to permit changes of research emphasis as the research progress |
| The operationalization of concepts to ensure clarity of definition | A realisation that the researcher is part of the research process |
| A highly structured approach | Less concern with the need to generalise |
| Researcher independence of what is being researched | |
| The necessity to select samples of sufficient size in order to generalise conclusions | |

Source: Saunders et al. (2007, p.120).

On the other hand, Saunders et al. (2012), state that there are three main research approaches: deductive, inductive, and abductive. He argues that the beginning of the research identifies the research approaches. If the research begins with the theory developed from literature and carries on to test the theory, then it is recommended to use the deductive approach. On the other hand, if the research starts with collecting data to explore the phenomena and after that generating a theory, then the researcher should use the inductive approach. In an abductive approach, the researcher starts with collecting data to explore phenomena, and identify themes to generate or modify an existing theory, which the researcher tests through additional data collection. Table 4.6 provides a comparison between the three research approaches, from reasons to research.

| Table 4.6: Deduction, induction, abduction from reasons to research | | | |
|---|---|---|---|
| | **Deduction** | **Induction** | **Abduction** |
| Logic | In a deductive inference when the premises are true, then the conclusion must also be true | In inductive inference, know premises are used to generate untested conclusions. | In an abductive inference, known premises are used to generate testable conclusions |
| Generalizability | Generalizing from general to the specific | Generalizing from the specific to general | Generalizing from interactions between the specific and general |
| Use of data | Data collection is used to evaluate propositions or hypotheses related to an existing theory | Data collection is used to explore a phenomena, identify themes and patterns and create a conceptual framework | Data collections is used to explore a phenomena, identify themes and patterns, locate these in  a conceptual |

| | | | framework and test this through subsequent data collection and so forth |
|---|---|---|---|
| Theory | Theory falsification or verification | Theory generating and building | Theory generating or modification; incorporating exist theory where appropriate, to build new theory or modify existing theory. |

Source: Saunders et al. (2012, p.144).

Moreover, Saunders et al. (2012) argue that the chosen research approach depends on research questions, which the researcher seeks to answer.

Consequently, the researcher has adopted the two approaches of inductive and deductive. Deductive is chosen to identify the common factors from the literature, which affect software maintenance, and the inductive approach for the field of study. Both approaches are used in the present research in order to achieve the following objectives:

➢ To review the relevant literature on software maintenance in order to understand software maintenance models, processes, practices, and the factors, which influence the software maintenance.

➢ To conduct an empirical study within the e-commerce companies in Jordan in order to understand the factors influencing the cost-effectiveness of software maintenance.

➢ To explore how and why these factors influence the software maintenance in Jordanian e-commerce companies.

➢ To propose a framework to address the factors that influence software maintenance activities in e-commerce companies in Jordan.

### 4.2.6. Justification for Selecting Company

The number of e-commerce companies in Jordan, according to the last statistics of 2012, is approximately twenty companies (E-Commerce in Jordan, 2012). However, the researcher observed when he conducted the preliminary study in e-commerce companies in Jordan, that there were only ten established office based companies, and the other companies were smaller businesses possibly based from home, although they were registered in the Ministry of Industry and Trade. Thus, the focus of the study will be these ten office based e-commerce companies.

The researcher has selected six companies (company one, company two, company three, company four, company five, and company six) from the ten e-commerce companies in Jordan. Those are the companies that have decided to participate in both the preliminary study and the main study. These agreements were reached as part of the preliminary study (cf. Appendix1). Indeed, the selected six companies will help to increase the external validity of the research. The next section shows the level and the numbers of interviewees.

### 4.2.7 Sample Size

Many scholars have dealt with sample size in the empirical research.

Uma Sekaran and Bougie (2010) put forward six factors affecting the sample size of the study, and the following factors should be considered:

- The research objective;
- The confidence interval;
- The acceptable risk in predicting that level of precision (confidence level);
- The amount of variability in the population itself;
- The cost and time constraints; and
- The size of the population.

Yin (2010) states that, there is no formula for defining number of instances in a qualitative study. On the other hand, Saunders et al. (2012) suggested the minimum sample size of

semi-structured interviews are 5 to 25. Gronhaug and Ghauri (2005, P.156) state that, "*Non-probability samples are often applied in qualitative research*".

Collis and Hussey (2003) state that, the researcher who conducts positivism paradigm research often use large samples because they conduct statistical analysis. On the other hand, the researcher who relies on the phenomenological paradigm can use a small sample because the aim of phenomenological is to get in-depth data to understand the phenomena in detail.

Based on the discussion above about the sample size, there are many factors affecting the choice of sample size in empirical research, so in the present research the size of the population is small and the amount of variability of the population is small too. Thus, the sample size of the present research is as follows:

The researcher discovered through the preliminary study (cf. Appendix 1) that, it is necessary to ensure each one of the companies include two groups A and B. Table 4.7 shows the categories and description of respondents.

| Table 4.7: The categories and description of respondents | | |
|---|---|---|
| **Categories of interviewees** | **Description of respondents** | **Number of respondents** |
| **Group A**: The employees | The employees who are responsible for maintaining the software application or follow- up actions related to software maintenance applications | 9 |
| **Group B**: The senior management | The general manager of the companies or assistant manager. | 6 |

## 4.2.8 Data Generation Method

Yin (2003) suggests six sources of data used in collecting data: interviews, documentation, archival records, direct observation, participant observation, and physical artifacts. Each one of them has its strengths and weaknesses. Table 4.8 shows the strengths and weaknesses of six sources. Oates (2005) describes four of these data generating methods as used in information system research: interviews, observation, questionnaires and documents.

| Table 4.8: Six sources of evidence: strengths and weaknesses | | |
|---|---|---|
| **Source of evidence** | **Strengths** | **Weakness** |
| Documentation | • Stable can be reviewed repeatedly.<br>• Unobtrusive-not created as a result of the case study.<br>• Specific-can contain the exact names, references, and details of an event.<br>• Broad-can along span of time, many events, and many settings. | • Retrievability- can be low.<br>• Biased selectivity, if collection is incomplete.<br>• Reporting bias-reflects<br>• Access- may be deliberately blocked. |
| Archival records | • Same as above for documentation<br>• Precise and quantitative | • Same as above for documentation<br>• Accessibility due to privacy reasons |
| Interviews | • Targeted-focuses directly on research topic<br>• Insightful-provides | • Bias due to poorly constructed question<br>• Response bias<br>• Inaccuracies due to |

| | | |
|---|---|---|
| | explanations as well as personal views. | • poor recall<br>• Reflexivity-interviewee gives what interviewer wants to hear. |
| Direct observation | • Immediacy-covers action in real time<br>• Contextual–can cover the case's context | • Time –consuming<br>• Selectivity –unless broad coverage.<br>• Reflexivity-event may proceed differently because it is beginning to be observed<br>• Cost-hours needed by human observers. |
| Participant observation | • Same as direct observation<br>• Insight into interpersonal behaviour and motives | • Same as direct observation<br>• Bias due to investigator's manipulation of events |
| Physical artifacts | • Insight into cultural features<br>• Insight into technical operations | • Selectivity<br>• Availability |

Source: Yin (2013, p.106)

Long and Johnson (2000) and Yin (2003) argue that using multiple sources of data helps to reduce the disadvantages of a single source. Moreover, Yin (2003) argues that the researcher must choose an appropriate and reliable source of evidence that fits with the nature of the study.

Indeed, many authors have written about research methodology and recommended using multiple sources of evidence when researchers collect data (Johnson, 2000; Yin, 2003; Oates, 2005; Saunders et al., 2012).

Accordingly, the researcher in the present research used two sources to collect data: interviews as a primary source of data, and documentation and archival records as a secondary source of data.

### 4.2.8.1 Interviews

Collis and Hussey defines interview as: *" a method for collecting primary data in which a sample of interviewees are asked questions to find out what they think, do or feel"* (Collis and Hussey , 2009, p.144).

Moreover, Gray (2014) reports that, interviews are suitable when the study is relatively small scale.

### 4.2.8.1.1 Categories of the Interview

According to Cavana et al. (2001), there are two types of interview: structured and unstructured. In addition, the interview may be conducted either face-to-face, over the telephone, or computer-assisted. The major advantage of a face-to-face interview is that the interviewer can clarify the question to the respondents of the study so that he ensures that they understand the questions. Indeed, the interview is a comfortable method for the respondents and provides a complete answer.

On the other hand, Oates (2005) and Saunders et al. (2012) provide three types of interview categories:

1. Structured interviews: the researcher prepares for the questions of the interview before the interview takes place; the static questions cannot change during the interview.
2. Semi-structured interviews: the researcher prepares for the questions asked in the interview but the questions are flexible to changes and updated at any time during the interview.

3. Unstructured interviews: the researcher has less control, poses the idea related to research topic and discusses the idea with the interviewees.

The researcher used semi-structured interviews in the present study to add flexibility to the interviews, and sometimes the respondent may mention certain aspects, which the researcher may not have thought about. The researcher personally interviewed the respondents in face-to-face interviews, which increases the validity of outcomes of the interview.

### 4.2.8.1.2 Justification for Choosing Interviews

In the present study the researcher used interviews as a primary source of data collection for the following reasons (Oates 2005; Saunders et al., 2012; Yin, 2013; Gray, 2014):

- The interview deals with the subject of the problem in depth and in specific details.
- The small sample size response from the companies related well to the topics of the research when the preliminary study was conducted.
- The interviews are considered a comfortable way for respondents, and some respondents prefer to talk rather than write.

### 4.2.8.2 Documentation and Archival Records

Yin (2013, p.105) states that, *"documentary information is likely to be relevant to every case study topic."* Moreover, the documents may include: letters, memoranda, agenda, announcements, minutes of meetings, newspaper clippings, and administrative reports.

Also, Oates (2005) states that, many documents in the company already exist for other reasons, and this makes it easy to access and use the documents for the study without any difficulty.

According to Yin (2013), the archival record takes the form of computer record and files. They often include: service records, maps, charts of geographical place, personal records, survey data, and lists of names. The archival records help in understanding the research context (Gray, 2014).

Indeed, many authors have written about research methodology and recommended using multiple sources of evidence when researchers collect data (Oates 2005; Saunders et al., 2012; Yin, 2013).

Accordingly, based on the above discussion about sources of evidence, the researcher will use semi-structured face-to-face interviews as the main source of data; and documentation, and archival records as a secondary source of data.

The researcher used available documentation and archival records in the participants' companies to support the primary data generation in the study, and to support the validity of interviews.

**4.2.9 Preparation for Fieldwork**

To avoid any delay in the field study, the researcher developed a comprehensive plan for the field study period of four months.

Figure 4.6 shows the plan for the field study. Furthermore, to avoid any possible risks occurring during the field study, the researcher developed a strategy to deal with any risks to avoid them having any effect on the research. Table 4.9 shows the probable risks during the empirical study. As a result, the researcher was able to collect data during the scheduled time for the field work (four months).

**Plan for the field study**

**Time:**

**Start time: 20/5/2014**

**End time:   20/9/2014**

| ID | Task Name | Start | Finish | Duration | May 2014 | | Jun 2014 | | | | Jul 2014 | | | | Aug 2014 | | | | Sep 2014 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 18/5 | 25/5 | 1/6 | 8/6 | 15/6 | 22/6 | 29/6 | 6/7 | 13/7 | 20/7 | 27/7 | 3/8 | 10/8 | 17/8 | 24/8 | 31/8 | 7/9 | 14/9 | 21/9 |
| 1 | Preparing for pilot study | 20/05/2014 | 27/05/2014 | 7d | ▪ | | | | | | | | | | | | | | | | | | |
| 2 | Conduct pilot study | 28/05/2014 | 04/06/2014 | 7d | | ▪ | | | | | | | | | | | | | | | | | |
| 3 | Review the interview questions after pilot study | 05/06/2014 | 10/06/2014 | 5d | | | ▪ | | | | | | | | | | | | | | | | |
| 4 | Setting a date for interviews | 10/06/2014 | 15/06/2014 | 5d | | | | ▪ | | | | | | | | | | | | | | | |
| 5 | Conduct interviews | 16/06/2014 | 04/09/2014 | 70d | | | | | ▬▬▬▬▬▬▬▬▬▬▬▬ | | | | | | | | | | | | | | |
| 6 | Collects the documentations from the companies | 16/06/2014 | 04/09/2014 | 70d | | | | | ▬▬▬▬▬▬▬▬▬▬▬▬ | | | | | | | | | | | | | | |
| 7 | Unexpected issues during the field study | 06/09/2014 | 20/09/2014 | 13d | | | | | | | | | | | | | | | | | ▪ | | |
| 8 | Review and translate the answers of interviews to English | 16/06/2014 | 20/09/2014 | 83d | | | | | ▬▬▬▬▬▬▬▬▬▬▬▬▬▬ | | | | | | | | | | | | | | |

Figure 4.6: The plan for the field study

| Table 4.9: Probable risks during the empirical study | | | | |
|-----|-----|-----|-----|-----|
| Num | Probable risks | Impact for the study | Strategy to deal with this risk | Strategy to reduce the impact if the risk occurs |
| 1 | One of the organisations that accepted to participate in the main study when the researcher conducted preliminary study apologizes for not continuing to participate in the main study. | Decrease in the number of companies. | The researcher will contact all the companies in advance before starting gathering data from the filed study, to insure that all the companies are still interested in participating in the study. | The researcher will focus on the other companies for collection of the data.<br><br>The researcher tries to visit new companies. Probably established after conducting preliminary study |
| 2 | Time management during the field study. | Not finished collecting all the data within the time period. | The researcher has already developed a plan to organize the data collection in the field study within four months.<br><br>Researcher will be contacted by each one of the organisations to ask him about appropriate times | The researcher will update the plan for the next years to ensure the study deals with this event if it occurs. |

| | | | |
|---|---|---|---|
| | | to conduct interviews. Include in the field study plan contingency time in case there is an issue. | |
| 3 | When the researcher visits the company with which he has fixed an appointment, it apologises either because it has a new event at the same time or the staff have forgotten the time of appointment | Time delay | The researcher will send an email 48 hours before the interview time to confirm the interview. Furthermore, the researcher will send a reminder message for the companies 24 hours before the time of interview. | The researcher will try to make contact with other companies to try to manage the interview with the same time. The field study plan includes two weeks for contingency. |
| 4 | The senior management in the company might be so busy and thereby give the order to any employee not in the senior management to do the interview (group two from interviews). | The data collected not being accurate or not the data that the researcher seeks to collect. | The researcher will tell the management that it is important to validate the study with the participation of senior management. | Change the interview to other times. The field study plan includes two weeks for contingency. |

| 5 | Some companies apologized for not allowing copies of documentation out of company. | The methodology of this study focuses on collected data about interviews as primary sources and documents and archival records as a secondary source. So, lack of access to certain documents may affect the understanding of the problem of the study. | The researcher will seek the possibility of accessing documents in the company without taking any copy outside the company.<br><br>The possibility of non-disclosure agreement. | Accessin the documentation in the company. |
|---|---|---|---|---|

### 4.2.9.1 Pilot Study

Pilot study is a very important phase before carrying out the collection of the main data for the research (Gill and Johnson 2002; Jankowicz, 2005; Yin, 2010).

Pilot study is defined as: *"small-scale study to test a questionnaire, interview checklist or observation schedule, to minimise the likelihood of respondents having problems in answering the questions and of data recording problems as well as to allow some assessment of the questions' validity and reliability of the data that will be collected"* (Saunders et al., 2012, p.606).

Yin (2010. p120) states that, *"pilot studies help to test and refine one or more aspects of a final study-for example, its design, fieldwork procedures, data collection instruments, or analysis plans"*.

The researcher has conducted pilot interview questions for the two groups of respondents in an effort to get feedback about the interview questions and to ensure that the interviewees understand the interview questions.

The pilot study was conducted in three of the organisation with three interviews from Group (A) and two interviews from Group (B).

The results of the pilot study show that, the majority of interview questions are clear for the respondents. Slight changes were made to the interview questions, of which the most important were as follows:

| Human Resources Category | |
| --- | --- |
| Question number 10 before pilot study | How many hours on average do you spend on maintenance each day? |
| Question number 10 after pilot study. | Deleted<br><br>The employees were not happy to answer this question for private reasons. |

| Software Characteristics Category | |
|---|---|
| Question number 1 before pilot study | Do you think the quality of original software products affects the maintenance? If yes, how? Why? |
| Question number 1 after pilot study. | Do you think the quality of original software products like system structure, programme language, affects the maintenance? If yes, how? Why? |
| Organisational Environment Category | |
| Question number 6 before pilot study | Do you have regular meetings in the organisation with people who deal with software maintenance? If yes, how many times a month? Why? If no, why not? |
| Question number 6 after pilot study. To be more accurate and more clear, the question was divided into two separate questions | Do you have regular meetings with the software maintenance team? If yes, how many times a month? Why? If no, why not? Do you have regular meetings with the IT department team? If yes, how many times a month? Why? If no, why not? |

### 4.2.10 Interview Protocol

This section describes how the researcher planned for interviews and likewise built the interview protocol.

### 4.2.10.1 Generating Interview Questions

The researcher generates questions that will be asked to interviewees during the interviews. The researcher focused on open-ended questions, because these types of question allow the interviewee to give more information about the situation (Jacob and Paige Furgerson, 2012; Yin, 2013).

In order to ensure all the obvious questions are being asked, the researcher reviews the interview questions with academic supervisors and with experienced persons in software maintenance research (cf. Appendix 2).

Also, to avoid bias in the interviews, the researcher attended many training sessions in interview protocol, and interview management.

### 4.2.10.2 Translating the Interview Questions

The interviews were conducted in an Arabic speaking country (Jordan), so in order to ensure the interviewees understood the specific meaning of the questions, the researcher translated the interview questions into Arabic. The translation was conducted with advice and guidance from an experienced lecturer in translating English /Arabic.

To ensure that the translation would not affect the meaning of the interview questions, the following process was done (Brislin, 1976):

> ➢ Translate the interview questions from English to Arabic through two sources: the first one is an Arabic student studying English in the UK and another source is a translation office in Jordan.
> ➢ Another translation of the interview questions from Arabic to English has been conducted through two sources: the first source is an Arabic student studying English in the UK and another source is the translation office in Jordan (the two sources were not used in the first translation English to Arabic).
> ➢ After the translation, the researcher compared the original version of interview questions with the new version, to ensure the translation did not affect the meaning of the interview questions. Finally, the two versions of interview questions were the same.
> ➢ As a result, the translation of interview questions of English to Arabic was acceptable.

### 4.2.10.3 Conducting the Pilot Study

As mentioned previously in the pilot study section, the researcher conducted a pilot study in order to ensure the interview questions were clear before starting the primary interviews.

### 4.2.10.4 During the Interviews

The researcher during the interview adopted Jacob and Paige Furgerson (2012) tips about interviews which includes:

➢ Asking the interviewee basic background data about her/ himself (like name, general issues)
➢ Beginning with easy to answer questions.
➢ Time management during the interviews.
➢ Keeping the interview on-track.
➢ Listening more than talking.
➢ Using basic counselling skills to help your interviewees feel heard.

To avoid losing any data during the interviews, the researcher asked interviewees about the possibility of recording the interviews. The majority of respondents refused.

### 4.2.11 Validity and Reliability in Research

According to Bryman and Bell (2003), validity in research is concerned with the integrity of the conclusions that are generated from a piece of research. Reliability is a term related to whether the findings of a study are repeatable.

According to Collis and Hussey (2003), reliability means if the research is repeated by another researcher, then the results of the research should be the same. Furthermore, usually the reliability in positivism research is high because a positivism research focuses on the precision of measurement. On the other hand, the reliability in phenomenological research is low. Furthermore, Yin (2013, p.49) stressed that, *"the goal of reliability is to minimize the errors and biases in the study"*.

As mentioned previously in section 4.2.9, the researcher in the present research uses multiple sources to collect data, including interviews, documents and archival records. Diversity in data sources in the study helps to enhance the validity and reliability of findings (Noor, 2008).

Furthermore, to gain more validity for the study, the researcher prepared accurate questions for the interviews and reviewed the interview questions with the academic supervisor as well as conducting a similar small-scale pilot study before the respondents are formally interviewed. Hopefully, this will help to iron out any faults in the interview questions.

**4.2.11.1 Validity and Reliability of Data**

In order to ensure the data collected during the field study is of high quality and to increase the validity and reliability of the data in the present study, many procedures were adopted.

The researcher has undertaken a number of training sessions and courses to improve his knowledge in research processes. Also, the researcher developed an interview protocol to avoid any bias in data collection (cf. 4.2.11) (Gray, 2014).

Moreover, the researcher revisited the respondents from the six organisation after transcribing the interviews to make sure the transcript of the data were as the respondents had stated during the interviews. All respondents agreed with the interviews transcription.

**4.2.12 Generalizability**

Collis and Hussey (2003) stated that in positivism paradigm, it is possible to generalize the findings and make conclusions from the sample of the study to the population. Also, in phenomenological paradigm, the findings and conclusion may be able to be generalized from one sitting to another. Also, Collis and Hussey (2003) report positivism (Quantitative) research tends to allow results to be generalized from the sample to the population, while "*Interpretivism (Qualitative) tends to allow findings to be generalized from one setting to another similar setting*" (Collis and Hussey, 2009, p.62).

The present research was conducted in e-commerce companies in Jordan. As mentioned in the rationale of the research in chapter one (cf.1.3), there are common characteristics between the e-commerce companies in Jordan and other Arab countries. The researcher in his research seeks to generalize the findings to other e-commerce companies in Arab countries in general and in Jordan particularly (similar setting).

### 4.2.13 Data Analysis

As stated earlier, the researcher used a qualitative data generating method to collect data. Golafshani (2003) states that use of multiple sources of data can help to increase the validity and enhance the reliability of research; furthermore, it helps the researcher to avoid bias.

Yin (2009) discusses the importance of using computer software packages in the analysis of data evidence collected through interviews, documents, and archival documents. The software package does not analyse the data but helps to organize the data and categorize the data; it is useful when collecting large textual data about the phenomena. There are multi software packages for analysis of textual data such as Hyper RESEARCH, NVivo, and Atlas.ti.

In the present research, the researcher adopts a qualitative research approach; the methods of collecting data as mentioned previously are interviews, documentation and archival records. Thus, the data will be analysed through software package NVivo.

### 4.2.13.1 Justification of Using Nvivo Software

NVivo is a software package designed to assist in the analysis of qualitative data. Indeed, it provides tools that help the researcher to easily work through the data, which was gathered from the qualitative data sources (QSR International, 2015).

The researcher used NVivo software for the reasons below:

- The University of Salford provides a full licence of NVivo software for the postgraduate students, and this helps to access the program without any constraints.
- The researcher has attended several training sessions related to NVivo in Salford University.

### 4.2.14 Ethical Consideration

Uma Sekaran and Bougie (2010) and Gray (2014) report that it is necessary to inform the participants about the purpose of the study and ensure them that data will be confidential, i.e. no other party has the right to examine the data. This is necessary because it increases comfort to the participants when conducting interviews. Some of the issues that participants must have prior knowledge of are:

- The participation in the study is voluntary;
- The data gathered from respondents will not be shared with a third party;
- When organisations are willing to participate, the researcher is responsible for protecting the data; and
- Also, the interviewees have the right of privacy and confidentiality.

To achieve the ethical considerations in the present research, the researcher has received ethical approval from Salford University to conduct the preliminary study, and another one for the main study (cf. Appendices 3 and 4).

**4.2.15 Chapter Summary**

The chapter research methodology has discussed the aim and objectives of the preliminary study. Also, the chapter discusses the rationale for choosing the interpretivism paradigm, and qualitative data.

Moreover, the chapter explains the source of data adopted in data collection semi-structured face-to-face interview, documents and archival records. Also, the plan of the field study was presented. Data analysis was discussed.

In the next chapter, the findings of the data are collected from six companies from two sources: interview, documentation and archival records.

# Chapter Five: Research Findings

## 5. Introduction

The aim of this chapter is to present the overall findings of the data collected from six organisations. The study was conducted in Jordanian e-commerce companies. As mentioned in chapter four (research methodology), two sources of data were used to collect the data from the organisation: semi-structured face-to-face interviews and documents and archival records (for more information about where the researcher has used each, see Appendix 5). The interviews were conducted over a period of four months in e-commerce companies in Jordan. Each interview lasted approximately one hour to an hour and a half and some of the interviews were audio recorded. The interviews were transcribed into Arabic and then translated into English.

The interview questions were designed to collect in-depth information about the factors that influence software maintenance through five main issues:

1. Human resources;
2. Organisational environment;
3. Operational environment;
4. Software characteristics; and
5. External factors.

The interview questions covered all the factors that affect software maintenance according to the literature review and the findings in the preliminary study. The number of questions for Group A was 35 questions and the number of questions for Group B was 23. For the interview questions for both Groups A and B with the main factors see (Appendix 2).

Furthermore, this chapter includes information about numbers of interview respondents, companies' profiles, respondents' profiles for Groups A and B, and a summary of the chapter.

### 5.1 Numbers of Interview Respondents

Six companies decided to participate in the study. Also, the researcher managed to collect data containing a range of perspectives in order to gain an in-depth understanding of the factors affecting software maintenance, as the two groups interviewed in the study included Group A, which included employees working in software maintenance and Group B, who

were the senior management in the participating companies. Table 5.1 shows the number of interviews for the two Groups (A, B).

| Table 5.1: The number of interviews for the two groups | | |
|---|---|---|
| Group | Number of interviews conducted | The number of interviews was justified in chapter four (methodology chapter) |
| Group A | 9 | |
| Group B | 6 | |
| Total | 15 | |

## 5.2 Companies' Profiles and Interviewees

The researcher in the present research deals with six companies. The justification of those companies and respondents chosen for interviews was mentioned and discussed in the chapter research methodology (cf. 4.2.7.3). Below is the profile of each company:

### 5.2.1 Company One

Company one was established in 2010 in the capital of Jordan. The nature of business in the company is sales goods online around the Middle Eastern countries.

The total employees who work in the company are thirty; only two of them have work in the software maintenance department.

The two employees who are working in software maintenance participated in the study from Group (A). Also, one of the senior management participated from Group (B).

### 5.2.2 Company Two

Company two was established in 2012 in the capital of Jordan. The nature of business in the company focused on sales goods online internally in Jordan.

The total employees who work in the company are ten employees; only one of them has worked in software maintenance.

The one employee who is working in software maintenance participated in the study from Group (A). Also, one of the senior management participated from Group (B).

### 5.2.3 Company Three

Company three was established in 2012 in the capital of Jordan. The nature of business in the company is sales goods online internally in Jordan.

The total employees who work in the company are thirty-five. Only two of them work in software maintenance. The two employees who are working in software maintenance participated in the study from Group (A). Also, one of the senior management participated from Group (B).

### 5.2.4 Company Four

Company four was established in 2011 in the capital of Jordan. The nature of business in the company is sales goods online around Middle Eastern countries.

The total employees who work in the company are twenty; only one of them works in software maintenance. One employee who is working in software maintenance participated in the study from Group (A). Also, one of the senior management participated from Group (B).

### 5.2.5 Company Five

Company five was established in 2011 in the capital of Jordan. The nature of business in the company is sales goods online around the world.

The total employees who work in the company are fifty. The company has three employees working in the software maintenance department.

Two employees from three employees who are working in software maintenance participated in the study from Group (A). Also, one of the senior management participated from Group (B).

### 5.2.6 Company Six

Company six was established in 2010 in the capital of Jordan. The nature of business in the company is sales of fruit and vegetables online around the capital of Jordan.

The total employees who work in the company are twelve. The company has one employee working in software maintenance. One employee who is working in software maintenance

participated in the study from Group (A). Also, one of the senior management participated from Group (B).

Table 5.2 shows summary profiles of the companies who participated in the study with the number of interviews in the company for the two Groups (A, B).

| Table 5.2: Summary of companies' profiles and number of interviewees | | | | | | |
|---|---|---|---|---|---|---|
| Company name | Establish-ment of the company | Number of employees in the company | Number of employees in IT department | Number of employees in software maintenance department | Number of interviews conducted for two groups | Source of software |
| C 1 | 2010 | 30 | 2 | 2 | 3 | In-house |
| C 2 | 2012 | 10 | 1 | 1 | 2 | Outsource |
| C3 | 2012 | 35 | 4 | 2 | 3 | In-house |
| C 4 | 2011 | 20 | 2 | 1 | 2 | Outsource |
| C 5 | 2011 | 50 | 5 | 3 | 3 | Outsource |
| C 6 | 2010 | 12 | 1 | 1 | 2 | Outsource |

## 5.3 Respondents' Profile Group (A)

The number of interviews in Group (A) from all the participating companies is nine. Table 5.3 shows the demographic information about the respondents' Group A. The reason for this was to obtain a more in-depth understanding of the staff's experience, level of education, and mother tongue in different e-commerce companies in Jordan. The effect of these drivers in software maintenance will be analysed later on in the study.

| Table 5.3: Respondents' profile Group (A) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Name of employee[1]** | **Gender** | **Job title** | **Level of education** | **Specialty** | **Years' experience in the company** | **Years' experience** | **Mother tongue** |
| C1GAP1 | Male | Software developer | Bachelor | Software engineering | Three years | Two years | Arabic |
| C1GAP2 | Male | Software developer and maintenance | Diploma | Computer science | Two years | Three years | Arabic |
| C2GAP1 | Male | Software maintenance | Bachelor | Computer science | One and a half years | Two years | Arabic |
| C3GAP1 | Male | Software maintenance | Bachelor | Computer information system | Two years | Two years | Arabic |
| C3GAP2 | Male | Software developer and maintenance | Bachelor | Software engineering | One year | Four years | Arabic |
| C4GAP1 | Male | Software maintenance | Bachelor | Computer science | Three years | Three years | Arabic |
| C5GAP1 | Male | Software developer and maintenance | Bachelor | Computer information system | Two years | Four years | Arabic |
| C5GAP2 | Male | Software maintenance | Bachelor | Computer engineering | Three years | Two years | Arabic |
| C6GAP1 | Male | System developer | Bachelor | Computer science | One year | Two years | Arabic |

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[1] The name of employee: First two char: Company name; Second two char: Group of interview (A OR B); Third two char: Participant number in the same company.

## 5.4 Respondents' Profile Group (B)

Table 5.4 shows the statistical information about respondents' Group B. Group B is made up of the senior management for the six companies. The first indicator in this table is the majority of the respondents are owners and managers of the company.

| Table 5.4: Respondents profile Group (B) | | | | |
|---|---|---|---|---|
| **Name of employee[2]** | **Gender** | **Job title** | **Level of education** | **Owner of the company** |
| C1GBM | Male | Company manager | Bachelor | Yes |
| C2GBM | Male | Company manager | ------- | Yes |
| C3GBM | Male | Company manager | Bachelor | Yes |
| C4GBM | Male | Company manager | Bachelor | Yes |
| C5GBM | Male | Company manager | Bachelor | No |
| C6GBM | Male | Company manager | ------- | Yes |

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[2] The name of employee: First two char: Company name; Second two char: Group of interview B; last char: Management

## 5.5 NVivo Software

As mentioned in chapter four (cf.4.2.14.1), the researcher adopted NVivo software version 10 to organize the interviews questions. Figure 5.1 shows the main screen for NVivo software.
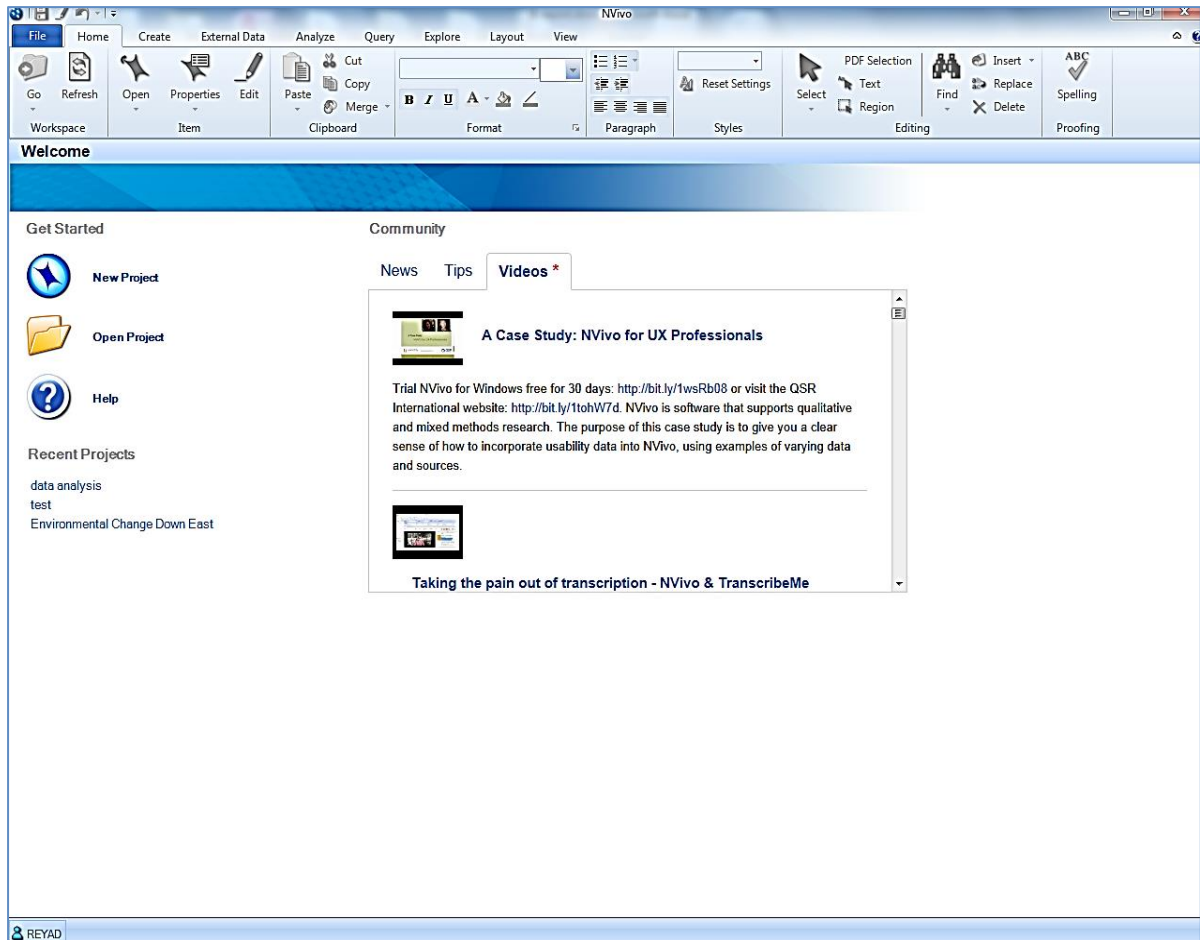


Figure 5.1: Screenshot from NVivo software.

Source: NVivo software version 10.

## 5.6 Research Findings

As mentioned in chapter four, semi-structured face-to-face interviews, documents and archival records were selected as the data collection instruments for this study. This section will present the results obtained from the interviews where the researcher interviewed the individuals responsible for software maintenance and senior management. The results obtained from the available documents and archival records in the companies will also be presented.

Furthermore, according to the literature review carried out related to software maintenance and the preliminary study in e-commerce companies in Jordan, the researcher was able to classify the factors that affect software maintenance into five main categories. The next section presents the findings from six organisations for the two groups involving employees in software maintenance and senior management. The findings are based on the nodes in Figure 5.2.

| Name | Sources | References |
|---|---|---|
| **Nodes** | | |
| Human Resource | 15 | 99 |
| Lack of experiences | 15 | 38 |
| Skills of maintainers | 15 | 25 |
| Employee turnover | 8 | 11 |
| Domain knowledge | 9 | 9 |
| Mother tongue | 15 | 16 |
| Software characteristics | 15 | 79 |
| Product quality | 13 | 73 |
| Documantaion | 10 | 26 |
| Quality of orginal system | 13 | 30 |
| Maintainability of the system | 9 | 17 |
| Organisational environment | 15 | 117 |
| Mangerial issues | 15 | 90 |
| Management support | 15 | 29 |
| Communication with management | 15 | 31 |
| Budget of the system and maintenance | 9 | 12 |
| Communication with IT staff | 9 | 18 |
| Classification and Standards | 9 | 27 |
| Standards and methodology adopted | 9 | 18 |
| Classification of software maintenance | 9 | 9 |
| Operational environment | 15 | 66 |
| System reliability | 15 | 38 |
| Enviroment reliability | 15 | 19 |
| Hardware and Operating system | 15 | 19 |
| Reasons of the maintenance | 9 | 18 |
| Operation users | 9 | 10 |
| External factors | 15 | 113 |
| Source of software | 15 | 55 |
| Outsource | 13 | 22 |
| In-house | 10 | 11 |
| Service level agreement | 15 | 30 |
| Outcomes of IT student in the university | 9 | 18 |
| Views of people | 9 | 9 |

Figure 5.2: A screen shot of NVivo 10 showing the nodes, sources, and references

## 5.7 Presentation of the Findings

To understand in-depth the problems of software maintenance in e-commerce companies in Jordan the researcher put all the findings from all the organisations for each interview question together. In this way it makes it easier to compare the findings for all the organisations according to the main themes and sub themes. Figure 5.3 shows the presentation way of the findings from the six organisations.
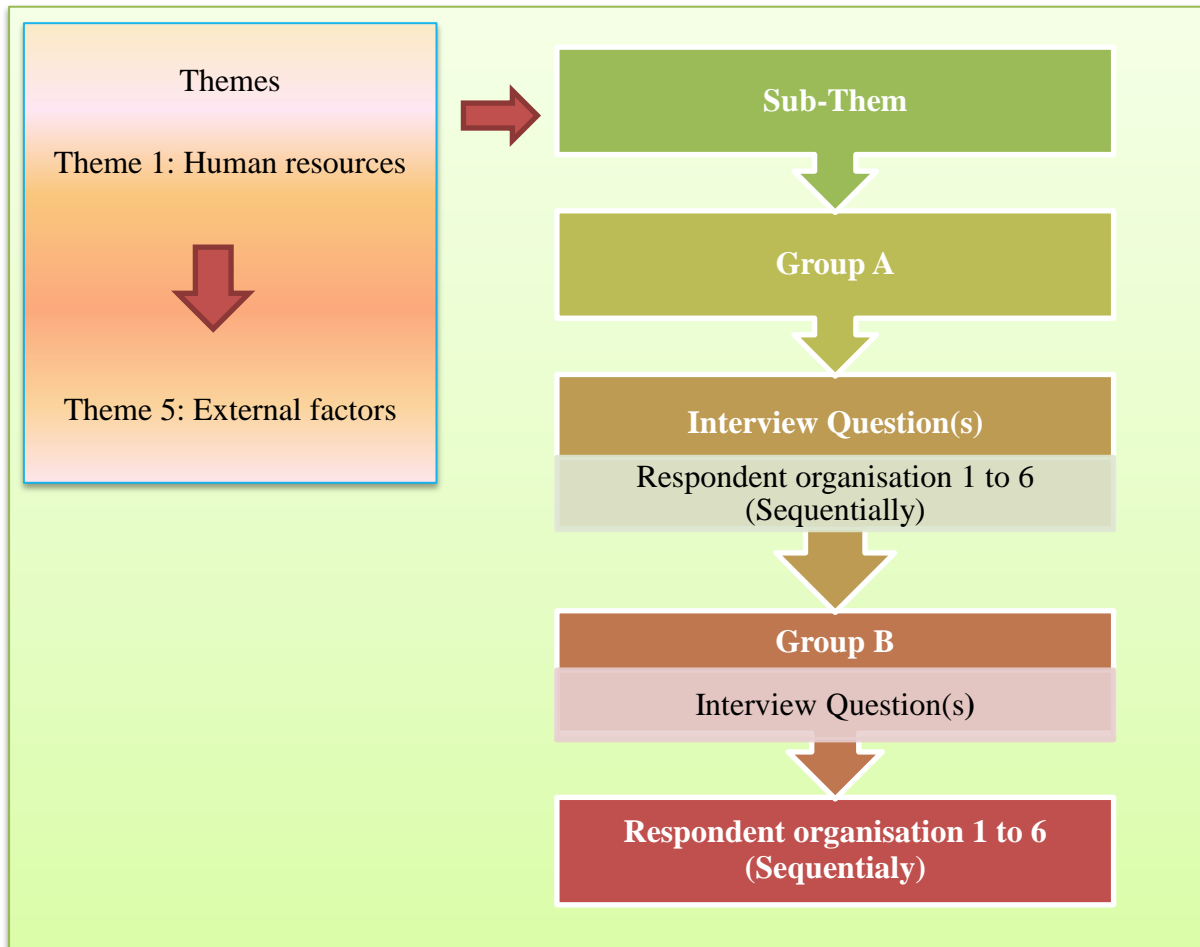


Figure 5.3: The presentation way of the findings from six organisations.

Source: Adopted from Gray (2014).

## 5.8 Study Findings

As mentioned previously, six e-commerce companies participated in the present study. Also, according to the listed problem factors developed in the literature review chapter two (cf. 2.15) and the results of the preliminarily study (cf. Appendix 2), twenty-three problem factors were classified into five themes of factors affecting software maintenance in e-commerce companies. Figure 5.4 shows the main themes related to factors affecting software maintenance. The next section will present the themes and sub-themes.

1. Human Resources Category

2. Organisational Environment Category

3. Operational Environment Category

4. Software Characteristics Category

5. External Factors Category

Figure 5.4: The main themes of factors affecting software maintenance.

## 5.9 Theme 1: Human Resources Category

In order to understand in-depth the influence of human resource factors on software maintenance, the researcher developed four sub-themes related to the main theme of human resources, and all the respondents were asked several questions about this issue.

### 5.9.1 Group (A) Software Maintenance Team

The first category of factors that affects software maintenance in the present research is the human resource factors. Table 5.5 shows the main theme, sub-themes high code, and sub-themes low code for human resource factors category, related to Group (A) software maintenance team.

| Table 5.5: The human resource factors category related to Group (A) | | |
|---|---|---|
| **Theme** | **Sub –Themes** <br><br> **High Code** | **Sub –Themes** <br><br> **Low Code** |
| Human resource | 5.9.1.1 Lack of employee experience in software maintenance. <br><br> 5.9.1.2 Skills of maintenance team. <br><br> 5.9.1.3 Domain knowledge. <br><br> 5.9.1.4 Mother tongue. | |

**5.9.1.1 Lack of employee experience in software maintenance**

The objective of this sub-theme is to understand in-depth if there is a lack of employee experience in software maintenance in e-commerce companies in Jordan or not.

**Interview Questions**

**Two interview questions asked to participants in Group (A)**

**Q1: Please, tell me about your work experience?**

**The Participants' Answers:**

**Company One:**

The participant (C1GAP1): I am a new graduate. I have just two years of experience in developing financial systems.

The other participant (C1GAP2) said: I have three years experience; two years in software development and one year in computer maintenance.

**Company Two**

The participant (C2GAP1) said: I have two years of experience; one year in computer maintenance and one year as a web designer.

**Company Three**

Participant (C3GAP1) said: I have two years' experience in programing oracle in the government sector.

In contrast, participant (C3GAP2) said: I worked for two years as a teacher in the Ministry of Education in Jordan and two years as a software developer.

**Company Four**

Participant (C4GAP1) said: I have three years experience; two years in e-commerce applications, and one year as a web designer.

**Company Five**

Participant (C5GAP1) said: I have four years experience; one year in computer maintenance, and three years as a software developer.

Participant (C5GAP2) said: I have two years experience; one year teaching computing in the Ministry of Education in Jordan and one year as a software developer.

**Company Six**

Participant (C6GAP1) said: I have two years experience; one year in a training company as a computer trainer and one year as a web designer.

Meanwhile, the researcher examined documents in the participants' companies and observed that all employees who have worked in software maintenance in e-commerce companies and moved to other companies have a lack of experience in maintenance of e-commerce applications.

**Q2: Are you working just in software maintenance or do you have other work in the company? If yes, explain the other work.**

**The Participants' Answers**

**Company One**

The participant (C1GAP1) said: Yes, I work in developing software and maintenance of software in the company, but also sometimes in data entry.

The participant (C1GAP2) said: Yes, I work in anything to do with IT. Sometimes, I am required to work in networking and sometimes the computer maintenance department.

**Company Two**

The participant (C2GAP1) said: Yes, sometimes the management requires me to do other work, especially if the e-commerce system is stable they ask me to do work in network maintenance and data entry.

**Company Three**

The participant (C3GAP1) said: Yes, I am working in software maintenance and software development, and also sometimes in data entry and maintenance of hardware.

However, participant (C3GAP2) said: No, I am working just in the software maintenance in this company.

**Company Four**

Participant (C4GAP1) said: No, I am just working in software maintenance and in anything related to maintaining or developing the system.

**Company Five**

Participant (C5GAP1) said: No, I am just working in software maintenance and in anything related to maintaining or developing the system.

Participant (C5GAP2) said: Yes, I am working in software maintenance and in management.

**Company Six**

Participant (C6GAP1) said: I am working in software maintenance and write reports to external maintenance companies to explain the problems in the system if required.

**5.9.1.2 Skills of Maintainers**

The objective of this point is to understand in-depth if the software maintenance team in e-commerce companies improve their skills by attending training courses related to software engineering.

Regarding this point, participants were asked about whether or not they attend training courses whilst working in e-commerce companies and if not, the reasons for not attending.

**Interview Questions**

**Q3: Do you attend any training courses for software engineering? If yes, what is the course and when was it last attended? If no, why not?**

**The Participants' Answers**

**Company One**

Participant (C1GAP1) said: No, there is no time to attend any courses. The management does not support training courses during working hours. Moreover, it is not required in the policy of the company for functional upgrade.

Participant (C1GAP2): No, because of the high cost of training the company does not provide any training course. Also, the management does not encourage doing so.

Meanwhile, with regard to skills of employees, the researcher examined records of employees who work in software maintenance in this company and observed that all employees' records do not contain any documents or certification about training courses.

**Company Two**

Participant (C2GAP1): I don't have time to attend any courses as I am working six days per week. Moreover, sometimes the management requests me to do other work, especially when the e-commerce system is stable. This might be network maintenance and data entry.

The researcher examined the records of employees who work in software maintenance and found it free of any documents related to improving skills.

**Company Three**

Participant (C3GAP1) said: Yes, I attended three courses last year; the last one was entitled "developing software in-house".

Participant (C3GAP2): Yes, I attended one training course last year, but it was not in my field; the course was "skills of employees".

In this respect, with regard to skills of employees the researcher examined records of employees who work in software maintenance in the company and observed that the employees who attended training courses did not get a certificate although some of the employees' records had attendance documents. Furthermore, the majority of training courses are not in the field of software maintenance, as some of the training courses names found are: skills of employees, senior management, and Microsoft Office.

**Company Four**

Participant (C4GAP1) said: No, I didn't attend any training courses in any topic, as the company doesn't support training. Moreover, I can't attend training courses, which are self-funded because the training in the field of software engineering is costly.

**Company Five**

Participant (C5GAP1) said: Yes, when I was starting work in the company I attended a course related to software adopted in the company. It lasted 40 hours.

Participant (C5GAP2) said: Yes, just when I was starting work in the company there was a course about "the structure of the system".

In this respect, the researcher examined the records of all employees who work in software maintenance in the company and he did not find any documents regarding training courses.

**Company Six**

Participant (C6GAP1) said: No, I did not attend any training course since starting work in the company; the company doesn't support any training courses.

Regarding improvement of skills, the researcher observed whilst asking the question about training that all employees in software maintenance stressed the significance of training for improving the skills of workers in software maintenance.

### 5.9.1.3 Domain Knowledge

The objective of this point is to understand if the maintenance team in e-commerce companies in Jordan save domain knowledge in the work or not. Also, it was to learn if the management has given any importance to saving domain knowledge in software maintenance work.

**Interview Question**

**Q4: Do you have any plan or system to save the domain knowledge that deals with maintenance processes in the system? If yes, explain. If no, why not?**

**The Participants' Answers**

**Company One**

Participant (C1GAP1) said: Saving domain knowledge is the management's responsibility, not the responsibility of staff in the company. Moreover, it is not required in my company.

Participant (C1GAP2) said: No, it is not required in the company to plan or save domain knowledge.

**Company Two**

Participant (C1GAP2) said: No, the senior management does not require or use any plan for software maintenance. Furthermore, saving domain knowledge is the responsibility of the management, not the employees.

**Company Three**

Participant (C3GAP1) said: No we don't have any plan or system to save domain knowledge in the process of software maintenance. Also, when I started working in the company I didn't find anything regards saving domain knowledge.

Also, participant (C3GAP2) said: No, we don't have any plan or system to save domain knowledge, it's not required from the senior management in the company.

**Company Four**

Participant (C4GAP1) said: No, we don't have any plan to save domain knowledge; it's not required by the management. Moreover, it is the responsibility of the management to create the policy or plan for work.

**Company Five**

Participant (C5GAP1) said: No, we don't have any plan to save domain knowledge. It is not required by the management.

Participant (C5GAP2) said: No, the company does not have any plan to save domain knowledge in software maintenance. I do what is required of me in my job.

**Company Six**

Participant (C6GAP1) said: No, we don't have any plan to save domain knowledge. It is not required from the management. Also, I think that is the responsibility of the management of the company, not the responsibility of employees.

In this respect, the researcher observed during asking questions to all participants that the management does not given any importance to domain knowledge

**5.9.1.4 Mother Tongue**

The researcher observed when conducting the preliminary study in e-commerce companies in Jordan that, the employees in software maintenance mentioned the effect of their native language on their work. Thus, the researcher in the main study asked the employees whether or not their native language influences software maintenance.

**Interview Questions**

**Q5: Do you face any problems related to your mother tongue as regards your work? If yes, how?**

**The Participants' Answers**

**Company One**

Participant (C1GAP1) said: Yes, sometimes I face problems related to my mother tongue of Arabic, especially when dealing with external companies.

Participant (C1GAP2) said: Yes, sometimes when I seek to solve a problem in the system I face problems related to translating the error message from English to Arabic. From my experience, I think sometimes the language affects my work.

**Company Two**

Participant (C2GAP1) said: Yes, sometimes when I contact external maintenance companies English is the common language.

**Company Three**

Participant (C3GAP1) said: No, I didn't face any problems related to my mother tongue in software maintenance work.

Participant (C3GAP2) said: Yes, sometimes when I am searching for a solution to software maintenance through websites.

**Company Four**

Participant (C4GAP1) said: Yes, sometimes when I am reviewing the user guide about the applications adopted in the company.

**Company Five**

Participant (C5GAP1) said: No, we didn't face any problems related to my mother tongue of "Arabic".

Also, participant (C5GAP2) emphasised the same answer of Participant (C5GAP1). He said: No, we didn't face any problem related to my mother tongue "Arabic".

**Company Six**

Participant (C6GAP1) said**:** Yes, the language of communication with external maintenance companies is English.

**5.9.2 Group (B) Senior Management**

Regarding the theme of human resource factors, the researcher has developed four sub themes related to Group (B) in the study. Table 5.6 shows the main theme, sub-themes high code, and sub-theme low code for human resource factors category, related to Group (B) senior management.

| Table 5.6: Human resource category related to Group (B) | | |
| --- | --- | --- |
| **Theme** | **Sub –Themes**<br><br>**High Code** | **Sub –Themes**<br><br>**Low Code** |
| Human resource | 5.9.2.1 Lack of employee experience in software maintenance<br><br>5.9.2.2 Skills of maintenance team.<br><br>5.9.2.3 Employee turnover<br><br>5.9.2.4 Mother tongue | |

**5.9.2.1 Lack of Employee Experience in Software Maintenance**

The objective of this point is to understand in-depth if there is a lack of employee experience in software maintenance in e-commerce companies in Jordan from senior management views. Also, the objective was to learn if the senior management adopt any criteria in selecting employees in software maintenance.

**Interview Questions**

**Q6: Do you think there is a lack of employee experience in system maintenance especially in e-commerce applications in Jordan?**

**The Participants' Answers**

**Company One**

Participant (C1GBM) said: Yes, there are a lot of employees in Jordan working in the field of IT, but few of them have experience in the field of software maintenance, especially in e-commerce application. Sometimes, we are forced to accept employees who have a lack of experience in software maintenance.

**Company Two**

Participant (C2GBM) said: Yes, there is a lack of employee experience in the field of software maintenance in e-commerce application.

**Company Three**

Participant (C3GBM) said: Yes, there is a lack of employees who work in maintenance of e-commerce application. And it's one of the factors that affect developing e-commerce in Jordan.

**Company Four**

Participant (C4GBM) said: Yes, in general there is a lack of employee experience of those working in software maintenance, particularly in the application of e-commerce.

**Company Five**

Participant (C5GBM) said: Yes, there is a lack of employee experience in the field of software maintenance. E-commerce entered Jordan a couple of years ago, so it is normal to find a lack of employees who have experience in software maintenance.

**Company Six**

Participant (C6GBM) said: Yes, there is a lack of employee experience in software maintenance, especially in maintenance of e-commerce application.

**Q7: Are there any criteria that help to select employees in software maintenance? If yes, what are these criteria?**

**Participant Answers**

**Company One**

Participant (C1GBM) said: Yes, there are criteria based on the qualifications of employees and experience in the field of e-commerce application. Moreover, the new employee should spend one month in an experimental stage to prove their ability to work in software maintenance, otherwise separated from work.

**Company Two**

Participant (C2GBM) said: Yes, the criteria are based on the qualifications, experience in the same field, and interviews.

**Company Three**

Participant (C3GBM) said: Yes, the criteria are based on qualifications of employees and experience, passing the exam and interviews with the management.

**Company Four**

Participant (C4GBM) said: Yes, the company has criteria to select employees in the software maintenance section. The criteria is based on qualifications of employees, experience in the field of software maintenance, and interviews.

**Company Five**

Participant (C5GBM) said: Yes, the criteria include passing a competitive examination and interviews. Also, there is a job description for any function.

**Company Six**

Participant (C6GBM) said: Yes, the criteria include qualifications, experience in software maintenance, and experience in maintenance in e-commerce companies.

**5.9.2.2 Skills of Maintenance Team**

The objective of this point is to know if the senior management in e-commerce companies in Jordan seek to improve the skills of the software maintenance team to reach the advancements in maintenance of technology.

**Interview Question**

**Q8: Are you interested in improving the skills of employees in software maintenance? If yes, how? If no, why not?**

**The Participants' Answers**

**Company One**

Participant (C1GBM) said: Yes, the policy of the company seeks to develop the skills of all employees in the company through training courses and workshops after working times.

**Company Two**

Participant (C2GBM) said: Yes, the company is interested in improving the skills of employees through participation with the employees in the training courses and paying part of the training costs.

**Company Three**

Participant (C3GBM) said: Yes, but without additional cost for the company. I think it is the responsibility of employees to improve their skills to be able to work in the company.

**Company Four**

Participant (C4GBM) said: Yes, but I think improving the skills of employees is the responsibility of the employees, not the company. The company gives the employees a salary for doing tasks, so the employees should do what is asked of them and improve their skills to perform their tasks.

**Company Five**

Participant (C5GBM) said: Yes, I am very interested in improving the skills of employees through the training courses and workshop sessions after working hours.

**Company Six**

Participant (C6GBM) said: Yes, I am interested but sometimes the problem of employee turnover affects the ability to improve the skills of employees.

**5.9.2.3 Employee Turnover**

The objective of this point is to know if there is functional stability in e-commerce companies in Jordan, particularly in the software maintenance team.

**Interview Question**

**Q9: Do you face problems with employee turnover in software maintenance? If yes, how do you deal with it? If no, what do you do to reduce the employee turnover?**

**The Participants' Answers**

**Company One**

Participant (C1GBM) said: No, I didn't face problems in employee turnover mainly because a software developer owns part of the company. We reduce the employee turnover in the company, because the software developer in the company is able to work alone. But I think there is a high employee turnover in e-commerce companies in Jordan, especially in the field of IT.

**Company Two**

Participant (C2GBM) said: Yes, there are problems of employee turnover, but to reduce the employee turnover the company deals with it through a penalty clause in the employee contract for if the employee leaves the job before finishing the contract.

**Company Three**

Participant (C3GBM) said: No, I don't face problems related to employee turnover in software maintenance, because the employee who developed the system owns part of the company.

**Company Four**

Participant (C4GBM) said: Yes, I faced the problem of employee turnover in the company. Indeed, to reduce the impact of employee turnover in software maintenance work the company increase the salary of employees every six months to encourage the employees to continue working in the company.

**Company Five**

Participant (C5GBM) said: Yes, turnover is the greatest problem facing the management in the company. The policy of the company is to give incentives to the employees to ensure the survival of employees in the company.

**Company Six**

Participant (C6GBM) said: The main factor that affects software maintenance is the employee turnover as new employees need more time in the beginning of the work to understand the system and maintenance. Many employees work in the company for a period of two months or three months, and unfortunately after that they move to another company that perhaps gives a better offer. This case occurred many times in the company. To reduce the turnover in the company, an annual bonuses system has been adopted to encourage employees to continue working in the company.

### 5.9.2.4 Mother Tongue

The objective of this point to understand if the mother tongue of the software maintenance team in e-commerce companies in Jordan affected software maintenance, through the experience of senior management.

**Interview Question**

**Q10: Do you think the mother tongue of the employees affect their work? If yes, how?**

**The Participants' Answers**

**Company One**

Participant (C1GBM) said: Yes, from my experience I think the mother tongue directly or indirectly affects software maintenance. Many times the employees in software maintenance misunderstand the error message in the system, which is usually written in English language. Moreover, the Arabic language affects the software when there is the need to translate the interface from English to Arabic.

**Company Two**

Participant (C2GBM) said: Yes, the mother tongue of employees affects software maintenance work, mostly in understanding the problem in the software or when translating the problems from English to Arabic.

**Company Three**

Participant (C3GBM) said: Yes sometimes, especially when the software maintenance employee is required to communicate with a consultation IT company. Also, the Arabic language affects their work when they need to translate the interface to Arabic in global software.

**Company Four**

Participant (C4GBM) said: Not always, the language does not always affect software maintenance work; sometimes it affects the translation of some errors in the software.

**Company Five**

Participant (C5GBM) said: Yes, especially when the employees are required to write a report about the problems in the software using the English language.

**Company Six**

Participant (C6GBM) said: Yes, the mother tongue affects the work. Very often the employees of software maintenance face problems in translating the error messages from English to Arabic and vice versa.

## 5.10 Theme Two: Organizational Environment Category

### 5.10.1 Group (A) Software Maintenance Team

In order to understand in-depth the influence of organisational environment on software maintenance, the researcher divided the theme organisational environment into two sub-themes: managerial issues and standards, and maintenance classifications and each one includes sub-themes. Table 5.7 shows the main category, theme, sub-themes high code, and sub-themes low code for the organisational environment category related to Group (A) software maintenance team. All the respondents were asked several questions about this issue.

| Table 5.7: Organisational environment factors category | | |
|---|---|---|
| **Theme** | **Sub –Themes** <br><br> **High Code** | **Sub –Themes** <br><br> **Low Code** |
| Organisational environment | 5.10.1.1 Managerial issues | 5.10.1.1.1 Management support. <br><br> 5.10.1.1.2 Communication with management. <br><br> 5.10.1.1.3 Communication with IT staff. <br><br> 5.10.1.1.4 Obstacle |
| | 5.10.1.2 Standards and maintenance classifications. | 5.10.1.2.1 Standard and methodology of software maintenance adopted. <br><br> 5.10.1.2.2 Classification of software maintenance. |

**5.10.1.1 Managerial Issues**

To understand in depth the effect of managerial issues on software maintenance and the performance of the work, the researcher has divided the themes of managerial issues into four sub-themes. Full findings about sub-themes are below:

**5.10.1.1.1 Management Support**

The objective of this point is to understand in-depth if the management supports the software maintenance team or not in e-commerce companies in Jordan, and also to understand how this support reflects on the software maintenance.

Two interview questions were asked to participants in Group (A) to get in-depth information regarding management support.

**Interview Questions**

**Q11: Does the senior management support the IT department and give the department attention? If yes, how?**

**The Participants' Answers**

**Company One**

The participant (C1GAP1) said: The attention of senior management in the IT department will be increased with the motivation in the work. And in addition, often the attention from the senior management is only on financial side while the human side is ignored.

Participant (C1GAP2) said: Yes, the management give attention and support to the IT department through financial rewards within the possibilities of the company. Sometimes the budget affects the level of support.

**Company Two**

Participant (C2GAP1) said: No, the management doesn't give the software maintenance team any attention. Indeed, there is pressure at work.

**Company Three**

Participant (C3GAP1) said: Yes, the senior management supports the IT department and gives them financial and moral support. It is also focused on giving training courses to improve their skills.

And, participant (C3GAP2) said: Yes, the management gives attention to the software maintenance department. Most of the attention is given to financial matters. But sometimes we face stress from the management with respect to the long working hours

**Company Four**

Participant (C4GAP1) said: Yes, the senior management supports the IT department and gives them attention through sharing the decisions related to improving the software maintenance. Moreover, senior management accepts the ideas offered by the software maintenance employees.

**Company Five**

Participant (C5GAP1) said: Not so much if we compare with the rest of the company.

Participant (C5GAP2) said: Yes, the management supports the IT department and gives them high priority in the company. Moreover, the company gives the employees in the IT department financial rewards.

**Company Six**

Participant (C6GAP1) said: The company doesn't have an IT department. I'm just an employee who works in the field of IT in the company and the management does not give me any attention.

**Q12: Do you get involved in the decisions related to software maintenance? How?**

**Participants' answers**

**Company One**

The participant (C1GAP1) said: Yes, when the system is broken or the company has a desire to update the system. Also, when the management needs to make a decision regarding changing the software application. But sometimes the management ignore the employees' maintenance feedback regarding the software maintenance process.

In addition, participant (C1GAP2) said: Sometimes the senior management orders me to provide and review the current status about software and the vision for the future of software. But the final decision lies with the high management.

**Company Two**

Participant (C2GAP1) said: No, the management does not involve the employees in the decisions.

**Company Three**

Participant (C3GAP1) said: Yes, sometimes when the company plans to buy new hardware for an e-commerce application or when the company wishes to change the operating system.

On other hand, participant (C3GAP2) said: Not always. The first person involved in the decision is the IT manager and the employees in the IT department give notes about the application used in the company.

**Company Four**

Participant (C4GAP1) said: Yes, sometimes the senior management when they need to make a decision related to improving the e-commerce application in the company they asked employees in the maintenance section their opinions about the decision.

**Company Five**

Participant (C5GAP1) said: Yes, the management asked me many times to write a report about the situation of existing software. Moreover, they did not make any decision related to software without consulting the software maintenance manager or the employees in the department.

Participant (C5GAP2) said: Yes, the management when they need to change or improve the system in the company seeks to involve the employees in the IT department in their decisions.

**Company Six**

Participant (C6GAP1) said: No, the management doesn't share the decision with any employees in the company.

**5.10.1.1.2 Communication with Management**

The objective of this point is to understand in-depth the relationship and communication channels between the management of the e-commerce companies in Jordan and the maintenance team from the view of the software maintenance team. Thus, the participants were asked about whether or not they have communication channels and regular meetings with the management and if there any barriers to communicating with the senior management.

**Interview Questions**

**Q13: Do you face any barrier(s) to communicating with senior management? If yes, why? How?**

**Participants' Answers**

**Company One**

The Participant (C1GAP1) said: No, there aren't any barriers to communicating with senior management any time when they are available. However, often the senior managers are busy.

Also, participant (C1GAP2) gave the same answer as participant one. He said: No, there aren't any barriers to communicating with senior management any time, but the senior management is often so busy.

**Company Two**

Participant (C2GAP1) said: No barriers to communicating with senior management.

**Company Three**

Participant (C3GAP1) said: No barriers are faced in communicating with senior management. Senior management are active with all employees in the IT department. Moreover, they have a good idea about the significance of software applications in the work of the company.

However, participant (C3GAP2) said: Yes, sometimes I faced barriers in communicating with senior management, because there are procedures that have to be followed in the company for communicating with high levels of management, the "Administrative hierarchy".

**Company Four**

Participant (C4GAP1) said: Yes, sometimes there are barriers to communicating with senior management due to the nature of their work. Also, regulations and instructions in the company form a barrier to direct contact with senior management.

**Company Five**

Participant (C5GAP1) said: No, there aren't any barriers related to communicating with IT managers or senior management. I can meet the management any time when they have time, but usually the management is busy.

Participant (C5GAP2) said: No, probably because I am working in management and software maintenance.

**Company Six**

Participant (C6GAP1) said: No, there aren't any barrier(s) to communicating with senior management. I am working in a small company and we can count the total employees on one hand.

**Q14: Do you have regular meetings with the senior management? If yes, how many times a month? Why? If no, why not?**

**Participants' Answers**

**Company One**

Participant (C1GAP1) said: Yes, but not regular meetings. The meetings are to discuss the percentage of achievement at work. The number of meetings in a month depends on the developments at work. The average number of meetings is once a month.

Participant (C1GAP1) said: I do not attend any meeting with senior management in the company during my work. Maybe the administrators of the software maintenance in the company attend some meetings.

**Company Two**

Participant (C2GAP1) said: Not regular meetings. The meetings depend on the progress in the work or when something abnormal occurs in the e-commerce application, but usually there is one meeting monthly.

**Company Three**

Participant (C3GAP1) said: Yes, the meeting is once a month to discuss the progress in the work and to avoid any challenges related to e-commerce application.

Participant (C3GAP2) said: Yes, we have regular meetings with senior management, which take place approximately once a month to discuss the challenges in the work.

**Company Four**

Participant (C4GAP1) said: No, not regular meetings. The meeting is to discuss managerial issues in the work, usually once every two months.

**Company Five**

Participant (C5GAP1) said: Not regular meetings, but sometimes once a month to discuss the progress of the work. The management does not give the meeting with small employees any attention.

Participant (C5GAP2): Not regular. It depends on the progress in the work in the company. Normally there is one meeting monthly.

**Company Six**

Participant (C6GAP1) said: Not regular and not formal meetings either. They are sometimes daily and sometimes weekly; it depends on the progress in the work.

As regards meetings with the senior management and software maintenance team in e-commerce companies, the researcher examined the documents and did not find any document documenting meetings.

### 5.10.1.1.3 Communication with IT Staff

The aim of this point is to understand in-depth the relationship between the IT staff via interview questions asked about the communicational channels with staff.

**Interview Question**

**Q15: Do you have regular meetings with the software maintenance team? If yes, how many times a month?**

**Participants' Answers**

**Company One**

Participant (C1GAP1) said: Yes, but not regular meetings. The meetings are to discuss the percentage of achievement at work. The meeting depends on the progress of the work. On average, it is once a month.

Participant (C1GAP2) said: Not regular meetings. The meetings with the team of software maintenance take place when something urgent occurs in the system. The last meeting was two months ago.

**In this respect, the researcher asked the two participants if they document the meetings.**

Participant (C1GAP1) said: Sometime we document meetings but not always.

Participant (C1GAP2) said: I don't have any idea if the meeting is documented or not.

Also, the researcher reviewed the documents of the company and did not find any meeting documents.

**Company Two**

Participant (C2GAP1) said: No, I am the only employee working in software maintenance in the company.

**Company Three**

Participant (C3GAP1) said: Yes, there are regular meetings with the software maintenance team. There are four meetings monthly to discuss the progress of the work and to discuss any new issues in the work.

Participant (C3GAP2) said: Yes, I have regular meetings with the team of software maintenance in the company. The meeting takes place once a week (four meetings monthly) and is to discuss the progress of the work and any problems in the system or in the company that is affecting the software maintenance work.

Meanwhile, the researcher accessed some agendas of the meetings in the company and observed that the meetings focused on managerial issues and ignored the technical issues.

**Company Four**

Participant (C4GAP1) said: At this time, the company doesn't have a software maintenance team. I am working alone in the software maintenance department. For seven months we had one employee working with the software maintenance team but he left the company. Indeed, when we were two employees working in the same department we didn't have regular meetings because we could manage everything directly when it happened.

**Company Five**

Participant (C5GAP1) said: Yes, we have daily in the morning a regular meeting to discuss the progress of work, and also to discuss the new tasks.

Participant (C5GAP2) said: Yes, we have regular meetings every day to discuss the distribution of tasks in software maintenance.

**Company Six**

Participant (C6GAP1) said: No, the company doesn't have a software maintenance team. I am working alone in the IT department.

**Q16: Do you have regular meetings with the IT department team? If yes, how many times a month? Why? If no, why not?**

**Participants' Answers**

**Company One**

Participant (C1GAP1) said: No, because the company doesn't have an IT department; it only has a development and maintenance section.

Participant (C1GAP2) said: No, because the company doesn't have an IT department.

**Company Two**

Participant (C2GAP1) said: No, I am the only employee in the company working in the IT field.

**Company Three**

Participant (C3GAP1) said: Yes, we have regular meetings with the employees in the IT department. The policy of the company is to focus on teamwork, and orders from the IT manager to discuss the plan of work. The IT department meets four times per month and sometimes more than four as it depends about the progress of the work.

Participant (C3GAP2) said: Yes, I have regular meetings with the software maintenance team in the company. The meeting takes place once a week, and the main objective of these meetings is to overcome obstacles facing the IT department.

The researcher asked whether the meeting is documented or not.

The answer from both participants was the same: No, we didn't document the meeting.

**Company Four**

Participant (C4GAP1) said: No, we don't have regular meetings. The meeting takes place when something urgent happened in the e-commerce application.

**Company Five**

Participant (C5GAP1) said: Not regular meetings. The meeting depends on the problems in the IT environment or when we need to change hardware or update the system to discuss the probable risks of the change.

Participant (C5GAP2) said: Not regular meetings. The meetings take place when something unusual happens in the system or in the work in software maintenance and these issues are dependent on other people in the IT department.

**Company Six**

Participant (C6GAP1) said: No, the company doesn't have a software maintenance team. I am working alone in the IT department.

As regards the meeting documents, the researcher accessed the documents in the IT departments that had meetings but he did not find any documents regards meeting documents. Also, the researcher observed that the meetings did not take any official status.

**5.10.1.1.4 Obstacle**

The objective of this point is to understand in-depth the obstacles that face the software maintenance team and influence software maintenance.

**Interview Question**

**Q17: Are there any obstacles in software maintenance that make the maintenance complex? If yes, explain.**

**Participants' Answers**

**Company One**

Participant (C1GAP1) said: Yes, sometimes the software used in the company is too old and without documentation, so that makes the maintenance complex. Also, improving the skills of employees is often ignored by the management.

Participant (C1GAP2) said: Usually the high speed of new technology means continuous updates to the system. Also, there is attention and support given from the management to employees.

**Company Two**

Participant (C2GAP1) said: One the most common obstacles in the company is related to software maintenance and the software built out of company (outsource), as sometimes there are problems in contacting the developer.

**Company Three**

Participant (C3GAP1) said: Yes, sometimes experience and the skills of employees affect the development of the software maintenance plans and creates problems in the work, especially with new graduates who work in the maintenance field.

Participant (C3GAP2) said: Yes, sometimes the low speed of internet connection with the end users increases the load on the maintenance team to deal with this problem and update the software to work on different speeds of internet and variety browsers.

**Company Four**

Participant (C4GAP1) said: Yes there are many obstacles that make maintenance complex such as, the skills of employees in the company, availability of training courses in the field of software maintenance, and the communication links with the software maintenance consultant companies that have been adopted in the company.

**Company Five**

Participant (C5GAP1) said: Yes, the communication between the company and the other company who produced the software. Sometimes it takes time to solve the problems.

Participant (C5GAP2) said: Yes, there are many obstacles faced by the company that affect the software maintenance, such as lack of experience in employees, and high speed in technology.

**Company Six**

Participant (C6GAP1) said: Yes there are many obstacles that make maintenance complex such as, the skills of employees in the company, availability of training courses in the field of software maintenance, and the communication links with the software maintenance consultant companies that have been adopted in the company.

### 5.10.1.2 Standards and Maintenance Classifications

The objective of the questions related to this sub-theme is to discover whether the employees in the software maintenance of e-commerce companies in Jordan have any idea about standards and methodology of software maintenance, and to understand if they use standards and methodologies of maintenance in their work.

### 5.10.1.2.1 Standard and Methodology of Software Maintenance Adopted

Regarding this point, the participants from Group (A) were asked about whether or not they adopt software maintenance standards in their work.

Two interview questions were asked to obtain in-depth information about using methodology or standards of software maintenance in e-commerce companies in Jordan.

**Interview Questions**

**Q18: Do you use any approaches or methodology in software maintenance? If yes, describe the approach? If no, why not?**

**Company One**

Participant (C1GAP1) emphasized that he did not use any methodology in software maintenance. He said: No, we don't use methodology in my work. From my perspective, I think the methodology needs a big team of workers while the company has just two employees in software development and maintenance. Moreover, I have not been required to use any methodology since I have worked in the company.

It is somewhat surprising that participant (C1GAP2) answered with the following: No, I don't use any methodology or approach in software maintenance. The reason is I don't have any idea about any methodology in software maintenance. Also, it is not required in the company to use any methodology.

**Company Two**

Participant (C2GAP1) said: No, there is no methodology supported in software maintenance in the company; it is not required by the management.

**Company Three**

Participant (C3GAP1) said: No, we don't use any software maintenance methodology or approach in software maintenance department. It is not required by the management.

Also, participant (C3GAP2) said: No, I don't use any approach or methodology in software maintenance in the work. Indeed, I don't have any knowledge about approach or methodology in software maintenance.

**Company Four**

Participant (C4GAP1) said: No, I don't use any standard or methodology for software maintenance. From my perspective, the approaches and methodologies need great teams and more time in work, so we do not adopt them in the company.

**Company Five**

Participant (C5GAP1) said: The company does not adopt any methodology or approach in software maintenance. This is the policy of the work in the company from senior management.

Participant (C5GAP2) said: The company does not adopt any methodology in software maintenance in the company. I think the reason is lack of experience and skills of employees in software maintenance.

**Company Six**

Participant (C6GAP1) said: No, we don't use any methodology in software maintenance. The company does not do maintenance in-house; we just translate the problems to the external software company.

**Q19: Do you use any standard in the software maintenance process? If yes, what is the standard?**

**Participants' Answers**

**Company One**

Participant (C1GAP1) said: No software maintenance standards are used in the software maintenance process.

Participant (C1GAP2) said: No, the company doesn't use any software maintenance standards in software maintenance work. Indeed, one of the reasons for not using any standards is that the system adopted in the company was not built to any software standards.

**Company Two**

Participant (C2GAP1) said: No software maintenance standards are used in software maintenance in the company.

**Company Three**

Participant (C3GAP1) said: No software maintenance standards are used in the company. It's not required from the management.

Participant (C3GAP2) said: No, we don't use any standards; the company hasn't adopted any software maintenance standards in the work.

**Company Four**

Participant (C4GAP1) said: No, the company has not adopted any software maintenance standards in the work.

**Company Five**

Participant (C5GAP1) said: No, we never used standards in the software maintenance in the company. Actually, I don't have any idea about software maintenance standards.

Participant (C5GAP2) said: No, the company doesn't use any standard for software maintenance standard. Furthermore, it is not required for the work in the company.

**Company Six**

Participant (C6GAP1) said: No, we don't use any software maintenance standard in the company.

### 5.10.1.2.2 Classification of Software Maintenance

The objective of this sub-theme is to understand in-depth if the software maintenance team in e-commerce companies in Jordan adopt any plan in the work or not, as well as to discover if they classify the problems when they occur in the e-commerce application or not.

**Interview Question**

**Q20: Does your company have any plan to deal with software maintenance processes? If yes, what is it? Why? If no, why not?**

**Participants' Answers**

**Company One**

Participant (C1GAP1) said: Yes, the company has a plan for software maintenance but the problem is the plan is very old and does not support the future of software use in e-commerce application.

**The researcher asked, what is the plan?**

The participant said: The plan is confidential; I can't tell you any information regarding the plan of work.

Participant (C1GAP2) said: The company has a small plan for software maintenance, which includes fixing bugs when they occur and ensuring the continuance of working on the system. The problems are not always classified, as we need to solve the problem as quickly as possible.

**Company Two**

Participant (C2GAP1) said: The company does not have any plan for dealing with software maintenance.

**Company Three**

Participant (C3GAP1) said: Yes, the company has a plan to deal with software maintenance and it includes the processes required through from discovering the problem to delivering the best solution.

Regarding the plan of software maintenance, the researcher asked the participant (C3GAP1), **could you please explain or show me the plan you adopted?**

The participant said (C3GAP1): The plan is confidential to the company.

Participant (C3GAP2) said: Yes, the company has planned to ensure the sustainability and continuation of work.

**The researcher asked a further question: What is the plan?** The answer was that the plan was confidential to the company.

**Company Four**

Participant (C4GAP1) said: Yes, the company has a plan to deal with the software maintenance to ensure business continuity during the occurrence of the problems in the system. Moreover, the plan includes classification of errors into two groups (urgent, not urgent).

The researcher asked participant (C4GAP1) about the plan.

**The question is: can you please show me the plan and explain to me more about it?**

The participant said: Sorry I can't, the plan is confidential.

**Company Five**

Participant (C5GAP1) said: The company has a plan for software maintenance. The plan includes the processes from discovering the problem until solving the problem. The IT manager, when they receive calls about problems in the system, gives a number for the problem and after that, transfers the problem to the responsible employee and gives a specific time for fixing the problem. If the problem is not solved in the IT department in the company, the company sends the problem to an outsource software maintenance company, which already has a contract with us.

Also, participant (C5GAP2) said: Yes, the company has plans to deal with software maintenance in the company, and the plan includes the process from fixing bugs or ordering updates until the required tasks are achieved. The plan is confidential for the company.

**Company Six**

Participant (C6GAP1) said: No, because I am working in the company as a mediator between the company and the external software maintenance company.

### 5.10.2 Group (B) Senior Management

As regards the theme organisational environment factors, the researcher sought to understand in-depth the factors that affect software maintenance from the view of senior management, and has developed sub-themes related to the main theme of organisational environment from the views of senior management. Table 5.8 shows the main theme, sub-themes high code and, sub-theme low code related to organisational environment factors.

| Table 5.8: Organisational environment category related to Group (B) | | |
|---|---|---|
| **Theme** | **Sub –Themes** <br><br> **High Code** | **Sub –Themes** <br><br> **Low Code** |
| Organisational environment | 5.10.2.1 Managerial issues | 5.10.2.1.1 Management support. <br><br> 5.10.2.1.2 Communication with management. |
| | 5.10.2.2 Budget of the company | |

### 5.10.2.1 Managerial Issues

### 5.10.2.1.1 Management Support

The objective of this point is to understand in-depth the attention and support from senior management to the IT team and software maintenance team especially. Also, the aim was to understand if the e-commerce companies in Jordan have a separate section in the IT department or not.

Two questions were asked to the senior management.

**Interview Questions**

**Q21: Do you have separate sections in the IT department? If yes, what are the sections? If no, why not?**

**Participants' Answers**

**Company One**

Participant (C1GBM) said: No, I have only one section. The section is software development and maintenance. The size of work in the company doesn't require separate sections.

**Company Two**

Participant (C2GBM) said: No, the company has one section of software maintenance, because the amount of work does not require a large number of employees.

**Company Three**

Participant (C3GBM) said: Yes the company has an IT support section and software maintenance section. The main reason for the separate sections is to make the IT work more organized.

**Company Four**

Participant (C4GBM) said: Yes, I have separate sections with small numbers of employees. The software maintenance section has one employee and the network and support section has one employee.

**Company Five**

Participant (C5GBM) said: Yes, I have two separate sections to organize the work, the sections are: IT support section and software maintenance section.

**Company Six**

Participant (C6GBM) said: No, the amount of work does not require a lot of employees in the field of IT so there is no need to make separate sections.

**Q22: Are the IT employees involved in making decisions in respect to the software or software maintenance?**

**Participants' Answers**

**Company One**

Participant (C1GBM) said: Yes, IT employees are the most important employees of the company and they are involved in anything related to software and software maintenance.

**Company Two**

Participant (C2GBM) said: Sometimes the IT employees are involved for some decisions in software maintenance.

**Company Three**

Participant (C3GBM) said: Yes, the IT employees are involved in decisions related to software maintenance. Indeed, "the IT employees are considered the beating heart of the company".

**Company Four**

Participant (C4GBM) said: Yes, the employees in the IT department are involved in any decision related to software or software maintenance. Furthermore, I welcome any views of employees for improving the performance of the work, especially in software and maintenance of the software.

**Company Five**

Participant (C5GBM) said: Yes, because the employees in the IT department have full knowledge about software and the maintenance, so they can make strong decisions related to the software maintenance.

**Company Six**

Participant (C6GBM) said: No, we do not involve the maintenance employees in the decision-making all the time, as only the management should be involved in the decisions.

**5.10.2.1.2 Communication with Management**

The objective of this sub-theme is to understand whether or not the senior management has communication channels and regular meetings with the software maintenance team or not.

**Interview Question**

**Q23: Do you have regular meetings with the software maintenance team?**

**Participants' Answers**

**Company One**

Participant (C1GBM) said: Not a regular meeting; the meeting depends on the development of the work. Usually, we have them when I have a time.

**Company Two**

Participant (C2GBM) said: Not a regular meeting. It depends on the problems in the work or the progress of the work. Usually, there is one or two per month.

**Company Three**

Participant (C3GBM) said: Yes, we meet the software maintenance team but not regularly. The meeting depends on the progress of the work.

**Company Four**

Participant (C4GBM) said: Not regular meetings, but usually once a month.

**Company Five**

Participant (C5GBM) said: Not regular meetings. The meeting depends about the progress of the work and when I have free time. Normally, it is once a month.

**Company Six**

Participant (C6GBM) said: Not regular meetings, because the company has a small amount of work and employees, so I can discuss matters with any of the employees at any time.

**5.10.2.2 Budget of the Company**

The objective of this point is to understand in-depth if the budget of the company affects software maintenance or not. Also, it is to understand how the budget affects it from the view of senior management, as they usually know the company's budget.

**Interview Question**

**Q24: Do you think the budget of the company affects the software maintenance? If yes, how? If no, why not?**

**Company One**

Participant (C1GBM) said: Yes, the budget affects the choice of workstation and devices used in the application of e-commerce type, such as storage devices, server, network, and communications. Many times the problems that occur in the system are related to the hardware used. Also, the budget affects the choice of employees working in software maintenance. The employees who have good experience demand high salaries. All the reasons above can lead to increasing the effort in software maintenance.

**Company Two**

Participant (C2GBM) said: Yes, the budget affects the quality of the software used in the company, and also the environment of software such as, the hardware used, the server, network, and storage devices.

**Company Three**

Participant (C3GBM) said: Yes, the budget affects the choice of hardware and original software adopted in the company, which plays an important role in software maintenance. The software maintenance team found that many of the problems that occur in the system are caused by the lack of quality of the equipment used in the application.

**Company Four**

Participant (C4GBM) said: Yes, the budget affects the software maintenance because the budget plays an important role for choosing the original software and also in choosing the employees. Moreover, the budget determines the type of maintenance in-house or outsource.

**Company Five**

Participant (C5GBM) said: Yes, the budget affects the software maintenance for many reasons: the budget determines the quality of the original software, the employee turnover, the hardware used in the company, and the quality of employees working in the company.

**Company Six**

Participant (C6GBM) said: From my experience, yes the budget of the company affects the software maintenance in multiple ways in software maintenance. The budget affects the choice of source and quality of software, type of hardware, and quality of employees working in

maintenance. Indeed, sometimes a limited budget means less quality of software and hardware used in the system, and that increases the effort for the software maintenance team.

## 5.11 Theme Three: Operational Environment Category

The third theme of the group factors affecting software maintenance is operational environment. The objective of this theme is to understand in-depth how the operational environment affects software maintenance in e-commerce companies in Jordan

### 5.11.1 Group (A) Software Maintenance Team

The operational environment category includes five sub-themes related to Group (A) software maintenance team. Table 5.9 shows the main theme, sub-themes high code, and sub-themes low code related to the operational environment category.

| Table 5.9: Operational environment category related to Group (A) | | |
|---|---|---|
| **Theme** | **Sub –Themes** <br><br> **High Code** | **Sub –Themes** <br><br> **Low Code** |
| Operational environment | 5.11.1.1 System reliability | 5.11.1.1.1 Environment reliability <br><br> 5.11.1.1.2 Hardware and Operating system reliability |
| | 5.11.1.2 Operation user | |
| | 5.11.1.3 Reasons of maintenance | |
| | 5.11.1.4 Most problems handled in software maintenance | |
| | 5.11.1.5 Most factors affect software maintenance | |

**5.11.1.1 System Reliability**

**5.11.1.1.1 Environment Reliability**

The participants from Group (A) in this point were asked one question to understand how the environment affects software maintenance, and also to understand the environment of e-commerce application.

**Interview Question**

**Q25: Do you face problems related to system compatibility with another system in the same e-commerce application? If yes, what is the source of the problem? How do you deal with it?**

**Participants' Answers**

**Company One**

Participant (C1GAP1) said: No, we didn't face any problem related to system compatibility with another system, because the system in the company does not depend on any other systems outside of the company.

Participant (C1GAP2) said: No, because the system adopted in the company does not have any relation with other systems. Also, the payment method adopted in the company is "cash on delivery".

**Company Two**

Participant (C2GAP1) said: No, I didn't face any problem regarding compatibility, because the system doesn't have any link with any other systems.

**Company Three**

Participant (C3GAP1) said: Yes, there are various problems in my work - one of the problems is dealing with the other side, like (payment gateway), and the second problem is related to communication links between the two companies.

Participant (C3GAP2) said: Yes, I faced problems related to the relationship of the system and other systems internally or externally. The majority of the problems are in the payment

companies. The company deals with this problem through service level agreement, but unfortunately there are problems in SLA itself.

**Company Four**

Participant (C4GAP1) said: Sometimes we faced problems with the other partner. We deal with this problem through service level agreement (SLA), but the SLA is not stable.

**Company Five**

Participant (C5GAP1) said: Yes, mostly the problem is communication links between the two companies. Sometimes changing software on one side will affect the other side and sometimes stop the system from working. In such cases, a contract is used to deal with other parties.

Participant (C5GAP2) said: Yes, sometimes in the payment gate way process. Usually, the problems are in the communication between two companies or when the changes in the e-commerce system do not conform to the system on the other side. To reduce the side effects of this problem if it happens, the company has a contract with an outside company who deal with the e-commerce system.

**Company Six**

Participant (C6GAP1) said: No, the system doesn't have any link with another system. Moreover, the payment method adopted in the company is "cash on delivery".

**5.11.1.1.2 Hardware and Operating System Reliability**

Questions were asked to Group (A) to understand if changing the hardware and/ or operating system affects software maintenance or not and whether it increases the effort for the maintenance team.

**Interview Question**

**Q26: Do you think that change of hardware or operating system will increase the maintenance efforts? If yes, how? Why?**

**Participants' Answers**

**Company One**

Participant (C1GAP1) said: Yes, any kind of change in hardware or operating system will affect the software and will lead to increasing maintenance efforts. Also, he emphasised that the e-commerce application cannot work in isolation of the hardware and operating system.

In addition, participant (C1GAP2) said: Yes, changing operating system or hardware increases the effort in software maintenance and sometimes make new problems in the system. Indeed, the change in hardware or operating system requires change in the system to confirm changes.

**Company Two**

Participant (C2GAP2) said: Yes, e-commerce application differs from any other system. E-commerce application is a homogeneous system of hardware and software, so any change in hardware or operating system leads to making changes in the e-commerce software.

**Company Three**

Participant (C3GAP1) said: Yes, e-commerce application is a very sensitive application, so any change in the hardware or operating system in the application will increase the work needed to manage the change in the system.

Also, participant (C3GAP2) said: Yes, the hardware and operating system increase the effort in software maintenance because the e-commerce application includes software and hardware, so any changes in hardware or software will affect the system. Moreover, the e-commerce system does not work in isolation from the operating system, so any module in the system should support the operating system and hardware.

**Company Four**

Participant (C4GAP1) said: Yes, a lot of work in software maintenance results from changes to the hardware or operating system. E-commerce applications are built under the operating system and hardware, so any changes will affect the system and increase the work for the software maintenance team.

**Company Five**

Participant (C5GAP1) said: Yes, changing hardware or operating system will affect the software and thus, it affects the software maintenance. Indeed, the e-commerce application

includes software, hardware, network, and operating system. Any change in one of the four items will affect software maintenance.

Participant (C5GAP2) said: Yes, changes in hardware or software require changes in software adopted in the company, which means the components of the e-commerce application and not only software, including software, hardware, and operating system.

**Company Six**

Participant (C6GAP1) said: Yes, because the e-commerce application is not just software; it includes hardware, software, and network. Therefore, any changes in any one of the components will affect the performance and create errors in the application.

**5.11.1.2 Operation User**

One of the factors, found as a result of the preliminarily study, affecting software maintenance is the operation user factor. To understand the effect of this factor in-depth the researcher developed the interview question below for all participants in Group (A).

**Interview Question**

**Q27: Do you think lack of understanding of the system by the operation user causes increasing maintenance problems? If yes, how? If no, why?**

**Participants' Answers**

**Company One**

Participant (C1GAP1) said: Every day I receive orders from operators to do maintenance on the system, but I find the reason of the problem is misunderstanding the operators to deal with the system.

Also, participant (C1GAP2) stressed about the effect of operations in software maintenance. He said: Every day the maintenance department receives orders from system operators to do maintenance on the system. Sometimes the software maintainer finds the software operators have a misunderstanding of dealing with the system, and especially the new employees in the company who are working in e-commerce application.

**Company Two**

Participant (C2GAP1) said: Yes, because misunderstanding any elements of the system leads to creating problems in the software used in the company, thus increasing the workload for the maintenance team.

**Company Three**

Participant (C3GAP1) said: Yes, because lack of understanding the system creates fresh errors in the system and sometimes "leads to stopping the system from working".

Participant (C3GAP2) said: Yes, sometimes the operational employees in the company misunderstand how to deal with software. Thus, it leads to loss of time and increases the need for maintenance.

**Company Four**

Participant (C4GAP1) said: Yes, lack of understanding the system by operation users increases the effort in maintenance. Every day the software maintenance section solves problems in software related to lack of understanding the system from the operators of the system in the company.

**Company Five**

Participant (C5GAP1) said: Yes, lack of understanding from operation users of how to deal with the system will lead to new errors in the system. Moreover, it can cause the system to stop working.

Participant (C5GAP2) said: Yes, sometimes the operator users follow processes in the system without having any idea about effect of the process on the other modules in the system. This leads to the need to call the maintenance team and increase the maintenance effort.

**Company Six**

Participant (C6GAP1) said: Yes, lack of understanding of the system will increase the demand for maintenance, and can also create bugs in the system.

### 5.11.1.3 Reasons of Maintenance

The objective of this point is to understand in-depth the main reasons for maintaining the software in e-commerce companies in Jordan.

**Interview Question**

**Q28: What are the most common reasons for the maintenance?**

**Participants' Answers**

**Company One**

Participant (C1GAP1) said: The most common problems in maintenance of e-commerce applications are fixing bugs, conflict in the system when changes of hardware or operating system are made, updating the software, weak performance in the system, and operators' mistakes.

Participant (C1GAP2) said: The most common reasons for maintenance are changes in the process of work in the company, changes in the policy of work, errors in the system, improving the performance of the system, a change in hardware, and new technology use.

**Company two**

Participant (C2GAP1) said: The most common reasons for maintenance are bugs in the system, new hardware in the company, change in the policy of the country such as new tax, and updates to the work procedures.

**Company Three**

Participant (C3GAP1) said: From my experience in software maintenance, there are many reasons for the maintenance in the e-commerce applications such as, software bugs, increases in the amount of work, changes in the policy in the company, and new hardware or operating system adopted in the work.

Also, participant (C3GAP2) mentioned similar reasons as he said: The reasons for software maintenance are to fix bugs, change hardware or operating system, update the system to deal with new processes in the work, and sometimes to change user interface.

**Company Four**

Participant (C4GAP1) said: From my experience, the most common reasons for maintenance are changes in hardware or operating system or change of browsers, process of work, integration with another system, and weaknesses in performance of the system.

**Company Five**

Participant (C5GAP1) said: The most common reasons for maintenance in the company are bugs in the system, changes in the process of work, changes in the storage device, and new devices used by end users, for example smartphones.

Participant (C5GAP2) said: Change in hardware or operating system, slowness of transactions in the system, security issues, weak performance of the system, and changes in the policy of work in the company.

**Company Six**

Participant (C6GAP1) said: The most common reasons for maintenance are changes in hardware or operating system, change of end user interface, especially to Arabic, and changes in the processes of work in the company.

The researcher observed during the field study and through the answers of participants that the reasons for maintenance in e-commerce companies in Jordan are similar.

**5.11.1.4 Most Common Problems Handled in Software Maintenance**

The objective of this point is to understand where the most effort is exerted for the maintenance team in e-commerce companies in Jordan.

**Interview Question**

**Q29: What are the most common problems to be handled in software maintenance in your work?**

**Participants' Answers**

**Company One**

Participant (C1GAP1) said: The most common problems handled in software maintenance in the work are fixing bugs, misuse from the operation, and new functions in the work, and sometimes changes in hardware.

Participant (C1GAP2) said: The most common problems handled in software maintenance are changes in the process of work in the company, changes in the policy of work, errors in the system, improving the performance of the system, and new technology use.

**Company Two**

Participant (C2GAP1) said: The most common reasons for maintenance are fixing bugs, weak performance in the system, and problems in the communication channel like the internet, and network.

**Company Three**

Participant (C3GAP1) said: The problems in software maintenance differ from day to day, but mostly the problems handled are related to fixing bugs, updating the system to fit with the new technology, and communication problems.

Also, participant (C3GAP2) stressed the same problems mentioned by participant (C3GAP1). He said the most common problems handled in software maintenance are fixing bugs, changing hardware or operating system, updating the system to support the new browsers, and updating the system to make it easier for the end users to deal with it.

**Company Four**

Participant (C4GAP1) said: In my work in this company the most common problems are fixing bugs, updating the system to deal with new hardware, updating the system to work on a new environment, and updating the system to work with new browsers.

**Company Five**

Participant (C5GAP1) said: Changes in hardware or operating system, updating the system to achieve new trends in the business, errors arising from translating the interface of applications to Arabic language, and changing user interface.

Participant (C5GAP2) said: The most common problems handled in the system are fixing bugs, updating the system to deal with user demands, updating the system to deal with the new processes in work, security issues, and changes in the hardware or storage device.

**Company Six**

Participant (C6GAP1) said: The most common problems handled in software maintenance in this company are fixing bugs, updating the system to deal with new processes in the work, and to deal with new hardware or new software, for example, explorer, mobile application.

### 5.11.1.5 Most Common Factors Affecting Software Maintenance

The objective of this point is to understand in-depth the most common factors affecting software maintenance in e-commerce companies in Jordan from the maintenance team's point of view.

**Interview Question**

**Q30: What are the most common factors affecting software maintenance from your perspective? How does it affect it?**

**Participants' Answers**

**Company One**

Participant (C1GAP1) said: From my experience, the most common factor affecting software maintenance is performance of the system, which increases the effort in software maintenance, especially when the system is old. Also, lack of experience of employees in software maintenance leads to increased problems in the system.

Participant (C1GAP2) stressed the subject of factors affecting software maintenance. He said: Many factors affect the software maintenance. One of these factors is human resources, as the HR plays an important role in software maintenance through the speed of maintenance and a reduction of the factors that problems may occur in the system. Structure of the system affects the maintenance as well as the operating system because sometimes the modules in the system operate in Windows XP but do not operate in Windows seven, which means we need to change these modules to work in new operating systems.

**Company Two**

Participant (C2GAP1) said: Employee experience in the software maintenance department and the quality of original software affects the speed of the maintenance. High turnover of employees working in software maintenance increases the problems in software maintenance, especially when the documents are incomplete or non-existent.

**Company Three**

Participant (C3GAP1) said: Many factors affect software maintenance. From my experience the employees' experience plays an important role in software maintenance, as well as their efficiency and skills in dealing with work. Moreover, the quality of software adopted in the company affects the quality of work in software maintenance. The attention of senior management to the IT department leads to increased motivation at work. Also, the employee turnover affects software maintenance.

Participant (C3GAP2) said: The most common factor affecting software maintenance is the quality of the original software. Indeed, the quality of software can make the maintenance easy or complex, because the maintenance depends on the structure of the system. Also, the experience of employees who are doing maintenance can affect it.

**Company Four**

Participant (C4GAP1) said: The most common factor affecting software maintenance is the structure of the original system, especially when the system is not built for updates in the future. The skills of employees working in software maintenance need to be continuously developed. Moreover, the source of original software (in-house, outsource) affects the software maintenance, as well as any change in environment of software such as, storage device, and hardware affecting the software maintenance.

**Company Five**

Participant (C5GAP1) said: From my perspective, the most common factors affecting software maintenance are the skills and expertise of the employees, which affect the understanding of the system and how they deal with problems when they occur in the system. In addition, the source of original software affects the software maintenance, and the structure of the original

system can make the maintenance easy or complex. Also, the budget of the company affects the quality of the original software and thus, affects its maintainability.

Participant (C5GAP2) said: From my perspective, the most important factors affecting software maintenance are the quality of original software, the experience and skills of employees, the budget of the company, and the senior management itself. Moreover, high employee turnover increases the problems in software maintenance, as new employees need more time to understand the system.

**Company Six**

Participant (C6GAP1) said: From my perspective, the most common factors affecting software maintenance are the quality of the original software, the source of software in-house or outsource, and the experience of employees in the maintenance. All these factors affect the process of maintenance and can make it more complex.

**5.11.2 Group (B) Senior Management**

Regarding the theme of operational environment factors, the researcher, in order to understand in-depth the factors that affect software maintenance from the view of senior management, has developed sub-themes related to the main theme operational environment from views of senior management. Table 5.10 shows the main theme, sub-themes high code, and sub-themes low code related to the operational environment category.

| Table 5.10: Operational environment category related to Group (B) | | |
|---|---|---|
| **Theme** | **Sub –Themes** <br><br> **High Code** | **Sub –Themes** <br><br> **Low Code** |
| Operational environment | 5.11.2.1 Environment reliability | 5.11.2.1.1 System reliability <br><br> 5.11.2.1.2 Hardware and operating system reliability |
| | 5.11.2.2 Most common factors affecting software maintenance | |

### 5.11.2.1 Environment Reliability

### 5.11.2.1.1 System Reliability

The objective of this point is to understand if the participating companies had changed the e-commerce application adopted in the company or not since the establishment of the company, and also to understand the reasons of any change.

**Interview Question**

**Q31: Have you changed the e-commerce application used in your company? If yes, how many times? Why?**

**Participants' Answers**

**Company One**

Participant (C1GBM) said: No, We haven't changed the e-commerce application used in the company, but we are planning to change the e-commerce application to another system to enhance it and add more quality and security. The strong candidate source of the system is outsourced.

**Company Two**

Participant (C2GBM) said: No, the company did not change the e-commerce application. Indeed, the existing application does not cover the electronic payment method, and we need to change it but the budget does not allow for it this year.

**Company Three**

Participant (C3GBM) said: No, I haven't changed the software, but we are studying in the company the possibility of changing the software to an outsourced company. We need a global e-commerce application.

**Company Four**

Participant (C4GBM) said: No, I haven't changed the e-commerce application. Indeed, I am not satisfied with the software adopted in the company but the budget does not allow for a change of application.

**Company Five**

Participant (C5GBM) said: No, I haven't changed the e-commerce application. I want to change the software to another software product (software that fits with global e-commerce transaction).

**Company Six**

Participant (C6GBM) said: The company since it was established has used the same e-commerce application. Indeed, the application needs modification or to be changed to another one but the budget does not allow for this.

### 5.11.2.1.2 Hardware and Operating System Reliability

The objective of this point is to understand if the participating companies had changed the hardware and/ or operating system adopted in the company or not since the establishment of the company, and if so, to understand the reasons for change.

**Interview Question**

**Q32: Have you changed the hardware or operating system in the organisation? Why? When?**

**Participants' Answers**

**Company One**

Participant (C1GBM) said: One year ago the company changed the operating system adopted at the request of the system developer. Also, the hardware has changed many times, because the company has expanded in its volume of work. The company, when it was established a couple of years ago, was a small business and the present size of work was unexpected, so the solution was to add or change the hardware and application when needed.

**Company Two**

Participant (C2GBM) said: Last year the company changed the operating system to deal with a new version of software because the new version is more secure.

**Company Three**

Participant (C3GBM) said: We changed the storage devices last year in order to accommodate the increase in work. Also, the company changed the operating system six months ago to support new technology.

**Company Four**

Participant (C4GBM) said: I haven't changed hardware or operating system in the company since the company was established because the hardware and operating system available in the company are suitable enough for the present workload.

**Company Five**

Participant (C5GBM) said: The company hasn't changed operating system since it was established. The hardware has changed in the last years to accommodate the increase in the volume of work.

**Company Six**

Participant (C6GBM) said: The operating system has been changed a couple of months ago, because the last version of software adopted in the organisation did not work on the previous operating system. Also, the hardware was changed to conform to the increased amount of work.

As regards the operating systems used in e-commerce companies in Jordan, the researcher observed during the field study that Windows XP is still being used in some e-commerce companies in Jordan.

### 5.11.2.2 Most Common Factors Affecting Software Maintenance

The objective of this point is to understand in-depth the most factors affecting software maintenance in e-commerce companies in Jordan from senior management points of view.

**Interview Question**

**Q33: What are the most common factors affecting software maintenance from your own perspective? How do they affect it? Why?**

**Participants' Answers**

**Company One**

Participant (C1GBM) said: The most common factor affecting software maintenance is budget of the company. The budget influences the choice of maintenance staff and choice of source of software. It also affects the choice of software maintenance team, as experience of employees in the e-commerce application need high salary. Moreover, quality of original software affects the speed of finding solutions to problems.

**Company Two**

Participant (C2GBM) said: The employees' experiences and turnover make progress slow in maintenance; the budget of the company affects the quality of software and in turn affects the quality of the maintenance.

**Company Three**

Participant (C3GBM) said: From my perspective, the most common factors affecting software maintenance are the quality of original software, which plays an important role in facility maintenance, the availability of documentation, the qualification and experience of employees in the field of software maintenance in e-commerce companies.

**Company Four**

Participant (C4GBM) said: The most common factors affecting software maintenance are: the source of software in-house or outsource, as sometimes the outsource increases the challenge to the company, especially in the maintenance; the budget of the company that affects the quality of software; the experience of employees who are working in software maintenance; and sometimes the service level agreement is not clear.

**Company Five**

Participant (C5GBM) said: The most common factors affecting software maintenance are: the employee turnover, as it affects the quality of the maintenance; change in hardware, which sometimes creates new problems and makes maintenance complex; also, the quality of original software, sometimes makes the maintenance complex and takes more time; and, the communication with the company owner of the software.

**Company Six**

Participant (C6GBM) said: The most common factors affecting software maintenance are: employee turnover, as new employees need more time in the beginning of the work to understand the system and maintenance; the budget of the company affects the type of original software and the type of employee, as highly experienced people demand more salary; the source of software outsource or in-house affects maintenance, as sometimes in outsource software the maintenance becomes costly after finishing the contract between the two companies. This leads to increasing the obstacles in e-commerce companies.

## 5.12 Theme 4: Software Characteristics Category

The objective of this category is to understand in-depth the factors that affect software maintenance related to the characteristics of software products such as, the quality of original software, documentation, programing language and maintainability of the system.

The researcher observed that when conducting the preliminary study in e-commerce companies in Jordan, the senior management has less information about technical issues. Therefore, the researcher will not ask the respondents from senior management about software characteristics. Instead, the majority of the questions were asked to Group (A).

## 5.12.1 Group (A) Software Maintenance Team

As mentioned previously, all the questions related to software characteristics category were asked just to Group (A). Table5.11 shows the main theme, and sub-theme high code, and sub-themes low code related to the software characteristics**.**

| Table5.11 : Software characteristics factors category | | |
|---|---|---|
| **Theme** | **Sub –Themes** <br><br> **High Code** | **Sub –Themes** <br><br> **Low Code** |
| Software characteristics | 5.12.1.1 Product quality | 5.12.1.1.1 Quality of original system <br><br> 5.12.1.1.2 Documentation quality <br><br> 5.12.1.1.3 Maintainability of the system |

### 5.12.1.1 Product Quality

### 5.12.1.1.1 Quality of Original System

The objective of this point is to understand if the quality of the system affects software maintenance, and how it affects it.

**Interview Question**

**Q34: Do you think the quality of the original software products like system structure, and programme language affects the maintenance? If yes, how? Why?**

**Participants' Answers**

**Company One**

Participant (C1GAP1) said: Yes, the quality of the original software product directly and indirectly affects software maintenance, because the quality of the system positively affects the performance of the system as well as the time spent solving the problems in the system and order tracking. Moreover, some programing languages do not accept change in the software, so that makes it impossible to maintain the system.

Participant (C1GAP2) said: Yes, because the structure of the system and programme language used play an important role in maintaining the system and makes the system easy to maintain and change when required. Indeed, there is a strong relationship between the structure of the system and maintainability of the system, and a clear system structure makes maintenance simple and uncomplicated.

**Company Two**

Participant (C2GAP1) said: Yes, some software is built in complex programme language that makes maintenance and updates more complex. Also, if the structure of the system is clear the maintenance becomes easier and quicker.

**Company Three**

Participant (C3GAP1) said: Yes, the quality of the original software affects the maintenance, as some programing language makes the maintenance complex and the structure of the system plays an important role in either facilitating or complicating the maintenance work.

Participant (C3GAP2) said: Yes, the quality of the original software leads to facilitating maintenance work, and vice versa. Many times I faced problems in maintaining the system related to poor quality of original software products.

**Company Four**

Participant (C4GAP1) said: Yes, the quality of original software plays an important role in software maintenance. If the structure of the system is complex the software maintenance will become complex. Moreover, the programing language affects software maintenance, as some programing languages do not accept amendments to the system.

**Company Five**

Participant (C5GAP1) said: Yes, the original software product plays an important role in the maintenance. Many software applications do not support updates or the updates are complex. Also, whenever system structure is clear the tracking of errors becomes easier and faster.

Participant (C5GAP2) said: The quality of original software affects the maintenance in any software product. A clear structure makes tracking errors in the system quicker, and also programme language plays an important role in facilitating maintenance procedures.

**Company Six**

Participant (C6GAP1) said: Yes, the most important item affecting the maintenance is the quality of original system. The structure of the system makes maintenance complex or easy; it depends on the nature of the structure. Moreover, programing language plays an important role in software maintenance. The changes in some programing languages are complex and need a great deal of time and effort.

**5.12.1.1.2 Documentation Quality**

The objective of this point is to understand in-depth the extent of availability and use of documentation related to software application in e-commerce companies in Jordan.

For this point, the participants in Group A were asked many questions related to the documentation such as the availability of documentation about the software adopted in the company and updating the documentation in the work.

**Interview Questions**

**Q35: Does the software application adopted in the company have any documentation? If yes, what do the documents include? If no, why not?**

**Participants' Answers**

**Company One**

Participant (C1GAP1) said: No, there isn't any documentation used in the company regards e-commerce application. I think the documentation needs more time from the maintainer to write and update the document when the system is updated, but unfortunately we do not have the time to do so.

Participant (C1GAP2) said: No, the system doesn't have any documentation, as it was built in-house. Furthermore, the developers who built the system are responsible for the maintenance of the system.

**Company Two**

Participant (C2GAP1) said: No, the system adopted in the company doesn't have any documentation.

**Company Three**

Participant (C3GAP1) said: Yes, the company adopted international software, which has full documentation, including data flow diagram, code, and user guide.

Participant (C3GAP2) said: Yes, the system has full documentation, including user help guide, code, and data flow diagram.

**Company Four**

Participant (C4GAP1) said: Yes, the software adopted in the company has documentation. The documentation of the software in the company includes the structure of the system and user guide explaining the screens of the system and the methods of use.

**Company Five**

Participant (C5GAP1) said: Yes, the software has full documentation that includes user guide help to use the system, code, and software structure.

Participant (C5GAP2) said: Yes, software is documented. The documentation includes user help guide, and structure of the system.

**Company Six**

Participant (C6GAP1) said: The software adopted in the company doesn't have any documentation.

**Q36: Do you refer to the documentation before you do maintenance to the system? If yes, why? If no, why not?**

**Participants' Answers**

**Company One**

Participant (C1GAP1) said: No, I didn't refer to the documentation, because the application adopted in the company doesn't have any documentation.

Participant (C1GAP2) said: No, because the system adopted in the company doesn't have documentation, and moreover, the company doesn't have any documentation for software and software maintenance.

**Company Two**

Participant (C2GAP1) said: No, I didn't refer to the documentation, because the application adopted in the company doesn't have any documentation.

**Company Three**

Participant (C3GAP1) said: I don't always refer to the documentation, because sometimes problems need to be solved quickly, so we don't have time to refer to documentation.

Similarly, participant (C3GAP2) said: I don't refer to the documentation because we need to solve the problems when they occur in software as soon as possible.

The researcher accessed the documentation of the software and observed that the documentation was not updated and was not useful.

**Company Four**

Participant (C4GAP1) said: Sometimes when I have time I refer to the documentation before doing any maintenance, but mostly I do not refer to the documentation because we need to solve problems in the system as quickly as possible.

The researcher accessed the documentation of software and observed that there is a lack of documentation. Furthermore, there is lack of documentation regarding the structure.

**Company Five**

Participant (C5GAP1) said: No, I don't have enough time to review the documentation, and the software documentation is not clear.

Participant (C5GAP2) said: In e-commerce application I am asked to solve the problem as soon as possible. Furthermore, the documentation of the system is disorganized.

The researcher accessed the documentation of software and observed that there is a lack of documentation. Furthermore, there is lack of documentation regarding the structure.

**Company Six**

Participant (C6GAP1) said: No, because the documentation of the system is not available in the company. Furthermore, we not do maintenance in the company; rather we send the problem or modification to an external support company.

**Q37: Do you update the documentation when you update the software application? If not, why not?**

**Participants' Answers**

**Company One**

Participant (C1GAP1) said: No, we don't have documentation for software applications, so we do not review or update documentation in the company.

Also, (C1GAP2) answered the same. He said: No, we don't have documentation for software application, so we do not review or update documentation in the company.

**Company Two**

Participant (C2GAP1) said: No, no documentation is used related to applications adopted in the company.

**Company Three**

Participant (C3GAP1) said: Not always, only when I have time.

Participant (C3GAP2) said:  No, I didn't update the documentation. It takes time and I think it's not important for the system, nor is it required from the management.

**Company Four**

Participant (C4GAP1) said: No, I don't update the documentation for two reasons: Firstly, it is not required from the management, and the second reason is I don't have time to update the documentation, especially as it is without any benefit.

**Company Five**

Participant (C5GAP1) said: No, I don't update the documentation, for two reasons: Sometimes the problem is solved internally and sometimes externally (outsource IT support company); and, the second reason is the update is not required in the company and I don't have time to update.

Participant (C5GAP2) said: No I don't update the documentation because documentation is incomplete, and it is not required in the work.

**Company Six**

Participant (C6GAP1) said: No, because we are not doing maintenance in the company; instead, we send the problem or modification to an external support company. Furthermore, the documentation isn't available in the company.

### 5.12.1.1.3 Maintainability of the System

The main objective of this point is to understand in-depth if the maintenance in e-commerce application differs from other types of software or not from the perspective of the software maintenance team in e-commerce companies in Jordan.

**Q38: Do you think software maintenance in e-commerce application differs from other types of software? If yes, why? If no, why not?**

**Company One**

Participant (C1GAP1) said: Yes, software maintenance in e-commerce application differs from other types of software related to characteristics of application, and also because the procedure of work is completely different to any other software. Moreover, maintenance in e-commerce application is very sensitive and forked.

In addition, participant (C1GAP2) said: Yes, software maintenance in e-commerce application needs more attention and more speed in solving problems, as it's a "complex system". Furthermore, e-commerce application needs more monitoring for application and continuous adjustments.

**Company Two**

Participant (C2GAP1) said: Yes, e-commerce application is "a sensitive and forked system". It needs more attention from the software maintenance team in order to maintain it.

**Company Three**

Participant (C3GAP1) said: Yes, maintenance of e-commerce application needs more attention and more control. Indeed, e-commerce application is a "sensitive system".

Participant (C3GAP2) said: Yes, maintenance in e-commerce application differs from other types of software. The maintenance in e-commerce applications requires speed and the company can't wait hours for problems to be solved. Also, e-commerce systems should work 24/7 (24 hours a day, seven days a week) without stopping whereas for the other systems it is not a big problem if the application stops working for one or two hours.

**Company Four**

Participant (C4GAP1) said: Yes, software maintenance in e-commerce application needs more attention and more skills from persons working in this field. The software should work 24 hours per day without stopping and also the update of software continues through all the lifecycle of the software.

**Company Five**

Participant (C5GAP1) said: Yes, software maintenance in e-commerce application is totally different to other software. The system in e-commerce should be working 24 hours. Moreover, the e-commerce application rapidly changes, so that increases the probability of errors occurring in the system.

Participant (C5GAP2) said: Yes, software maintenance in e-commerce application is complex. Many times changes in hardware affect the software and requires the system to be updated. Moreover, the system needs more attention from the maintainer and needs more preventive maintenance.

**Company Six**

Participant (C6GAP1) said: Yes, e-commerce application totally differs from other software regarding components of the system and relationships with other systems. In maintenance e-commerce applications many issues should be taken into consideration, such as hardware and software browsers.

## 5.13 Theme Five: External Factors Category

The fifth theme in the present research is external factors category. The objective of this theme is to understand in-depth the external factors that happen outside of company control and influence software maintenance, and also to understand how they affect software maintenance.

### 5.13.1 Group (A) Software Maintenance Team

The objective of this point is to understand the external factors that happen outside of company control related to the software maintenance team. Moreover, the aim is to understand how these factors affect software maintenance. Table 5.12 shows the main theme, sub-themes high code, and sub-theme low code related to external factors category Group (A).

| Theme | Sub –Themes High Code | Sub –Themes Low Code |
|---|---|---|
| External factors | 5.13.1.1 Source of software | |
| | 5.13.1.2 Service level agreement (SLA) | |
| | 5.13.1.3 Views of people about software maintenance job. | |

Table 5.12: External factors category related to Group (A).

**5.13.1.1 Source of Software**

The objective of this point was to learn about the source of software used in e-commerce companies in Jordan, and to understand in depth the effects of source of software (In-house, outsource) in maintenance activities.

**Interview Questions**

**Q39: From your perspective, what is the perfect choice in developing in-house software or outsource? Why?**

**Participants' Answers**

**Company One**

Participant (C1GAP1) said: From my view, I think developing e-commerce systems in-house needs great team work and employees specialised in e-commerce systems and this is very expensive for the company. So, the outsource is the better choice and may also produce higher quality.

Participant (C1GAP2) said: Outsourced software is more expensive but more efficient. The outsource application is built by an expert team specialised in e-commerce application.

**Company Two**

Participant (C2GAP1) said: Away from financial matters, the outsource is the best choice in e-commerce application because the outsource software is of higher quality than the software built in-house.

**Company Three**

Participant (C3GAP1) said: I think outsource is the better choice, because when you need to adopt outsource software you will have several options and you will choose the best one for the budget of the company, whilst when adopting in-house software you have just one choice of software. Furthermore, the problem of employee turnover affects software maintenance, especially when the software is built in-house.

Participant (C3GAP2) said: I think outsource software is the perfect choice, especially in e-commerce application. This is for many reasons. The first reason is that the e-commerce system is huge so needs an expert team for its development. The second reason is that the e-commerce system is rapidly changing, which means the system should be built with maintainability in mind. The third reason is that it is costly to build it in-house.

**Company Four**

Participant (C4GAP1) said: From my perspective, the perfect choice is outsource for many reasons: the quality is better, outsource is more specialised in the system and the cost of software is less than the cost if the company develops it in-house.

**Company Five**

Participant (C5GAP1) said: I think it depends on the amount of the work and the budget of the company. For small work the in-house is perfect and can manage most processes of the work, while in large businesses outsource is the better choice, because the e-commerce application is a huge system and needs a large team to work on developing the system.

Participant (C5GAP2) said: I think the perfect choice is outsource, because the software gains a higher level of quality and more usability.

**Company Six**

Participant (C6GAP1) said: From my experience, it depends on the budget of the company. It is not reasonable for a company that has a small budget to decide to adopt outsource software because it is costly. On the other hand, if the company has a high budget that means a greater workload in the future. So, outsource will be the best choice.

**Q40: If you want to adopt the outsourcing of software in the company, do you obtain any information about the software before buying it? If yes, describe the information you were interested in obtaining? If not, why not?**

**Participants' Answers**

**Company One**

Participant (C1GAP1) said: Yes, if we need to adopt outsource software it is very important to collect information about the system before buying the system. The information and queries should include number of company using the system, portability and ease of an update on the system when needed, and documentation of the system.

Participant (C1GAP2) said: Yes, the information I am interested in collecting is the proliferation of the system, feedback from the companies that use the system, age of system, and reliability of the system.

**Company Two**

Participant (C2GAP1) said: Yes, the information included should be: age of the system, number of company using the system, the structure of the system, and the documentation of the system.

**Company Three**

Participant (C3GAP1) said: Yes, I think the company should be collecting full information about the software in advance before buying software. The information should include: the reputation of the company that produced the system, spread of the system, availability of documentation, and the applicability of doing maintenance in the company.

Also, participant (C3GAP2) said: Yes, it's very important to collect information about the system before the company decides to buy it. The information should include: spread of the

system, age of system, its structure, availability of documentation, and applicability of the system to update when required.

**Company Four**

Participant (C4GAP1) said: Yes, the company, before deciding to buy outsourcing software, should collect information about software, with information including: the age of the system, possibility of updates, age of system, and the number of e-commerce companies using the software.

**Company Five**

Participant (C5GAP1) said: Yes, the information should include: age of the system, feedback from companies who have used the software, the programing language used to build the system, possibility of doing updates in the future internally in the company, and availability of documentation about the system.

Participant (C5GAP2) said: Yes, the company who decides to adopt outsource should collect information about the system. The information should include: the structure of the system, the programing language, the age of the system, the feedback about software and information about the company that produced the product, and the number of companies that have approved the system.

**Company Six**

Participant (C6GAP1) said: Yes, it's very important to have knowledge about the software before deciding to buy it. The information should include: the programme language, the usability of the system, applicability to change user interface to another language, the security of the system, applicability to doing maintenance in-house, and applicability to working in any environment.

Regarding the previous question, the researcher observed that all participants stressed the importance of collecting information in advance before buying outsource software, and the majority of participants mentioned maintenance issues that may arise in the future.

### 5.13.1.2 Service Level Agreement (SLA)

The objective of this point is to understand in-depth if the e-commerce companies in Jordan use service level agreements to deal with the IT support company or any partners out of the company.

As regards this sub-theme, the participants were asked about whether or not they use service level agreements to deal with external partners related to software maintenance work. Also, they were asked about the problems faced in service level agreements.

**Interview Questions**

**Q41: Do you use service level agreements (SLA) to deal with IT support companies? If yes, are there any problems with it? If no, why not?**

**Participants' Answers**

**Company One**

The answers of the two participants were similar.

Participant (C1GAP1) said: No, we don't use SLA in the company, because the system has been built In-house and we do not need any service level agreement to deal with any partners out of the company.

Participant (C1GAP2) said: No, we don't use SLA, because the system was built In-house so we do not need any service level agreement.

**Company Two**

Participant (C2GAP1) said: Yes, the company uses (SLA) with external maintenance companies. The problems facing the company when dealing with the external maintenance company is the communication between the two companies, and also sometimes some items in the SLA are not clear.

**Company Three**

Participant (C3GAP1) said: Yes, the company uses service level agreement to deal with the IT support company, but sometimes the (SLA) is unclear and vague. Furthermore, there is a delay in contact when support is needed.

Participant (C3GAP2) said: The company uses service level agreements to deal with IT support companies. Indeed, often the two companies disagree. Also, sometimes the IT support adds extra charges for offering support for the system while in the SLA they said: the request is out of scope and that needs extra charge.

**Company Four**

Participant (C4GAP1) said: Yes, the company has a service level agreement to deal with the IT Support Company. The problem with the service level agreement is that it is mysterious.

The researcher accessed the service level agreements and observed that the SLA did not mention the contact channels between the two companies or the response time.

**Company Five**

Participant (C5GAP1) said: Yes, the company has an SLA to deal with the IT Support Company. Yet, sometimes the company faces problem in terms of delayed response from the support company. Furthermore, the (SLA) does not include everything about the processes of software maintenance.

Participant (C5GAP2) said: Yes, the company uses a service level agreement (SLA), because sometimes there is a problem in communication protocol between us.

The researcher accessed the service level agreements and observed that SLA did not clear

**Company Six**

Participant (C6GAP1) said: The company does not use service level agreements (SLA) to deal with IT support companies. The company, when buying software, gets five years of free maintenance.

**Q42: Do you have any external contract in software maintenance? If yes, why? How do you choose the external support company?**

**Participants' Answers**

**Company One**

Participant (C1GAP1) said: No, the company doesn't have any external contract with the software maintenance. The company usually does maintenance internally in the company;

sometimes they need an external company to update the system but this is done without a contract.

Participant (C1GAP2) said: No, the company doesn't have any external contract with the software maintenance. The company usually does maintenance internally in the company. Indeed, the software maintenance contracts are costly to the company and affect the company budget.

**Company Two**

Participant (C2GAP1) said: Yes, the company has a contract with external software maintenance. I don't have any idea about the criteria adopted in the company for choosing these companies.

**Company Three**

Participant (C3GAP1) said: At the moment, the company doesn't have any software maintenance contract. The company terminated the contract after one year because of dishonest business practices. Regarding the last contract, the company simply chose the support company that submitted the lowest price.

Participant (C3GAP2) said: Now the company doesn't have any contract in software maintenance. The company built the system in-house and has a software maintenance department to deal with maintenance.

**Company Four**

Participant (C4GAP1) said: Yes, the company has chosen the same company who built the software as a consultant company to maintain the system.

**Company Five**

Participant (C5GAP1) said: Yes, the company has chosen the same company who built the original system. This is because one of conditions when buying the system was to provide three years of free support maintenance.

Participant (C5GAP2) said: Yes, the company has a contract with the same company that produced the software.

**Company Six**

Participant (C6GAP1) said: No, because the company, when buying software, got five-year maintenance free. The contract is still valid for three years.

### 5.13.1.3 Views of People about Software Maintenance Job

This sub-theme deals with the new factor affecting software maintenance that the researcher observed when conducting the preliminary study. The participants from Group A were asked about the view of Jordanian people about the software maintenance job, and how this affects the software maintenance.

**Interview Question**

**Q43: What is the view of people as regards to the software maintenance job? Do you think it affects your work? If yes, why?**

**Participants' Answers**

**Company One**

Participant (C1GAP1) said: The majority of people view software maintenance as a high-class job in the IT field. That view increases the motivation to work.

Participant (C1GAP2) said: Most of the people view the software maintenance job as a good job and high class. Yes, views of people about the job increase the motivation in the work and help to improve the software maintenance work.

**Company Two**

Participant (C2GAP1) said: People see a software maintenance job as a tiring job, but I love my job. The view of other people does not affect my work.

**Company Three**

Participant (C3GAP1) said: Most people view computer jobs in general as a "prestigious job", and yes that gives me a push to succeed in my job.

Participant (C3GAP2) said: Most people see software maintenance jobs as a high revenue job. Yes, the view of people about the job is very important, especially in Arab countries.

**Company Four**

Participant (C4GAP1) said: Software maintenance is a good job. In the Arab society people's opinions about jobs are important. This view gives me a push at work.

**Company Five**

Participant (C5GAP1) said: People see software maintenance jobs as a normal job. Nevertheless, this view of people does not affect my work in any way.

Participant (C5GAP2) said: People see software maintenance as a normal job. That view affects my work, as now I am seeking a new job in any field.

**Company Six**

Participant (C6GAP1) said: People look at software maintenance jobs as high revenue jobs. This increases the motivation to work in software maintenance.

**5.13.2 Group (B) Senior Management**

The objective of this point is to understand in-depth the external factors that happen outside of company control from the view of senior management in e-commerce companies in Jordan. Moreover, the aim is to understand how these factors affect software maintenance. Table 5.13 shows the main theme, sub-themes high code, and sub-theme low code related to external factors category Group (B).

| Table 5.13: External factors category related to Group (B) | | |
|---|---|---|
| **Theme** | **Sub –Themes**<br><br>**High Code** | **Sub –Themes**<br><br>**Low Code** |
| External factors | 5.13.2.1 Source of software | |
| | 5.13.2.2 Service level agreement (SLA) | |

### 5.13.2.1 Source of Software

The objective of this point was to learn about the source of software used in e-commerce companies in Jordan, and to understand in-depth the problems related to each one of the sources (In-house, outsource) from the views of the senior management.

**Interview Questions**

**Q44: Do you adopt outsourcing or in-house software in your company? Why?**

**Participants' Answers**

**Company One**

Participant (C1GBM) said: The company adopts In-house software because In-house software is not costly and is suitable for small businesses in the beginning of the establishment of the company. Furthermore, the developer who built the system is responsible for the maintenance of the system.

**Company Two**

Participant (C2GBM) said: The company adopts outsourcing software, because it is cheap and appropriate for the volume of work in the company.

**Company Three**

Participant (C3GBM) said: The company adopts In-house software, because when the company was established they have a small budget and small amount of work.

**Company Four**

Participant (C4GBM) said: The company adopted outsourcing software, because it is very cheap and the price covers the maintenance for three years.

**Company Five**

Participant (C5GBM) said: The company adopted outsourcing software, because employees in the IT sector don't have the experience to build e-commerce systems in-house. The company adopted software built outside of the company.

**Company Six**

Participant (C6GBM) said: I adopted outsource software in the company, because it's cheap and it is suitable for the amount of work.

**Q45: From your perspective, what is the perfect choice to develop in-house software or outsourced software? Why?**

**Participants' Answers**

**Company One**

Participant (C1GBM) said: I think outsourcing is the perfect choice because with in-house you have one choice for the structure and quality of the system, but with outsourcing you have many choices with high quality.

**Company Two**

Participant (C2GBM) said: I think it depends on two issues: the budget of the company, and amount of work. If the company has a large amount of work and the budget allows then the perfect choice is outsourced software.

**Company Three**

Participant (C3GBM) said: From my perspective and experience, outsourcing is the perfect choice, because the outsourced software is more efficient and applicable for updating. Also, the probability of errors is less.

**Company Four**

Participant (C4GBM) said: I think if the budget of the company allows for development in-house it is better, but that needs a huge team in development. Developing the system in house reduces the risk of maintenance, and also monopolism from outsourced IT company.

**Company Five**

Participant (C5GBM) said: I think the current situation in the company with outsourcing is the perfect choice, because the e-commerce company doesn't have an experienced team to build the system. Moreover, the e-commerce system is an international system and needs a large team to develop it.

**Company Six**

Participant (C6GBM) said: Outsourcing is the perfect choice, because the e-commerce companies in Jordan don't have experienced teams to build the system. Moreover, the e-commerce system is an international system and needs a large team to develop it.

**Q46: From your perspective, what is the perfect and cheapest choice: software maintenance In-house or with outsource support companies? Why?**

**Participants' Answers**

**Company One**

Participant (C1GBM) said: We can't collect for both lower price and high quality in software maintenance. Indeed, the maintenance In-house or outsourcing depends on the budget of the company and the source of software adopted.

**Company Two**

Participant (C2GBM) said: If we seek quality in the maintenance In-house is better; if we are seeking the lowest price in the maintenance then outsourced is better.

**Company Three**

Participant (C3GBM) said: It depends on the source of software and the quality of original software. As a result, whatever the source of software is, maintenance should be done internally in the company.

**Company Four**

Participant (C4GBM) said: I think maintenance in-house is the perfect choice, because the quality of work becomes better and also, we solve the problem of delay in delivery of the requests of modification by outsourced company.

**Company Five**

Participant (C5GBM) said: From my perspective, maintenance in-house is better, because in maintenance we seek to produce a service to the system as soon as possible. The maintenance when outsourced takes more time and the cost of maintenance after the expiry of the contract is high.

**Company Six**

Participant (C6GBM) said: From my experience, outsource is the perfect choice to get rid of problems of employee turnover. Moreover, the quality of the software is better.

**Q47: What are the most common problems you face when you are adopting outsourcing software? Why?**

**Participants' Answers**

**Company One**

Participant (C1GBM) said: The company has not adopted outsource software, because the system was developed in-house.

**Company Two**

Participant (C2GBM) said: Delays in the time of delivery of the required modifications in the system, the communication link between the two companies, the documentation of software not available with software.

**Company Three**

Participant (C3GBM) said: The company has not adopted outsource software, because the system was developed in-house.

**Company Four**

Participant (C4GBM) said: The greatest problem faced is a delay in delivery of the requests of modification and the maintenance when needed.

**Company Five**

Participant (C5GBM) said: The communication channels between the two companies, and maintenance of software after finishing the contract, especially when the company did not take that into consideration when buying the system.

**Company Six**

Participant (C6GBM) said: The communication channels between two companies and there are always delays in responding to requests.

### 5.13.2.2 Service Level Agreement (SLA)

The objective of this point is to understand in-depth how e-commerce companies in Jordan deal with external partners such as IT support companies and with e-payment.

Regarding this sub-theme, the participants were asked how they deal with software maintenance if the company bought outsource software. Also, they were asked about how they deal with external partners related to software application adopted.

**Interview Questions**

**Q48: How do you deal with software maintenance if you bought software that is outsourced? Why?**

**Participants' answers**

**Company One**

Participants (C1GBM) said: If we bought outsource software for the company, first of all the system should be maintainable. Also, we stress moving the maintenance in the company. That means the software maintenance should be handled internally in e-commerce companies. Furthermore, the system should have full documentation.

**Company Two**

Participants (C2GBM) said: The company deals with software maintenance through contracts between the company and the company developing the software.

**Company Three**

Participant (C3GBM) said: From my experience, if the company adopts outsourced software the maintenance should take place internally in the company. The company developing the software should do maintenance of the system for one or two years, and after that the maintenance should move to the maintenance team in the company who bought the software.

**Company Four**

Participant (C4GBM) said: The company deals with the outsourced company through a contract and service level agreement (SLA).

**Company Five**

Participant (C5GBM) said: We have a contract for software maintenance for five years through a service level agreement. Also, we have a team for software maintenance working on fixing bugs and as a mediator between two companies for identifying the problems in the system.

**Company Six**

Participant (C6GBM) said: If a company is going to adopt outsource software, they must take into consideration the process of maintenance. We now deal with software maintenance through the same company that developed the system, because the company that developed the software ensured the maintenance of the system for a period of three years, but we have not yet decided what will happen after the three years.

**Q49: How do you deal with partners related to software application in the company like e-payment partners?**

**Participants' Answers**

**Company One**

Participant (C1GBM) said: The e-commerce application adopted in the company doesn't have any link with another application. Furthermore, the payment method adopted in the company is "cash on delivery."

**Company Two**

Participant (C2GBM) said: We are dealing with partners through contracts.

**Company Three**

Participant (C3GBM) said: We are dealing with partners through a service level agreement (SLA).

**Company Four**

Participant (C4GBM) said: The company uses just one payment method of "cash on delivery." So, we don't have any partners. If we have partners we will deal with the partners through the contracts.

**Company Five**

Participant (C5GBM) said: We are dealing with partners through contracts and a service level agreement (SLA).

**Company Six**

Participant (C6GBM) said: The company does not have any link with other system internal and external. Moreover, the company adopted the payment method of "cash on delivery".

## 5.14 Chapter Summary

The chapter has presented the findings from multiple sources of evidence, semi-structured face-to-face interviews as the main source, and documents and archival records as secondary sources. Also, the chapter introduced the approach, which was applied for the study findings.

Full findings of issues related to the five main categories influencing software maintenance in six e-commerce companies in Jordan have been presented.

The next chapter will present the analysis of the findings from the two sources of semi-structured interviews and the documents and archival records along with highlighting the similarities between the findings and literature review.

# Chapter Six: Data Analysis and Discussion

## 6. Introduction

As mentioned in chapter one, the aim of the research is to identify and investigate the key factors that influence the software maintenance relevant to e-commerce companies in the country of Jordan. Furthermore, it hopes to propose a framework to address factors that affect the context described.

This chapter presents the analysis of the findings from two sources, namely semi-structured face-to-face interviews and available documents and archival records in e-commerce companies in Jordan, in order to fulfil the research aim, objectives and answer the research questions (cf. 1.4). Moreover, the chapter highlights the findings' connections with the related literature in chapter two.

As mentioned in chapter four and five, the researcher adopted NVivo software to analyse the data from the interviews. Also, the researcher organized the factors that influence software maintenance in e-commerce companies into five main themes as follows (cf. 2.14):

### 6.1 Theme 1: Human Resources Category

Human resources are one of the most important factors in the software industry. It plays an important role in the success of the software maintenance processes (Sneed and Opferkuch, 2008; Nasir and Abbasi, 2010; Islam and Katiyar, 2014; and Foster, 2014).

The first category of factors in the present study that affects software maintenance is the human resource factors. Table 6.1 shows the main theme, sub–themes high code, and sub–themes low code related to the human resource factors. Also, Figure 6.1 shows the nodes with sources related to human resource factors.

| Table 6.1: Human resources category | | |
|---|---|---|
| **Theme** | **Sub –Themes High Code** | **Sub –Themes Low Code** |
| Human resource factors | 6.1.1 Lack of employee experience in software maintenance 6.1.2 Skills of maintainers 6.1.3 Employee turnover 6.1.4 Domain knowledge 6.1.5 Mother tongue | |
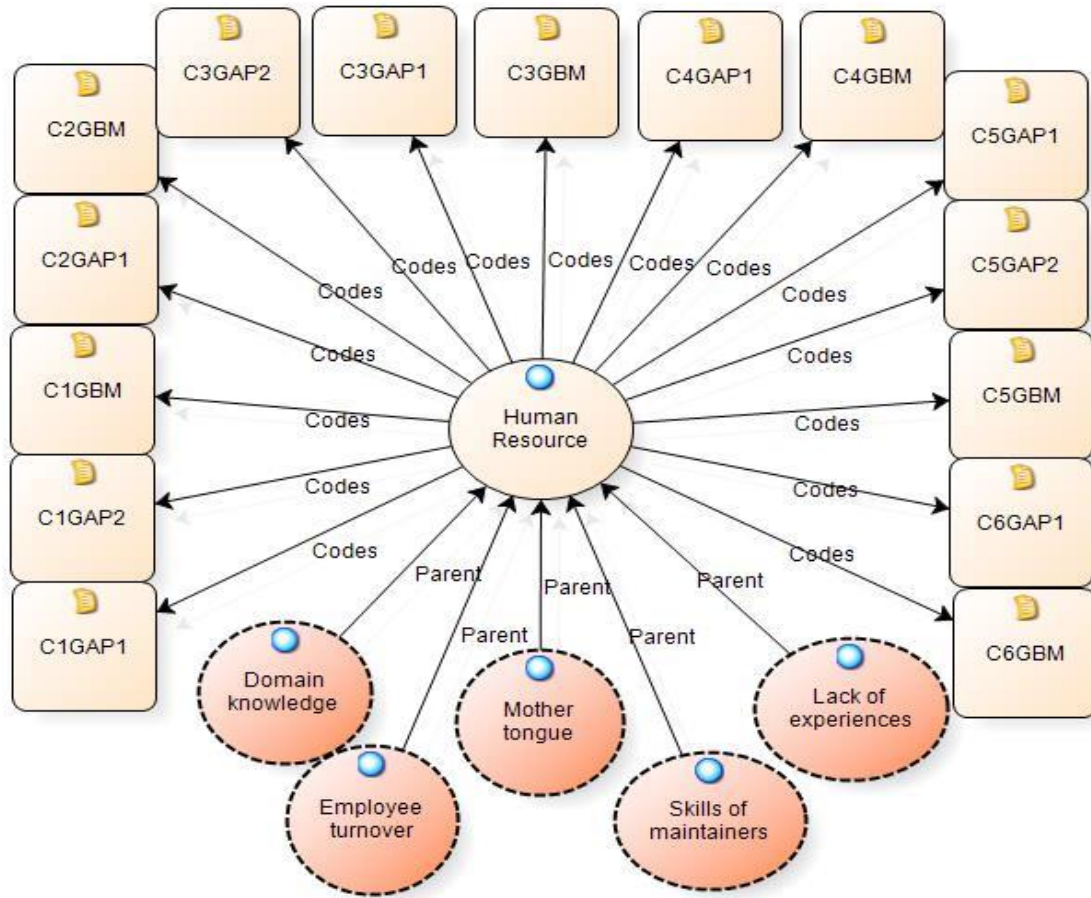
Figure 6.1: The tree nodes with sources for human resource category

Table 6.2 below summarises the number of sources and number of references related to the human resource factors theme.

| Table 6.2: Summary of the tree nodes of human resources | | |
|---|---|---|
| **Tree nod** | **No. of sources** | **No. of references** |
| Human resource | 15 | 99 |
| o   Lack of employee experience in software maintenance | 15 | 38 |
| o   Skills of maintainers | 15 | 25 |
| o   Employee turnover | 9 | 11 |
| o   Domain knowledge | 9 | 9 |
| o   Mother tongue | 15 | 16 |

### 6.1.1 Lack of Employee Experience in Software Maintenance

Table 6.2 shows 38 references from 15 sources mentioned the node lack of employees experience in software maintenance in e-commerce companies in Jordan.

The findings show that the majority of respondents from six organisations have one to three years experience in the work. Moreover, the majority of respondents do not have experience in the field of software maintenance. Indeed, the experience of the participants is in a variety of fields. Table 6.3 provides a summary of the previous jobs of the software maintenance team (who participated in the study) before working in the IT department in e-commerce companies in Jordan.

The experience of the participants is as follows (for more details see Table 5.3 chapter five):

The experience of the two participants from company one (C1) is:

The participant (C1GAP1) has worked for two years as a software developer. Also, the participant (C1GAP2) has worked for one year in computer maintenance.

While company two (C2), which has one participant:

Participant (C2GAP1) has worked for one year in computer maintenance and one year as a web designer.

The two participants from company three (C3) are:

One of the participants (C3GAP1) has worked for two years in software programming, while the other participant (C3GAP2) has worked for two years as a teacher in the Ministry of Education in Jordan and two years as a software developer.

Company four (C4) has one participant (C4GAP1) who has one year experience in e-commerce applications and one year as a web designer.

The experience of participants from company five (C5) are:

The participant (C5GAP1) has worked for one year in computer maintenance and three years as a software developer, and the participant (C5GAP2) has two years' experience: one year teaching in the Ministry of Education in Jordan and one year as a software developer.

Company six (C6) has one participant (C6GAP1) who has two years experience: one year as a trainer and one year as a web designer.

| Table 6.3: Previous jobs of software maintenance team in e-commerce companies. | |
|---|---|
| **Number** | **Jobs** |
| 1 | Software developer |
| 2 | Web designer |
| 3 | Computer maintenance |
| 4 | Teach and computer training |
| 5 | Management |
| 6 | e-commerce application |

Regarding work in software maintenance and work in other jobs in the company, the researcher found from the interviews that the software maintenance employees in some companies also have other jobs, for example, participant (C1GAP2) said: "*sometimes, it is required that I work in networks and the computer maintenance department.*" Also, participant (C3GAP1) stressed that they have other jobs in the company and that affects their main work in software maintenance. In addition, he said: "*I am working in software maintenance and software developer, also sometimes in data entry.*" Furthermore, participant (C5GAP2) said: "*I am working in software maintenance and in management*".

On the other hand, all participants in Group B (senior management) were asked about whether or not there is a lack of employee experience in software maintenance in e-commerce companies. All of them answered yes and all of them agreed that one of the most common factors that affects the developing and maintenance of the software in Jordanian e-commerce companies is the lack of employee experience.

Participant (C5GBM) said: "*yes there is a lack of employee experience in the field of software maintenance. E-commerce entered Jordan a couple of years ago, so it is normal to find a lack of employees who have experience in software maintenance.*"

Overall, these results from two Groups (A, B), indicate that there is a lack of employee experience in software maintenance in all the participants' companies. Also, the criteria of selection of employees in software maintenance jobs is not clear for the majority of respondents. Meanwhile, the researcher examined documents in the company and observed

that all employees who have worked in software maintenance in e-commerce companies and moved to other companies have a lack of experience in maintenance of e-commerce applications.

Based on the analysis of the findings above, which is related to lack of employee experience, we conclude that there is a lack of employee experience in software maintenance in e-commerce companies in Jordan. Those findings support that which is noted Swanson and Beath (1989), Pigoski (1996), Polo et al. (2002) and Agrawal et al. (2012). They all confirmed that there is a lack of experience in the field of software maintenance and the majority of employees work in software maintenance without experience in the field. Moreover, this finding confirmed the studies of Sneed and Opferkuch (2008), Agrawal et al. (2012) and Islam and Katiyar (2014), who argue that the lack of employee experience leads to increased effort and problems in software maintenance. Moreover, this confirms the findings of Swanson and Beath (1989) and Pigoski (1996) who report that major problems in the software maintenance field are due to a lack of expertise among the staff who work in software maintenance.

Moreover, this finding confirms the findings of Kalboneh et al. (2015) who reported that the availability of skills and experience of employees are one of the challenges that face the Jordanian industrial companies in adopting e-commerce.

On the other hand, this finding is inconsistent with the views of Singer (1998), who concluded that the software maintenance engineers and employees are experts in the system they are maintaining.

**6.1.2 Skills of Maintainers**

Table 6.2 shows 25 references from 15 sources mentioned to nodes skills of employees in software maintenance in e-commerce companies in Jordan.

Regarding this point, participants from Group (A) were asked about whether or not they attend training courses whilst working in e-commerce companies. All employees in software maintenance stressed the significance of training for improving the skills of workers in software maintenance. This finding confirms the views of Sommerville (2007), Galar et al. (2011), Agrawal et al. (2012), Colomo-Palacios et al. (2013) and Islam and Katiyar (2014) who all stressed the significance of training activities in developing employees who work in

software maintenance to avoid the problem of lack of understanding the system from the software maintenance team.

The majority of participants (five participants from nine participants) did not attend any training courses whilst working in the company for various reasons. Participant (C1GAP1) said: *"There is no time to attend any courses. The Management does not support a training course during working hours."* Participant (C1GAP2) stated: *"Because of the high cost of training the company does not provide any training course."* Participant (C2GAP1*)* claimed*: "I don't have time to attend any courses as I am working six days per week. Moreover, sometimes the management requests me to do other work, especially when the e-commerce system is stable. This might be network maintenance and data entry.*

Participant (C4GAP1) and (C6GAP1) said: *"The company doesn't support any training courses."*

These findings are supported by April and Abran (2012), who noted that there is a lack of training plans from management to employees who work in software maintenance. Moreover, this finding confirms the study of Sommerville (2007) who reported that one of the factors affecting software maintenance is the skills of employees who deal with maintenance.

The study findings show that there are three reasons revealed by the interviewees for not attending training sessions:

- The companies do not support training sessions, particularly during work time.
- The high cost of training sessions in the field of software or software maintenance.
- The employees do not have time to attend training sessions.

These findings are contrary to the recommendations of Agrawal et al. (2012) who report that the senior management should make sure the employees have requisite knowledge and skills required to do their job. However, participants (C3GAP1), (C3GAP2), (C5GAP1), and (C5GAP2) stated that they just attended training courses when they started working in the company but not after. The courses were about dealing with the specific software adopted in the company. This finding supports the recommendation of Islam and Katiyar (2014) who stressed the significance of training for new employees in software maintenance before starting to work in software maintenance to understand the structure of the system in use.

On the other hand, the participants in Group (B) were asked about whether or not they were interested in improving the skills of employees in software maintenance. All answers came with a strong yes, but without additional costs for the company. For example, participant (C2GBM) said: "*Yes, the company is interested in improving the skills of employees through participation with the employees in the training courses and paying part of the training costs.*"

One of the participants explained that one of the obstacles faced in the company in improving the skills of employees was the "employee turnover". Participant (C6GBM) said: *"Yes, I am interested but sometimes the problem of employee turnover affects the ability to improve the skills of employees."*

Alternatively, (C3GBM) and (C4GBM) believe that improving the skills is the responsibility of the employees, not the company. The company gives the employees a salary for doing tasks, so the employees should do what they are asked and improve their skills to achieve these tasks. Participants (C1GBM) and (C5GBM) added that training should take place outside working hours.

In this regard, the researcher had an opportunity to review many documents related to employee records in all six organisations during the field work and did not find any training certification in the employee records.

Thus, it can be stated that the majority of senior management does not support the training sessions for a variety of reasons including the cost of training, the employee turnover, and the belief that developing skills of employees is the responsibility of the employees themselves and not the company. These findings confirm the findings of Nasir and Abbasi (2010), April and Abran (2012) and Agrawal et al. (2012) who noted that there is a lack of training plans from management to employees who work in software maintenance. Conversely, the findings do not match the view of Agrawal et al. (2012) who reported that the senior management should give more attention to supporting the skills of employees.

### 6.1.3 Employee Turnover

Table 6.2 shows that 11 references related to 9 sources mentioned the node employee turnover. Six of the references came from Group (B) senior management and three references from Group (A). This seems natural because the senior management feel there is a problem of employee turnover in software maintenance work.

The researcher, through the results in Table 5.3 in chapter five (Research Findings), observed that there is no functional stability in e-commerce companies in Jordan. As the level of experience ranges between one year to three years, this is an indicator that, there is a high turnover of employees in software maintenance in e-commerce companies in Jordan. This finding confirms the study of Colomo-Palacios et al. (2013) and Islam and Katiyar (2014), who all stressed that there is a lack of an established career for software engineers.

Three of the employees from Group (A), namely (C2GAP1), (C3GAP1) and (C5GAP2), mentioned the risks of employee turnover in software maintenance in e-commerce and emphasized that this increases the problems in software maintenance.

On the other hand, the majority of participants from Group (B), namely (C2GBM), (C4GBM), (C5GBM) and (C6GBM) face the problem of high employee turnover and the management seek to reduce the employee turnover through increasing the salary of employees after a couple of months of working in the company to encourage them to stay. This finding is supported by the work of Yang et al. (2008), Floris and Harald (2010) and Islam and Katiyar (2014) who all believe that the employee turnover increases the effort, complexity and cost in software maintenance. Addressing this problem in advance helps to increase the productivity in software maintenance.

On the other hand, two participants (C1GBM) and (C3GBM) claim that they do not face problems of employee turnover. The company built the system In-house, and furthermore, the employees who develop the software in the company and maintain the system own part of the company. This finding confirms the recommendations of Yang et al. (2008) who recommended addressing the problem of employee turnover when making planning decisions.

### 6.1.4 Domain Knowledge

Table 6.2 shows 9 references from 9 sources mentioned to node domain knowledge.

All the sources were related to Group (A). The participants in Group A were asked: Do you have any plan or system to save the domain knowledge that deals with maintenance processes in the system?

All participants answered that there was no plan or system to save domain knowledge in the work of software maintenance. It can be understood from the answers that the management does not given any importance to domain knowledge.

However, the majority of participants (C1GAP1, C2GAP1, C3GAP2, C4GAP1, C5GAP1, C5GAP2, and C6GAP1) stressed that, the management are not required to save domain knowledge in their work. Also, saving domain knowledge is the responsibility of the management and not the employees.

This finding supports the studies of Anquetil et al. (2007) and Li et al. (2010) who all confirmed that people do not tend to save domain knowledge in software maintenance. Moreover, the finding confirms the studies of Pigoski (1996), Pfleeger (2001), Grubb and Takang (2003) and Serna and Serna (2014) who stressed that this issue affects software maintenance and increases the effort and time to understand the system.

### 6.1.5 Mother Tongue

The researcher, when conducting the preliminarily study in six e-commerce companies in Jordan, observed that the participants mentioned the effect of their mother tongue on software maintenance. So, the researcher took this factor into consideration in the main study to understand in-depth if the mother tongue of the employees affected software maintenance and how. Table 6.2 shows 16 references from 15 sources mentioned mother tongue.

The mother tongue for all participants from two Groups (A) and (B) is Arabic language. Six participants (C1GAP1, C1GAP2, C2GAP1, C3GAP1, C3GAP2 and C6GAP1) state that they face problems in software maintenance related to native language when:

- Contacting external companies speaking English;
- Using help in the program language; and

- Sometimes when using the internet to search for solutions for the system.

On the other hand, all participants in Group (B) believed the mother tongue affected software maintenance in different ways, for instance:

- In translating error messages from English to Arabic; and
- Writing reports about the performance of the software.

Based on the findings above about the effect of the mother tongue on software maintenance processes, we can conclude that the mother tongue (Arabic language) is a new factor affecting software maintenance processes in e-commerce companies in Jordan, especially when the company adopts global software.

**6.2 Theme Two: Organisational Environment Category**

Table 6.4 shows the main theme, sub –themes high code, and sub –themes low code related to the organisational environment**.** Also, Figure 6.2 shows the nodes with sources related to organisational environment**.**

| Table 6.4: Organisational environment category | | |
|---|---|---|
| **Theme** | **Sub –Themes High Code** | **Sub –Themes Low Code** |
| Organisational environment | 6.2.1 Managerial issues. | 6.2.1.1 Management support. <br><br> 6.2.1.2 Communication with management. <br><br> 6.2.1.3 Communication with IT staff. <br><br> 6.2.1.4 Budget of the system and maintenance. |
| | 6.2.2 Standards and maintenance classifications. | 6.2.2.1 Standard and methodology of software maintenance adopted <br><br> 6.2.2.2 Classification of software maintenance problems |
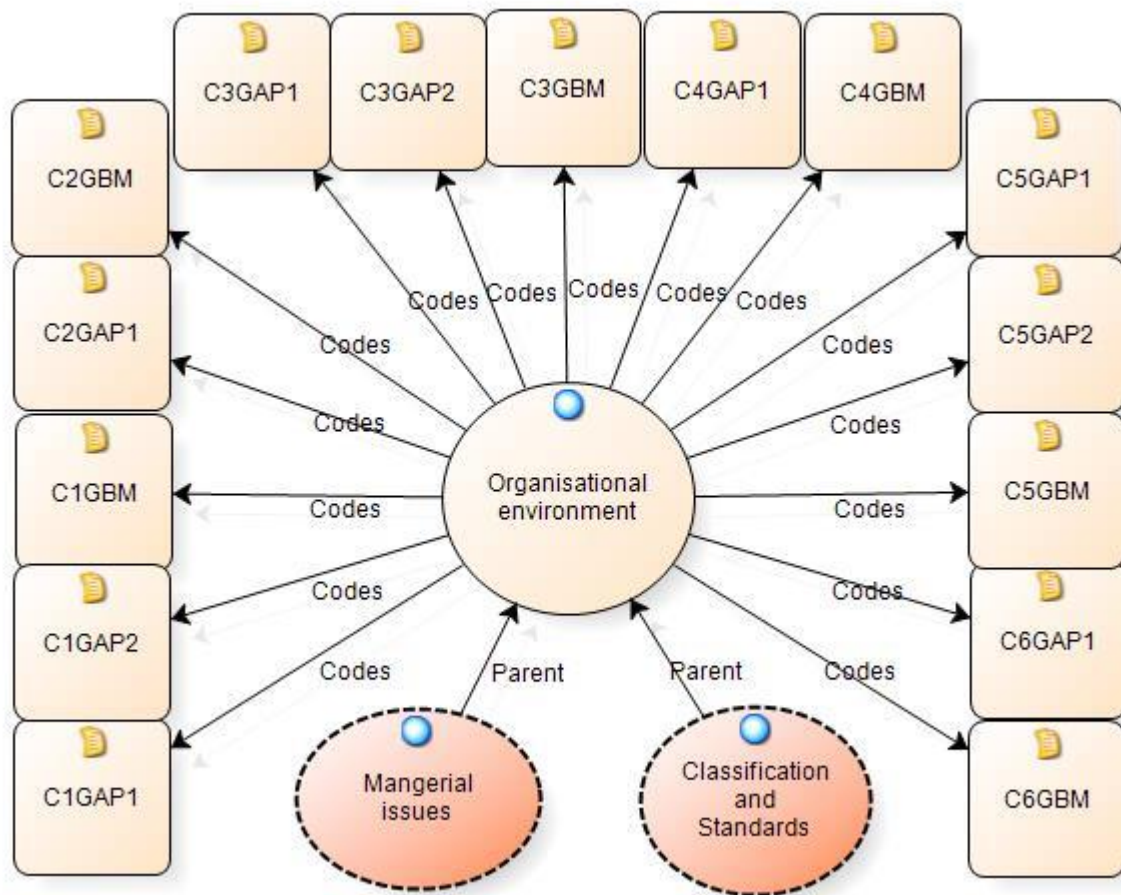
Figure 6.2: The tree nodes with sources for organisational environment category

The number of sources and number of references that were found from the interviews related to organisational factors category are shown in Table 6.5.

| Tree node | No. of Sources | No. of references |
|---|---|---|
| Table 6.5: Tree nodes with number of sources and references related to organisational environment category. | | |
| Organisational environment | 15 | 117 |
| Managerial issues | 15 | 90 |
| • Management support | 15 | 29 |
| • Communication with management. | 15 | 31 |
| • Communication with IT staff | 9 | 18 |

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| | | |
|---|---|---|
| • Budget of the system and maintenance | 9 | 12 |
| Standards and maintenance classifications | 9 | 27 |
| • Standard and methodology of software maintenance adopted | 9 | 18 |
| • Classification of software maintenance problems | 9 | 9 |

As shown in Table 6.5 above, the categories of organisational environment are divided into two main factors: Managerial issues and standards and maintenance classifications, and each one includes a group of sub-factors. In this section the researcher will analyse the findings, dealing with each of the main factors separately.

**6.2.1 Managerial Issues**

Table 6.5 above shows 15 sources and 90 references related to the node of managerial issues.

**6.2.1.1 Management support**

Fifteen sources spoke about management support across twenty nine references.

The majority of participants in Group A (approximately 78%) stressed that they have support and attention from management in Jordanian e-commerce companies in some issues but not always. However, the management support is only in financial rewards. Also, the participants indicated that the management sometimes ignore the human side of things. All participants stressed the significance of support and attention of management to employees at work.

For example, participant (C1GAP1) said: *"The attention of senior management in the IT department will be increased with the motivation in the work."*

This finding is in line with Nasir and Abbasi (2010) and April and Abran (2012) who report that maintaining software is not an easy task, as it requires more attention and better management from senior management in the organisation. This finding corresponds with the studies of Galar et al. (2011), Agrawal et al. (2012) and Foster (2014) who believe that human resources is the most important resource that needs more attention from the management.

On the other hand, two participants from two different companies (C2GAP1) and (C6GAP1) stated that they face stress at work but the managers do not give them any attention. This

finding confirms the studies of Polo et al. (2002) and Agrawal et al. (2012) who indicate that the problem of software maintenance comes from managerial processes like a lack of managing and control of human resources.

### 6.2.1.2 Communication with Management

The participants in Group (A) were asked about whether or not they have communication channels and regular meetings with the management. The majority of participants in Group A (six participants) stated that there were not any barriers for communicating with senior management in the e-commerce companies, but the management does not have enough time to communicate with all employees in the company due to the nature of e-commerce work.

(C3GAP2) and (C4GAP1) explained that, sometimes they face barriers in communication with senior management, because there are certain procedures to follow in order to communicate with high levels of management, the so-called "Administrative hierarchy".

All participants indicated that they only really have meetings with senior management for the reasons below:

- When something is urgent.
- When the system is broken or the company has the desire to update the system.

On the other hand, all participants from Group (B) indicated that they recognise the significance of software maintenance employees. Also, 67% of them claim to involve the employees in decisions related to the software. However, the participants admitted that they do not hold regular meetings in the company. Participant (C6GBM) stated that: "*We do not involve the maintenance employees in the decision-making all the time, as only the management should be involved in some of the decisions.*"

Meanwhile, the researcher examined documents in the participants' companies and observed that the average number of meetings in three of the companies is eight formal meetings in a year, and two participants companies have three formal meetings in a year and one companies does not have any formal meetings.

Based on an analysis of the data above, it appears that the nature of the relationship between employees in software maintenance and the senior management is not clear and not strong in Jordanian e-commerce companies.

This finding is not in line with Nuha and Dema's (2006) study, which states that management is a key success factor in any software development process. Moreover, this finding does not meet the view of Thayer (1997), Weihrich (2000) and Kamsu-Foguem (2014) regarding functionality of management.

### 6.2.1.3 Communication with IT Staff

At this point, the participants were asked about whether the company has separate sections in the IT department and asked about the communicational and cooperation channels with staff. Table 6.5 above shows 9 sources and 18 references mention the node communication with IT staff.

All participants from Group (A) stressed the significance of separate sections in the IT department for organizing the work and for the significance of cooperation between team members in developing the work of software maintenance. This finding supports the study of Lanubile et al. (2010), Wei et al. (2014) and Fagerholm et al. (2014), who stressed the significance of cooperation between the team members in the software industry.

In addition, the findings show the majority of participants (68%) did not have separate sections in the IT department and did not always have regular meetings with the IT team. This finding is inconsistent with the views of Gupta and Fernandez (2011), Wei et al. (2014) and Fagerholm et al. (2014) who stressed about improving the performance of the team and building strong relationships between IT team members in the organisation to develop better work and increase the efficacy in the software maintenance.

Three of the participants from two different companies (C3GAP1, C3GAP2 and C5GAP1) answered yes; they have separate sections in the IT department, and have regular meetings with IT staff. In this respect, the researcher observes from Table 5.2 in chapter five regarding the companies' profiles that, those two companies have the largest number of employees in the company and in the IT department in comparison with the other four companies. Thus, the existence of sections may depend on the number of employees in the company and in the IT department. This finding is supported by Gewaltig and Cannon (2014) who noted that often new software is developed quickly by individual people or small teams so there is the potential of failure to achieve the requirements and it is hard to pretend that the results of the software are right.

The senior management were also asked whether they have separate sections in the IT department or not and why. The majority of the participants mentioned the same reasons related to the existence of separate sections and those reasons were: size of the job and the number of employees in the company. Indeed, only two participants from the six had separate sections in the IT department.

The researcher observed that the majority of participating companies had a small number of IT employees (cf. Table 5.3).

### 6.2.1.4 Budget of the System and Maintenance

Only three of the participants in Group A referred to how the budget affected the software maintenance.

Two of the participants (C5GAP1 and C5GAP2) mentioned that, one of the factors that affected software maintenance was the budget of the company and the budget of the IT department. The budget affects the quality of the original software and thus, it affects the maintenance of the software.

On the other hand, C6GAP1 explained that, the budget affects the choice of source of software in the company (outsource or In-house). He said: "*From my experience, the source of software depends on the budget of the company. It is not reasonable for a company with a small budget to decide to adopt outsourced software because it is costly. On the other hand, if the company has a high budget that means they will have a high workload in the future. So, outsourcing will be the best choice.*"

All six participants from Group (B) asserted that the budget affected software maintenance, and all the answers were similar to Group (A):

- Quality of original software;
- The type of software;
- Source of software;
- Type of hardware; and
- Quality of employees working in maintenance.

This finding is supported by many scholars who mention the high cost of software maintenance, namely Yongchang et al. (2001), Al-Najjar (2007), Floris and Harald (2010), Stojanov et al. (2013), Dehaghani and Hajrahimi (2013), and Islam and Katiyar (2014).

We conclude from these findings and from the profile of participating companies that the majority of e-commerce companies in Jordan are in their infancy so they do not have a high budget for the IT department as many authors mention the high cost of software and resources of the IT environment. Therefore, that means according to the findings, the budget affects the choice of type of software, and sometimes the companies are forced to select cheap software within the budget of the companies. The majority (not all) of cheap software is not adequate, as some participants' state, and that reflects on the maintenance needed in the future.

### 6.2.2 Standards and Maintenance Classifications

The objective of the questions related to this factor is to discover whether the employees in the software maintenance of e-commerce companies in Jordan have any idea about standards and methodology of software maintenance, and to understand if they use standards and methodologies of maintenance in their work.

The questions for this factor and the two sub-factors were for Group (A) employees in software maintenance.

### 6.2.2.1 Standard and Methodology of Software Maintenance Adopted

Table 6.5 above shows 9 sources and 18 references related to this node. The participants were asked about whether or not they adopt software maintenance standards in their work. All the participants from Group (A) answered that they do not adopt any standards of software maintenance in their work.

Also, all nine participants stressed that they do not use any methodology in software maintenance, and the majority did not have any idea about software maintenance methodology or standards. The majority of participants mentioned two reasons for not using a methodology or any standards. They were that methodology is not required by the management and the second reason is that, the participants do not have enough knowledge about software maintenance standards and methodology. This finding is inconsistent with the recommendations of many scholars about the significance of adopting software maintenance standards to improve software maintenance activities and to help organisations to understand

the quality process IEEE std (1998), ISO/IEC 14764 (2006), Robillard et al. (2007), April and Abran (2012) and Rata (2014).

**6.2.2.2 Classification of Software Maintenance Problems**

The participants in Group (A) were asked about if they adopted any plan in their work or not. The majority of participants (seven participants) answered yes, they have a plan, but sometimes the plan is old and not up-to-date. In addition, the majority of them did not explain the plan, as it is "confidential".

On the other hand, two of the participants (C2GAP1 and C6GAP1) did not have any plan or methodology for the software. Meanwhile, the researcher examined documents in the companies and observed that the plan of major companies, if they existed, were very old. This finding is not in line with the thinking of authors such as Thayer (1997), Weihrich (2000) and Chang (2002), who present five functions of management, one of which is planning.

Moreover, it can be observed that the majority of e-commerce companies do not adopt or use any software maintenance classification in their work. Also, the majority of them use old plans for dealing with maintenance without classification for the problems of maintenance. This finding is inconsistent with studies and standards of Lientz and Swanson (1980), Abran and Nguyenkim (1993), IEEE std (1998), Abran et al. (2004), ISO/IEC 14764 (2006),  and López and Salmeron (2012), who all stressed the significance of classifying maintenance requests in order to deal with maintenance activities. Also, the finding is not in line with the study of Li et al. (2010) who emphasized that improving process classification schema to classify defects could reduce the effort of the maintenance.

### 6.3 Theme Three: Operational Environment Category

The theme operational environment includes three main factors and each factor includes many sub-factors. Table 6.6 shows the main theme, sub –themes high code, and sub –themes low code related to the operational environment. Also, Figure 6.3 shows the nodes with sources related to operational environment category.

| Table 6.6: The operational environment factors category. | | |
|---|---|---|
| **Theme** | **Sub –Themes High Code** | **Sub –Themes Low Code** |
| Operational environment | 6.3.1 System reliability | 6.3.1.1 Environment reliability<br>6.3.1.2 Hardware and Operating system reliability |
| | 6.3.2 Operation user | |
| | 6.3.3 Reasons of maintenance | |
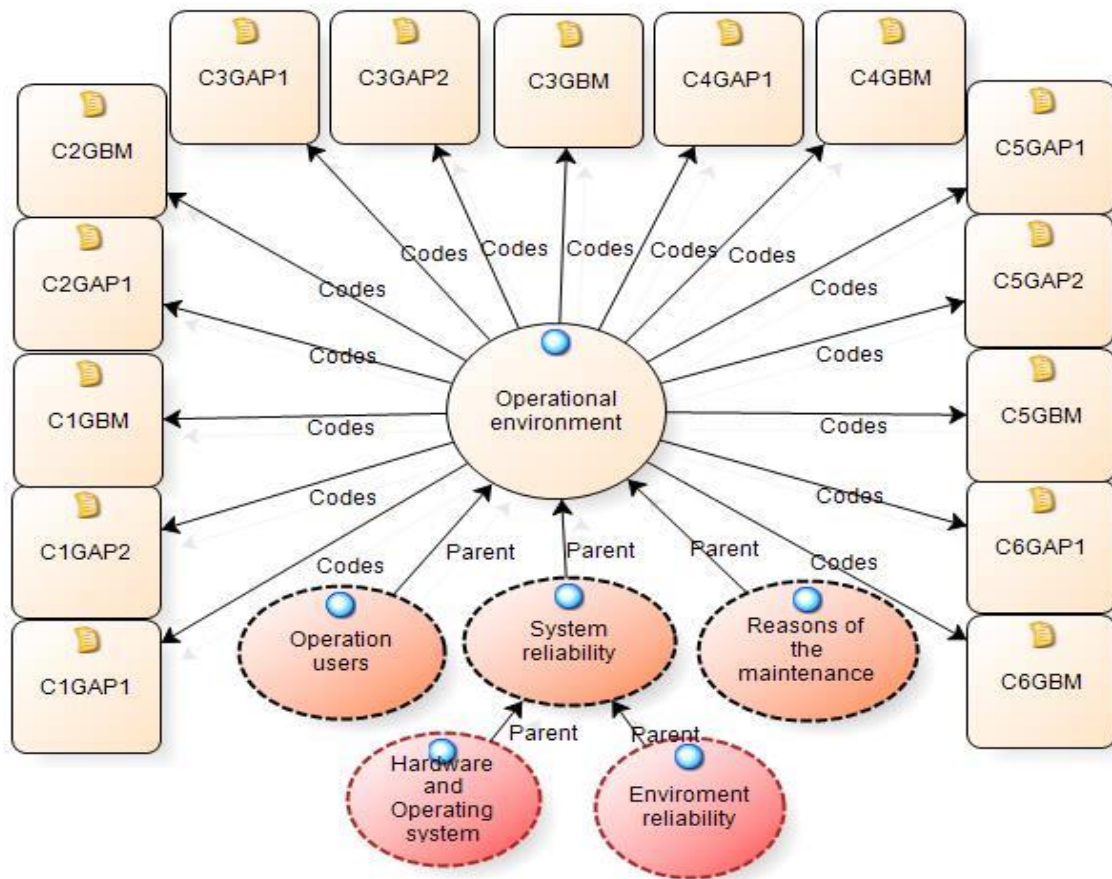
Figure 6.3: The tree nodes with sources operational environment category.

The number of references and sources related to operational environment category is 66 references and 15 sources. Table 6.7 below summarises the number of sources and number of references related to operational environment category.

| Table 6.7: Summary of the tree nodes of operational environment category | | |
|---|---|---|
| **Tree node** | **No. of sources** | **No. of references** |
| Operational environment | 15 | 66 |
| System reliability | 15 | 38 |
| • Environment reliability | 15 | 19 |
| • Hardware and operating system | 15 | 19 |
| Operation users | 9 | 10 |
| Reasons of maintenance | 9 | 18 |

**6.3.1 System Reliability**

Table 6.6 above shows the sub-factors of system reliability factors, which are:

- Environment reliability; and,
- Hardware and operating system reliability.

Also, Table 6.7 above shows the 15 sources and 38 references related to the factor of system reliability.

**6.3.1.1 Environment Reliability**

Regarding this factor the participants were asked many questions to understand how the environment affects software maintenance, and also to understand the environment of e-commerce applications.

One of the features in e-commerce companies in Jordan is the method of payment. Only a few of the participants use an electronic payment method in the sales. One of the most famous payment methods is "cash on delivery". Three participants of the e-commerce companies in Jordan (C1, C2 and C6) use just this one payment method, "cash on delivery".

The participants (C3GAP1, C3GAP1, C4GAP1, C5GAP1, and C5GAP2) who use electronic payment methods in some transactions face problems related to communicational channels between the two companies.

Furthermore, the participants from Group (B) were asked if they had changed the software adopted in the company or not since the establishment of the company. All participants answered that they had not changed the e-commerce application since the establishment of the company and the majority of the participants were not satisfied with the software adopted.

One of the participants (C1GBM) said: "*We haven't changed the e-commerce application used in the company. But we are planning to change the e-commerce application to another system to enhance the quality and security. The strong candidate source of the system is outsourced.*" Also, participant (C3GBM) said: "*No, I haven't changed the software, but we are studying in the company the possibility of changing the software to an outsourced company.*"

Four of the participants (C2GBM, C4GBM, C5GBM, and C6GBM) from four of the companies would prefer to change to another software but the budget does not allow for it. Indeed, the four participants state that there are two reasons leading to the need to change the software adopted in the companies. The first reason comes from the complexities of maintaining the current system adopted in their companies. This finding is supported by Sommerville (2007), who argues that changing the system after delivery is expensive and sometimes takes a long time to find the right version of the system. The second reason is the system sometimes does not fit with the changes in the environment. This finding is supported by Niessink and Van Vliet (2000), who reports that the system must meet the requirements of the users, and must fit with environment change. This finding is confirmed by the views of Mallikarjuna et al. (2014), who report that the maintainability of the system means the ability of the system to make changes in a simple way.

Based on the discussion above, we can conclude that the majority of the participating companies are not satisfied with the current software application adopted in their companies. This finding is confirmed by Jackson (2015), who stressed that one of the global challenges in e-commerce business is designing an electronic infrastructure to support the online business.

**6.3.1.2 Hardware and Operating System Reliability**

Questions were asked to the two Groups (A) and (B) about the effects of changing hardware and/ or operating system on software maintenance. Also, the interviewer sought to find out when and why the e-commerce companies changed the hardware/ operating system. The next section will explain their answers.

All the participants in Group (A) mentioned the effect of changing hardware/ operating system in the e-commerce application and the increase in effort for the software maintenance team that entailed. In addition, they explained that the e-commerce system differs for other software in other areas. The e-commerce system is a homogenous system that includes hardware, software, and network, so any changes in one of the components will of course affect the other components and the overall e-commerce system. This finding supports the findings of Storey et al. (2000), who report that the e-commerce industry is a mixture of products and services including hardware, software products, network and transmutation networks. Moreover, this finding is in line with Di Sciascio et al. (2003) study, which argues that the problems in website applications arise from the three components of hardware, software and network

issues. Moreover, the finding confirms the studies of Abran et al. (2004) and Zhang and Versteeg (2013), who noted that one of the reasons for doing maintenance is the change in hardware or operating system.

Figure 6.4 shows the components of e-commerce applications according to software maintenance employees in e-commerce companies in Jordan.
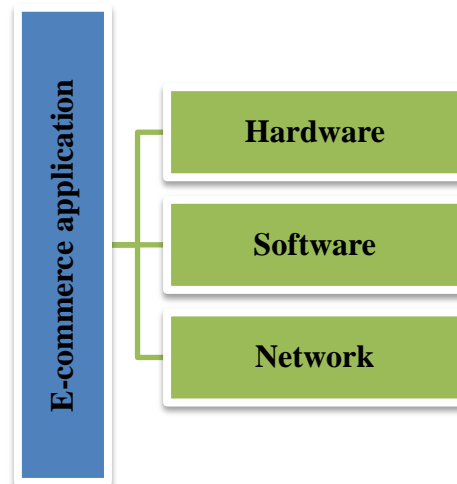


Figure 6.4: E-commerce application components in Jordanian e-commerce companies

It was found that, the operating system has been changed in four of the companies (C1GBM, C2GBM, C3GBM and C6GBM). The main reason for the change was to deal with a new version of software.

Five participants (C1GBM, C2GBM, C3GBM, C5GBM and C6GBM) out of six stated that the company changed the hardware at different times. The vast majority of the companies that have changed the hardware stressed that the reason for the change was due to the expansion of labour.

Based on all discussions above and on Table 5.2  Companies' profiles (chapter five), it can be observed that, the majority of e-commerce companies changed the hardware a short time after the company was established. Two of the companies that changed the hardware were established in the year 2012 and one company in 2011 and two companies in 2010. That is an indicator of one of the reasons that increases the effort in software maintenance in e-commerce companies in Jordan, the fact that they are changing hardware rapidly and repeatedly. This finding confirms Lientz and Swanson (1980), IEEE Std (1998), ISO/IEC 14764 (2006) software maintenance categories, who classify one of the software maintenance

activities as modification of the software system to make sure it is working when a new change occurs in a work environment, for example, new hardware, operating system, DBMS, network.

### 6.3.2 Operation Users

All nine participants from Group (A) stated that, misunderstanding the process of software application in e-commerce companies from operations leads to the creation of new problems in the system and sometimes stops the system. (C1GAP1) and (C1GAP2) state that every day they received orders from operators to do maintenance on the system and they found the cause of the problem was misunderstanding from the operators. This means operators are one of the factors affecting software maintenance. This finding supports the views of Nasir and Abbasi (2010), who report that the operator users must take full training about using the system before dealing with the system to avoid any errors in the software application.

### 6.3.3 Reasons of maintenance

All nine participants in Group (A) stressed that the main reasons for software maintenance in Jordanian e-commerce companies are related to:

- Fixing bugs;
- Changing hardware and software;
- Changing operating system;
- Weak performance in the system;
- Changing the policy of the work;
- New browsers;
- New technology adopted such as iPhone browsers; and
- Increasing the size of the workload.

This finding is in line with the studies of Grubb and Takang (2003), Abran et al. (2004), Midha et al. (2010), Zhang and Versteeg (2013), Cortellessa et al. (2015), who find the same reasons for doing maintenance to software.

In addition, participant (C6GAP1) mentioned another reason for software maintenance, which leads to increasing the effort needed in software maintenance and that is change of end user

interface, especially to Arabic. The effect of Arabic language on software maintenance in e-commerce companies in Jordan was explained in detail in theme one (cf. 6.1.5).

**6.4 Theme Four: Software Characteristics Category**

The goal of this theme is to understand in depth the factors that affect software maintenance related to the characteristics of software products, such as the quality, documentation, programing language and maintainability of the system.

All the interview questions were designed directly for Group (A), because Group (A) was the main source for data related to software characteristics. For more detail and justification for constructing the interview questions for Group (A) see preliminary study (Appendix 1) and interview questions (Appendix 2).

Table 6.8 shows the main theme, sub–themes high code, and sub–themes low code related to the software characteristics. Also, Figure 6.5 shows the nodes with sources related to software characteristics.

| Table 6.8: The software characteristics factors category. | | |
| --- | --- | --- |
| **Theme** | **Sub –Themes** **High Code** | **Sub –Themes** **Low Code** |
| Software characteristics | 6.4.1 Product quality | 6.4.1.1 Documentation quality 6.4.1.2 Quality of original system 6.4.1.3 Maintainability of the system |
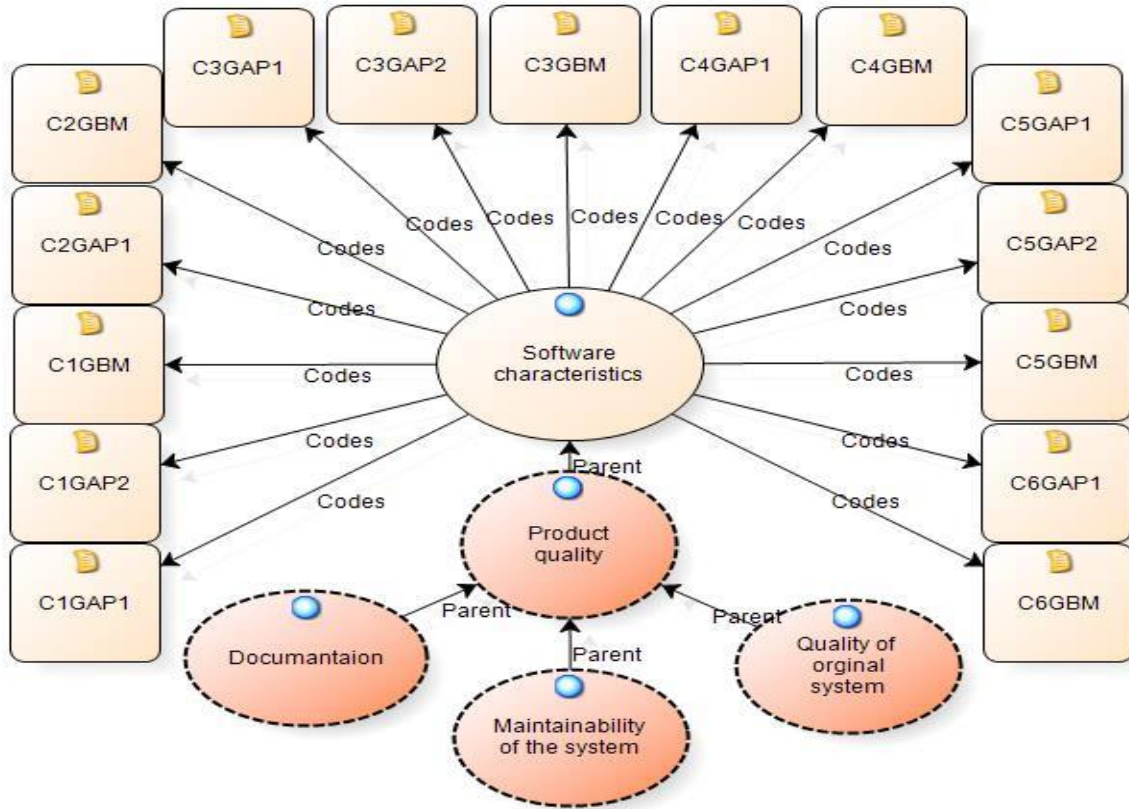
Figure 6.5: The tree nodes with sources software characteristics category.

Table 6.9 summarises the number of sources and number of references related to software characteristics category.

| Table 6.9: Summary of the tree nodes of software characteristics category. | | |
|---|---|---|
| Tree node | No. of sources | No. of references |
| Software characteristics | 15 | 79 |
| Product quality | 13 | 73 |
| • Documentation | 10 | 26 |
| • Quality of original system | 13 | 30 |
| • Maintainability of the system | 9 | 17 |

### 6.4.1 Product Quality

Nine sources from a total of fifteen sources spoke about product quality across seventy three references.

### 6.4.1.1 Documentation

At this point, the participants in Group (A) were asked many questions related to the documentation such as availability of documentation about the software adopted in the company and updating the documentation in the work.

### 6.4.1.1.1 Availability of Documentation

Four participants (C1GAP1, C1GAP2, C2GAP1, and C6GAP1) stated that the software adopted in the company did not have any documentation. These participants were from three different e-commerce companies. This means 50% of the companies do not have any documentation for the system. This finding is not in line with many studies that mentioned the significance of using documentation in software maintenance in order to reduce the effort and the time when doing maintenance (Niessink and Van Vliet, 2000; Grubb and Takang, 2003; Sommerville, 2007; Das et al., 2007; April and Abran, 2012; and Garousi et al., 2015).

One of the participants (C1GAP2) said: *"The system was built in-house. Furthermore, the developers who built the system are responsible for the maintenance of the system".*

The participants (C3GAP1, C3GAP2, C4GAP1, C5GAP1 and C5GAP2) have documentation for the software and the documentation includes user guide, software structure, and screenshot about the system.

### 6.4.1.1.2 Use and Updating the Documentation

As previously explained, only 50% of participants' companies have documentation for the system. The participants who have documentation were asked about whether or not they use documentation provided and if so, whether they update it. All participants who have documentation for the system stated that they do not review the documentation before solving the errors in the system, and they do not update the documentation.

This finding supports the finding of Singer (1998), who reports that problems occur when the software is updated without updating the records/ documentation. However, the finding is not

in line with software maintenance process standards IEEE Std (1998) and ISO/IEC 14764 (2006), which outline that one of the processes should be to review and update documentation. The finding supports the studies of Dean and McCune (1983), Grubb and Takang (2003), Das et al. (2007), Lo et al. (2008), Floris and Harald (2010) and Islam and Katiyar (2014), who all noted that the problems increase in software maintenance when the documents are incomplete or non-existent. Lack of or incomplete documentation leads to spending a lot of time understanding the system maintenance.

One of the participants (C3GBM) from Group (B) stated that one of the factors affecting software maintenance is availability of documentation. This finding confirms the study of Lethbridge et al. (2003), who reports that the maintainers often update the software without updating the documentation and do not maintain documentation.

On the other hand, the participants (C3GAP1, C3GAP2, and C4GAP1) claimed that, they do not have time to review the documentation, as they need to solve the problem as soon as possible. Participant (C5GAP2) said: "*In e-commerce application I am asked to solve the problem as soon as possible. Furthermore, the company doesn't have a full documentation about the system*".

Moreover, the finding is in line with software maintenance process methodology, "Quickly Modify Model". The maintenance team seeks to solve the errors when they occur in the software as soon as possible without reviewing the potential risks or the change effect to another component in the system. The documentation is sometimes updated after fixing the errors if they have time (Basili, 1990; Grubb and Takang, 2003)

In summary, regarding the software documentation in the e-commerce companies in Jordan, three organisations from six organisations participating in the study do not have software documentation. Furthermore, the three organisations that have software documentation did not review or update the documentation during software maintenance activity. This finding is similar to that which has been reported by authors such as El-Khalili and Dema (2006) who argue that few IT employees in software development organizations in Jordan review their documents in the development and maintenance stages. Also, the documents were not updated when updating or maintaining the product.

Moreover, the researcher examined the available documents in the IT department in all six organisations and he did not find any useful documentation related to software adopted in the company. Based on the discussion above, we can observe an absence of use of the documentation in software maintenance activities in e-commerce companies in Jordan.

**6.4.1.2 Quality of Original System**

Table 6.9 above shows 13 sources and 30 references referring to the quality of the original system. We focused in this node on the quality of programing language and the structure of software.

All the participants in Group (A) stressed the significance of the quality of the original software in the maintenance process. Moreover, they stated that the structure of the software and program language play an important role in software maintenance, and one of the main factors affecting software maintenance is the quality of the original software.

C3GAP2 said: *"The quality of the original program leads to facilitating maintenance work, and vice versa."* In addition, participant (C5GAP2) said: *"The quality of original software affects the maintenance in any software product. A clear structure makes tracking errors in the system quicker, and also programme language plays an important role in facilitating maintenance procedures."*

Similarly, three participants from Group B (C1GBM, C3GBM and C5GBM) stated that one of the main factors affecting the software maintenance in the company is the quality of original software.

This finding confirmed Kohli and Singh (2013), Grant and Cordy (2014) and Islam and Katiyar (2014) studies, which all argue that the programing language plays an important role in software maintenance. The programme language can reduce or increase the effort in software maintenance. The finding is supported by the research of Islam and Katiyar (2014), which argues that using fourth generation languages allow software to be developed and maintained more quickly than third generation languages.

These findings are also in line with Nasir and Abbasi (2010), who concluded that code is built in a structured manner that leads to reducing the effort in identifying faults. Furthermore, fixing bugs or updating the system is very complex and takes time away from the software maintenance team if the code and architecture of the system are complex.

### 6.4.1.3 Maintainability of the System

Table 6.9 above shows 17 references from 9 sources regarding the maintainability of the system. The goal of this point is to understand in detail if maintenance of e-commerce applications differs from other types of software application. The participants were asked: Do you think software maintenance in e-commerce applications differs from other types of software?

All nine participants from six organisations answered yes, software maintenance in e-commerce applications differs from other types of software and all the justifications were:

- E-commerce systems are sensitive and forked;
- The procedure of work is totally different to any other software; and
- E-commerce application needs more attention. This finding is supported by Hibu Company (2014).

One of the participants said: *"The maintenance in e-commerce applications requires speed and the company can't wait hours to solve problems. Also, e-commerce systems should work 24/7 (24 hours a day, seven days a week) without stopping whereas for the other systems it is not a big problem if it stops working for one or two hours"*.

This finding is supported by the work of Sommerville (2007), who argues that all the software products have attributes affecting and reflecting the quality of software. These attributes are different from one software to another according to the application environment.

This finding is confirmed by Islam and Katiyar (2014), who stress that there are different types of application areas, and the software application is affected by the characteristics of the area of work.

Moreover, all participants in Group (A) stressed that one of the most important attributes in any software product is the maintainability of the system. Moreover, they stressed the significance of maintainability of the system in facilitating the software maintenance work and saving time and cost of maintenance. This finding is supported by many authors such as Singh et al. (2009), Stojanov et al. (2013) and Mallikarjuna et al. (2014), who all believe that improving the maintainability can increase availability and reduce time and effort in the software maintenance process.

## 6.5 Them Five: External Factors Category

The aim of this point is to understand the external factors that happen outside of company control and what and how they affect software maintenance.

Table 6.10 shows the main category, factors, and sub-factors related to the external factors category. Also, Figure 6.6 shows the nodes with sources related to external factors category.

| Table 6.10: External factors category | | |
|---|---|---|
| **Theme** | **Sub –Themes** <br> **High Code** | **Sub –Themes** <br> **Low Code** |
| External factors | 6.5.1 Source of software. | 6.5.1.1 In house. <br> 6.5.1.2 Outsource. |
| | 6.5.2 Service level agreement (SLA). | |
| | 6.5.3 Views of people about software maintenance job. | |
| | 6.5.4 Outcomes of IT student from university | |
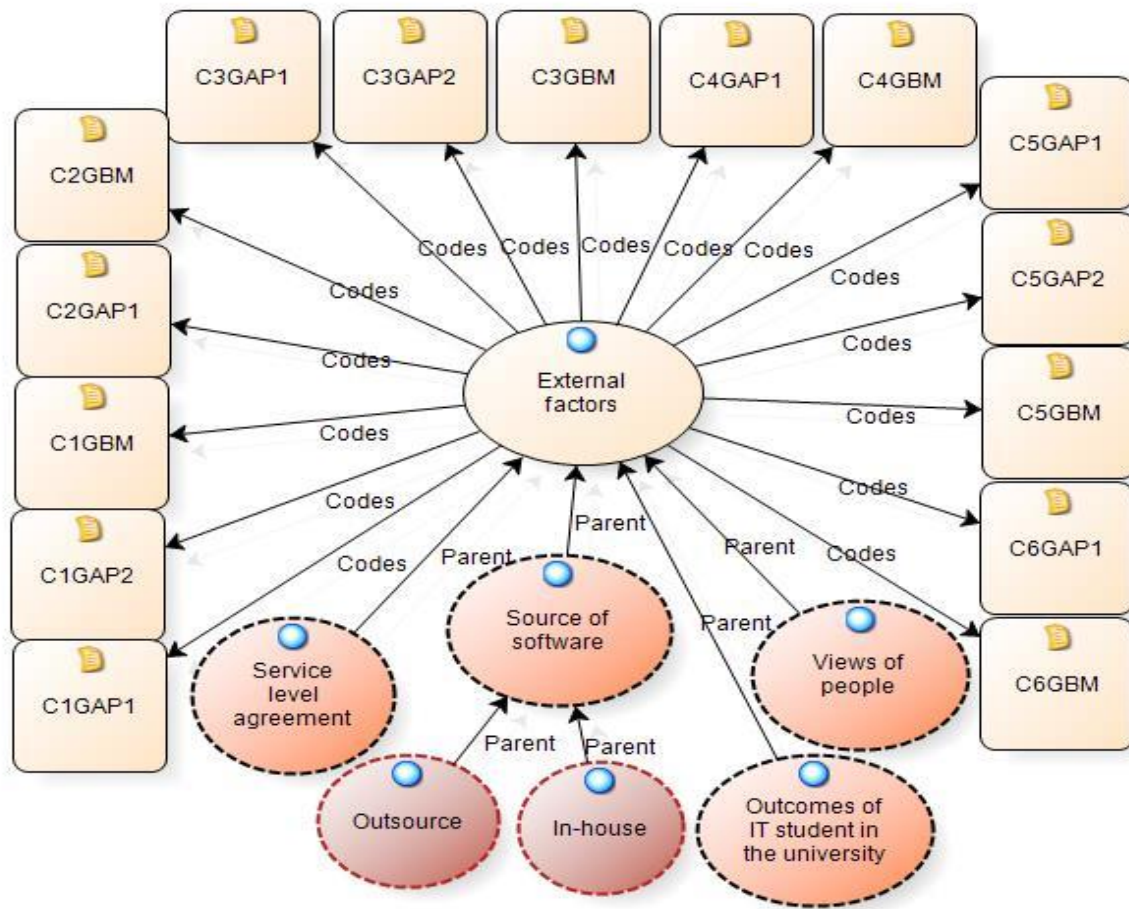
Figure 6.6: The tree nodes with sources external factors category.

Table 6.11 shows a summary of the number of sources and number of references related to external factors category.

| Table 6.11: Summary of the tree nodes of external factors category | | |
|---|---|---|
| **Tree node** | **No. of sources** | **No. of references** |
| External factors | 15 | 113 |
| • Source of software | 15 | 55 |
| o  In house | 10 | 11 |
| o  Outsource | 13 | 21 |
| • Service level agreement (SLA) | 15 | 30 |

| | | |
|---|---|---|
| • Views of people about software maintenance job. | 9 | 9 |
| • Outcomes of IT student from university | 9 | 18 |

**6.5.1 Source of Software**

The objective of this point is to learn about the source of software used in e-commerce companies in Jordan, and to understand in depth the problems related to each one of the sources (In-house, Outsource). Table 6.11 above shows 15 sources and 55 references related to this point.

First of all, the participants from Group (A) were asked what information they were interested in obtaining before buying the software. All participants were interested in obtaining information about the software before adopting it and below is a summary of the information that the participants were interested in:

- Age of the system;
- Proliferation of the system;
- Feedback about the software;
- Availability of the documentation;
- Maintainability of the system;
- Programme language;
- Security of the system;
- Reputation of the company that produced the system; and
- Possibility of doing maintenance internally in the company.

**6.5.1.1 In-house Software**

Table 6.11 shows 10 sources and 11 references mentioning in-house software. The participants in Group (A) were asked about in-house and outsource software. The majority of participants (seven participants) stressed that in-house software requires a great team to develop the software. This finding is similar to the recommendation of Rata (2014), who concludes that software has grown and they need a great team to build the system.

Moreover, the majority of participants stressed that they could not say one source was better than another source as that should depend on the scale of work and the budget of the company.

One of the participants (C5GAP1) said: *"For small work the in-house is perfect and can manage most processes of the work, while in large businesses outsource is the better choice, because the e-commerce application is a huge system and needs a large team to work on developing the system"*

Another participant (C3GAP1) said: *"I think outsource is the better choice, because when you need to adopt outsource software you will have several options and you will choose the best one for the budget of the company, whilst when adopting in-house software you have just one choice of software. Furthermore, there is the problem of employee turnover when the software is built in-house"*.

Furthermore, two participants from Group B (C1GBM and C3GBM) stated that they adopted in-house software built in the company. Participant (C1GBM), although he adopted in-house software, said: *"I think outsourcing is the perfect choice because with in-house you have one choice for the structure and quality of the system, but with outsourcing you have many choices with high quality"*. Participant (C3GBM) also said: *"From my perspective and experience, outsourcing is the perfect choice, because the outsourced software is more efficient and applicable for updating"*. (C5GBM) stressed that: *"the company adopted outsourcing software, because the employees in the IT sector don't have experience to build an e-commerce system in-house. The company adopted software built outside of the country"*.

Four organisations from six organisations participating in the present study adopted outsource software, while two companies (C1 and C3) adopted in-house software. This finding is confirmed by Ahmed (2006) and Jiménez et al. (2009), who reported that several companies are outsourcing the software product and the maintenance to reduce costs and to improve efficiency, and also because the technical resources are scarce in some companies.

### 6.5.1.2 Outsourcing

All nine participants from Group (A) stressed that within the current resources (any resource related to the software or maintaining the software) in e-commerce companies in Jordan outsourcing is the best choice for the reasons below:

- Outsourcing offers more quality
- More usability
- Outsourcing is more specialized in the system, supported by Jiménez et al. (2009)

- Less cost if we compare with in-house, as claimed by Ahmed (2006)

Four participants form Group (B), (C2GBM, C4GBM, C5GBM, and C6GBM) stated that they adopt outsourced software in the company. This means approximately 67% of the participants' companies adopt outsourced software. The vast majority of them faced problems in communication channels and delay in delivering the request. This finding confirms the recommendations of Ahmed (2006) and Bennett and Rajlich (2000), who report that poor communication between organizations and outsourcing company should be addressed in the project plan.

On the other hand, two of the participants from Group B (C1GBM and C3GBM) who develop in-house software stressed that, the software maintenance should be handled internally in e-commerce companies if the company adopts outsource software.

Based on the discussion above and on the documents in the companies, the employees in the IT department and senior management in e-commerce companies in Jordan prefer outsourced software. However, they are also interested in doing maintenance internally in the company.

Two participating companies adopt In-house software (C1 and C3), and they are not satisfied with the software. The numbers of employees in the IT department in their companies are as follows: company C1 has two employees and company C3 has four employees. This finding confirms the findings of Rata (2014), who noted that a large sized software requires great teams of specialised people to build the software. So, based on findings regarding source of software (outsource and in-house), we can find links between these findings and the findings related to lack of experience of employees in software maintenance in e-commerce companies in Jordan (cf. 6.1.1).

Therefore, we can conclude that built In-house software in e-commerce companies in Jordan within the existing resources is unusable. Moreover, this finding is supported by Gewaltig and Cannon (2014), who noted that often new software is developed quickly by an individual person or small team. So, in these cases, there is the potential of failure to achieve the requirements and it is hard to pretend that the results of the software are right.

### 6.5.2 Service Level Agreement (SLA)

Table 6.11 above shows 30 references in 15 sources mentioned service level agreement. The participants in the two groups were asked about whether or not they use service level agreements to deal with external partners related to software maintenance work. Also, they were asked about the problems faced in service level agreement.

Three of the participants from two companies stated that, the company does not use service level agreements, and two participants (C1GAP1 and C1GAP2) explain that the reason for this is that the software is built in-house. On the other hand, participant (C6GAP1) justifies the reason as: "*The company does not use service level agreement (SLA) to deal with IT support companies. The company, when buying software, got five years of free maintenance*". This finding is not in line with Ahmed (2006) and Wu et al. (2014) recommendation, which stated that if the company decided to conduct maintenance via outsourcing, they must address (SLA) in advance before starting the contract of maintenance.

Three participants who use SLA (C2GAP1, C3GAP1 and C4GAP1) stated that service level agreement is vague and not clear. Participants (C2GAP1, C5GAP1 and C5GAP1) stated that the problem facing the company when using SLA is communication channels between the two companies.

Similarly, the majority of participants from Group B (four participants) have used service level agreement in work, and all of them stated that service level agreements are not clear. This finding is supported by Bennett and Rajlich (2000) and McCracken (2002), who all argue that there is a lack of justifying the relationship between service company and company using the software product and the service level agreement is not clear.

### 6.5.3 Views of People about Software Maintenance Job

This section deals with the new factors that the researcher observed when conducting the preliminary study in e-commerce companies in Jordan (cf. Appendix 1) about what may affect software maintenance. The participants from Group (A) were asked about the view of Jordanian people about the software maintenance job, and how this affects software maintenance. The answers were similar.

The majority of participants were interested in the views of people related to their job. Participant (C4GAP1) said: "*Software maintenance is a good job. In the Arab society people's*

*opinions about jobs are important".* Also, participants C1GAP1, CGAP2, C3GAP1, C3GAP2 and C6GAP1 stated that, the views of people affect their work. For example, positive views of people about their job will increase the motivation to work and vice versa. Also, they state that the view of people about software maintenance is that it is a "good job and high revenue job".

This finding is supported by Nasir and Abbasi (2010), who noted the motivations of the maintenance team in the work helps to deliver better results in the software maintenance.

Based on the discussion above as regards the views of people about software maintenance jobs, approximately 70% of the participants stressed the significance of the views of people about the software maintenance job for improving the software maintenance work.

### 6.5.4 Outcomes of IT Students from University

Table 5.3 in chapter five (Research Findings) shows that eight of the participants from the employees who are working in software maintenance in Jordanian e-commerce companies have studied at universities and they have a Bachelor's degree; one of them has a diploma degree in the field of IT. This is an indicator that all employees working in software maintenance in e-commerce companies have a degree in the field of IT. This finding is inconsistent with Canfora et al. (2000) and Offutt (2002), who report that students work in software maintenance without experience.

Moreover, Table 3.3 in chapter three (context chapter) shows the majority of universities in Jordan provide courses in the field of IT. This finding confirms the finding of Jardine and Tsang (2013), who reported that there is growing demand in universities, colleges, and professional courses in maintainability, reliability, and maintainability engineering in the software area.

### 6.6 Obstacles in Software Maintenance in E-Commerce Companies in Jordan

The participants in Group (A) were asked if there are any obstacles in software maintenance that makes maintenance complex. All the answers came back in the affirmative that there are indeed obstacles in software maintenance in e-commerce companies in Jordan related to:

- High speed in technology. This is supported by Islam and Katiyar (2014), Hibu Company (2014) and ISO/IEC 12207.

- The performance of the system. This is supported by IEEE Std (1998) and Sommerville (2007).
- Incomplete or non-existing documentation. This is supported by Takang (2003), Das et al. (2007), Floris and Harald (2010), Nasir and Abbasi (2010) and Garousi et al. (2015).
- The communication with the developer. This is supported by IEEE Std (1998).
- Internet connection. This is supported by Saleh (2002) and Stair and Reynolds (2012).
- Lack of experience in software maintenance in e-commerce application, as supported by Sneed and Opferkuch (2008) and Islam and Katiyar (2014).
- Availability of training courses in the field of software maintenance, as supported by ISO/IEC 12207, Galar et al. (2011), Agrawal et al. (2012), April and Abran (2012) and Islam and Katiyar (2014).

## 6.7 Summary of the Key Findings

The key findings below arise from the analysis of the interviews and documents and archival records in six Jordanian e-commerce companies.

The majority of reasons for software maintenance in Jordanian e-commerce companies are:

- To fix bugs;
- To change hardware and software;
- To change operating system;
- Weak performance in the system;
- To change the policy of the work;
- New browsers;
- New technology adopted;
- To increase the size of the work; and
- Operation users.

## 6.7.1 Human Resources

The majority of respondents from both groups in six organisations stressed that there is a high turnover and lack of employee experience in software maintenance, as the average experience of employees in software maintenance is two years. Also, the senior management did not give

much attention to developing the skills of employees or to saving domain knowledge in the company. Furthermore, the findings showed that in Jordan, which is one of the Middle East countries where Arabic is the official language, having Arabic as the mother tongue can also affect software maintenance.

### 6.7.2 Organisational Environment

There is little or no communication between software maintenance teams and IT and between IT and senior management, and there is a lack of encouragement to do so. Also, the participants affirm that the budget affects software and affects software maintenance.

The other aspect in the organisational environment is related to methodology and plans in the software maintenance. All the participants stressed that they did not adopt any methodology or software maintenance standards in their work. Moreover, the plans are incomplete or lost. In addition, all the participating companies did not use software maintenance classification in software maintenance activities.

Moreover, the study shows that the budget of the e-commerce company affects software maintenance in terms of choosing the original software, choosing hardware and choosing employees.

### 6.7.3 Operational Environment

The most popular payment method in Jordanian e-commerce companies is cash on delivery, which means there are few links to external systems. Changes in the hardware and software affect software maintenance and increase the effort needed in the maintenance. Also, the findings found new factors affecting software maintenance related to operational environment, which are operation users.

### 6.7.4 Software Characteristics

All the participants in Group (A) from six organisations stressed that software maintenance in e-commerce applications differ from other software applications. Furthermore, the study showed that the quality of the system, documentation of the software, maintainability of the system and programming language affect software maintenance. In addition, software documentation in e-commerce companies in Jordan is non-existent or not in use.

### 6.7.5 External Factors

The findings show the majority of participants use SLA when they have a contract with other support companies, but they face problems when using SLA due to the unclear service level agreement. Also, they face problems in delays to delivering the requests from external support companies. Likewise, the findings show that all the employees working in software maintenance in Jordanian e-commerce companies have a degree in the field of IT.

Regarding the source of software, the employees and senior management in e-commerce companies in Jordan prefer outsourced software. However, they are interested in doing maintenance internally in the company.

Furthermore, the findings showed that the views of people about software maintenance jobs affects employees (who work in software maintenance) in their work.

### 6.8 Chapter Summary

This chapter has dealt with the analysis and discussion of the findings from multiple sources of evidence, namely interviews as the main sources and documents and archival records as secondary sources.

It has identified the main and sub themes along with the sources and references used. Moreover, the findings from the six organisations were discussed in the light of the literature reviewed in chapter two. Many factors found in the present study affect software maintenance in e-commerce companies in Jordan. The end of the chapter provides a summary of the key findings of the study. The next chapter will explain the proposed framework of software maintenance activities for e-commerce companies in Jordan. The framework is based on five main issues found from the study findings.

# Chapter Seven: Proposed Framework

## 7. Introduction

The researcher has concluded from the findings of the study that there is an urgent need to develop a framework that improves the practices of software maintenance in Jordanian e-commerce companies. As a result, this chapter presents a proposed framework aiming to improve the software maintenance processes in e-commerce companies in Jordan. This framework will hopefully help reduce the effort needed and keep cost-effectiveness. The framework is based on an analysis of the findings in chapter six and on the literature review in chapter two.

### 7.1 Issue 1: Human Resources

The sections below illustrate the framework regarding employees' issues in e-commerce companies in Jordan. Also, Figure 7.1 shows the proposed framework for all issues related to human resources.

### 7.1.1 Issue: Experiences and Skills of Employees

An examination of the six organisations participants shows clear evidence of the lack of IT employees for the basic experience and skills in the field of software maintenance (cf. 6.1.1 and 6.1.2). Therefore, actions should be taken to deal with this issue.

- Selecting employees who have high experience and specialists in the e-commerce applications.
- The senior management should have criteria to select new employees. The company should identify the basic requirements for the respective position like necessary basic knowledge, intellectual abilities, educational qualifications, work experience and specific software industries.
- The senior management should give good offers for employees to attract qualified people. The company should offer a good salary, job security and stability at the work place for qualified employees.
- Giving employees some IT training courses that develop their skills. The management should focus on developing the skills of software maintenance staff through training courses and workshops related to the IT sector in general and related to software maintenance in particular.

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**7.1.2 Issue: Employees Turnover**

The findings of the study show that there is high turnover of employees in software maintenance staff, and the participants in managerial positions stress the negative effect of employee turnover on the work (cf. 6.1.3). Furthermore, the study shows that the main reasons for the frequent turnover of employees are stress in the workplace and the desire of employees to search for a better salary.

So, to reduce the employee turnover, the actions should be:

- The need for a comfortable and stable work environment for employees at the work place. Company management should provide flexibility and a secure work environment to reduce the load and the stress during the work.

- The senior management should give more attention to employees in the IT department by making employees feel that they are an important part of the company and providing appreciation for his/her work and rewarding financially and with supporting certificate documents.

- The company should know the real reasons that lead software maintenance employees to resign before approving their requests. The management should understand why employees want to leave the company (the general reasons for moving). They should also take proper feedback at the time of exit.

**7.1.3 Issue: Domain knowledge**

The majority of participating companies do not have a plan to save domain knowledge (cf. 6.1.4), while domain knowledge is very important in software maintenance work to save the effort and the time (Anquetil et al., 2007; Serna and Serna, 2014).

Actions should be taken for this issue:

- The management should take into consideration plans that save domain knowledge in software maintenance, and the company should update the plans and training development to encourage the software maintenance team to do that.
- Giving a high priority to save domain knowledge in software maintenance work.

**7.1.4 Issue: Mother Tongue**

The findings of the study have shown that the mother tongue of employees (Arabic language) affects software maintenance activities (cf. 6.1.5), so actions should be taken for this issue:

- It is important that companies take into consideration the effect of Arabic language on the future of the software application even before these companies plan to buy or develop e-commerce applications.

- IT employees should undertake training courses in English language to develop their skills, and the company should encourage the software maintenance team to do that.
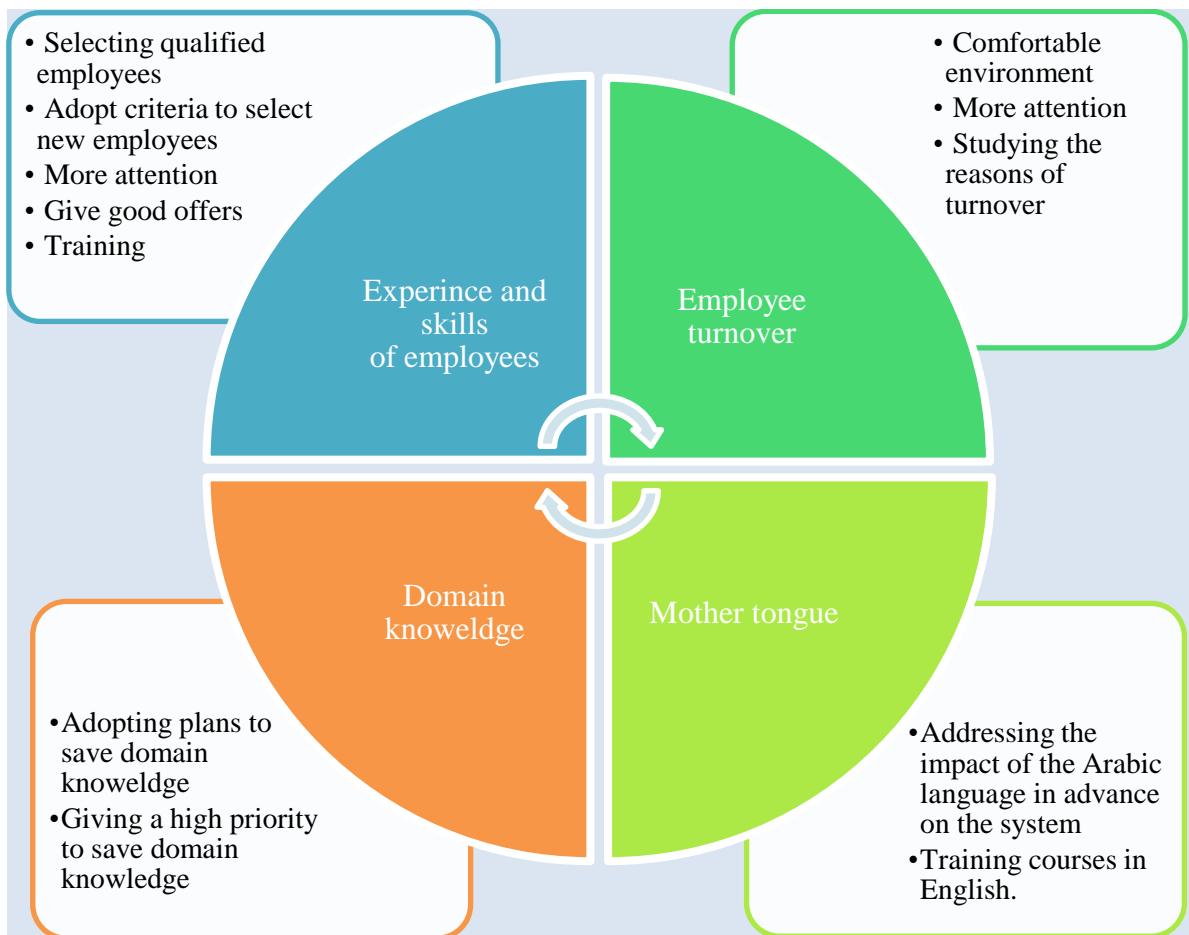


Figure 7.1: Framework illustrating the human resources issues.

## 7.2 Issues 2: Organisational Environment

The sections below illustrate the framework regarding organisational environment issues in e-commerce companies in Jordan. Also, Figure 7.2 shows the proposed framework for all issues related to organisational environment.

### 7.2.1 Issue: Management Support

Management support plays an important role in increasing the motivation of employees at work (Polo et al., 2002 and Agrawal et al., 2012).

The study shows that there is less attention from the majority of senior management to employees who work in software maintenance in e-commerce companies in Jordan. On the other hand, the study found that one of the participating companies gives the software maintenance administrator part of the company profit as a financial support to encourage him to stay in the company (cf. 6.2.1.1).

So, the management should take this action to support the employees:

- The senior management should give more support and attention to the software maintenance team. The attention should focus on both people and financial aspects.
- Financial rewards for outstanding staff. It is a good idea to do that regular basis; quarterly or monthly award programmes. Management should select the best performer on basis of an agreed criteria for selecting outstanding staff. The amount of financial rewards should adopt company norms and regulations.
- Engagement of employees in any decision related to software or maintaining the software. Some decisions related to changing hardware, software, e-commerce applications; the contract between the company and the company who produced the software or maintains the software. To do this, management should ask employees to share best practice and seek their opinion and utilise their experience to maintain the software.

### 7.2.2 Issue: Communication Channel between the IT Team and the Management

Improving the performance of teams and building a strong relationship between IT team members in the organisation helps develop better work and increase the efficacy in software maintenance (Gupta and Fernandez 2011; Wei et al., 2014; Fagerholm et al., 2014). While the

study findings show there is a lack of relationship and communication between the IT team and senior management, sometimes there is also a gap between employees in the software maintenance department and the senior management. Enhancing the relationship between the IT team and between IT team and management positively affects software maintenance activities (cf. 6.2.1.2 and cf. 6.2.1.3).

So, for this the actions should be:

- Strengthening the relation between the IT team. The company should focus on developing the cooperation between the software maintenance team in work hours and over-time work and encourage the employees to do that.
- Holding regular meetings between IT team (minimum once weekly) to discuss the progress of the work and overcome obstacles in work.
- Holding regular meetings between IT team and senior management (minimum once monthly) to discuss the progress of the work and to overcome obstacles in the work. Also conduct knowledge based tests to keep knowledge of software maintenance up to date.
- All meetings should be documented.
- Building social relationships between all the staff and management in the company (Wei et al., 2014).

## 7.2.3 Issue: Software Maintenance Standards

The study shows that the majority of e-commerce companies in Jordan do not use any software maintenance standards in the software maintenance activities (cf. 6.2.2.1), while the standard can help the software maintenance team to organise the work and help the organizations to understand the quality process (April and Abran, 2012; Rata, 2014).

The actions that should be taken are:

- Adopting software maintenance standards in the software maintenance activities. Standards can help reduce the risks in software maintenance. Worldwide there are many standard organizations or computer societies available to show the quality standard of software maintenance such as standard ISO/IEC 12207, IEEE/EIA 12207, ISO/IEC 14764, IEEE 1219, and ISO/IEC 15504
- Adopting e-commerce applications, which are built under software standards.

### 7.2.4 Issue: Classification of Software Maintenance Problems

The study findings show that all six organisations do not use any software maintenance classification to deal with software maintenance processes, while classification maintenance requests categories when dealing with maintenance activities to help organise the work (cf. 6.2.2.2).

The action should be:

- The e-commerce companies should adopt and use software maintenance classifications to deal with software maintenance requests. The most adopted categories are: Lientz and Swanson Categories, IEEE STD Categories and ISO/IEC 14764 Categories
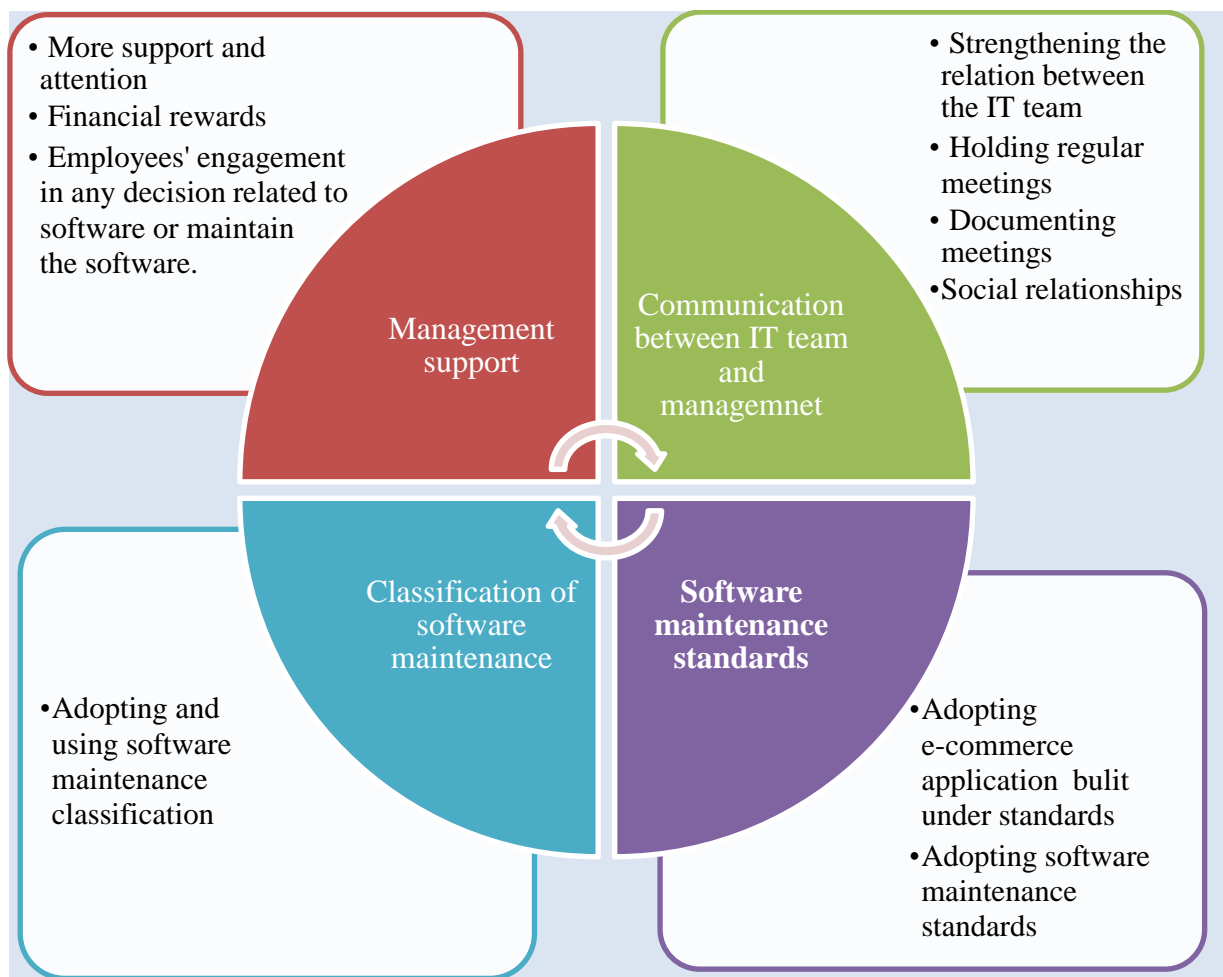


Figure 7.2: Framework illustrating the organisation environment issues.

### 7.3 Issues 3: Operational Environment

The sections below illustrate the framework regarding operational environment issues in e-commerce companies in Jordan. Figure 7.3 shows the proposed framework for all issues related to operational environment.

### 7.3.1 Issue: Environment Reliability

The study findings show that the majority of participants in the company are not satisfied with the current e-commerce applications and they study the possibility to change to other systems because the system does not fit the development in the business (cf. 6.3.1.1).

So, the actions that should be taken are:

- The owner and the manager of the company should take enough time when the company manages to address the best e-commerce application that can achieve the objective and the vision of the company.
- Ask consultation IT companies who have experience about e-commerce applications about the e-commerce system environment and about what the best ones are.
- The senior management and the owner should make the right decisions about adopting in-house or outsource applications within the possibilities of the company. The decision should be made after evaluating the advantages and disadvantages of which to adopt. Moreover the resources (experiences of software maintenance team, hardware and budget) of the company should be considered before taking a decision

### 7.3.2 Issue: Hardware and Operating System

Changes in hardware or operating system after the e-commerce application is launched can lead to increasing the problems in the application. However, the majority of participant companies in the present study change hardware frequently, and also some of the participants change the operating system after the application is launched (cf. 6.3.1.2). So, to avoid the problems that may occur as a result of these changes, the actions that should be taken are:

- Plan for appropriate hardware and operating system when developing in-house or purchasing outsource e-commerce applications.
- Select high specification hardware.

- The system should be fit to work with different operating systems or browsers. This issue should be considered in the early stages of acquiring the system to avoid the problems in application when the company changes the software.

### 7.3.3 Issue: Operation Users

The findings show that there is a lack of knowledge from operation users about using the system and that has led to new problems in the system (cf. 6.3.2). So, to avoid the problems that may occur from lack of knowledge, the actions should be:

- The operator users must take full training about using the system before dealing with the system. The training should cover all the issues related to system (technical and managerial issues) and the company should evaluate the employees' learning to make sure they achieved the goal of the training session (performance evaluation). This is supported by Nasir and Abbasi (2010).



**Environment reliability**
- Choose the best e-commerce application
- Ask consultation IT companies
- Choose right source of software (in-house or outsource) within the possibilities of the company

**Hardware and operating system**
- Appropriate hardware and operating system
- Select high specification hardware
- The system should be able to work with the new hardware or software

**Operation users**
- Full training for operator users about how to deal with the system

Figure 7.3: Framework illustrating the operational environment issues

**7.4 Issue 4: Software Characteristics**

This section discusses the main issues that face the software maintenance team in e-commerce companies in Jordan and help to increase the effort and cost of software maintenance. Moreover, the researcher presents some of the solutions that could help to reduce the impact of each issue. The Figure 7.4 shows the proposed framework for all issues related to software characteristics

**7.4.1 Documentation**

The findings of the study show the majority of participants' e-commerce companies do not have software documentation. Furthermore, the companies who have documentation did not review or update the documentation when updating or solving problems with the system (cf. 6.4.1.1). Yet, many scholars mentioned about the significance of documentation in software maintenance activities (Niessink and Van Vliet, 2000; Sommerville, 2007; April and Abran, 2012; Garousi et al., 2015).

So the actions that should be taken are:

- They need to provide a full documentation for the system (programing language, functions, user manual and unified modelling language) parallel with the system.
- The software maintenance team must review the documentation before doing the maintenance.
- The documentation should be updated when the system is updated.

**7.4.2 Quality of Original System**

The quality of the original system plays an important role in facilitating the maintenance operations. The two important things of the original system are: structure of the system and the programing language (cf. 6.4.1.2).

So to keep the quality of the system, the action should be:

- The company should choose high quality e-commerce applications, by addressing all the available e-commerce systems in the world (addressing the advantages and disadvantages of each one taking an expert opinion in e-commerce applications).
- The company should choose systems, which are built in fourth generation language.

### 7.4.3 Maintainability of the System

The findings of the study show that the maintainability of the system plays an important role in the software maintenance process, and furthermore, improving the maintainability can increase availability and reduce time and effort in the software maintenance process (cf. 6.4.1.3).

So, to achieve and facilitate the maintenance process, the action should be:

- Companies should choose a system that will allow for modification and change in the future (maintainability system).



| Documentation | • Full documentation for the system.<br>• Review the documentation before doing the maintenance.<br>• Updated documentation. |
| Quality of original system | • Choose high quality e-commerce application.<br>• Choose system which is built in fourth generation language. |
| Maintainability | • Choose a system that will allow for modification and change in the future. |
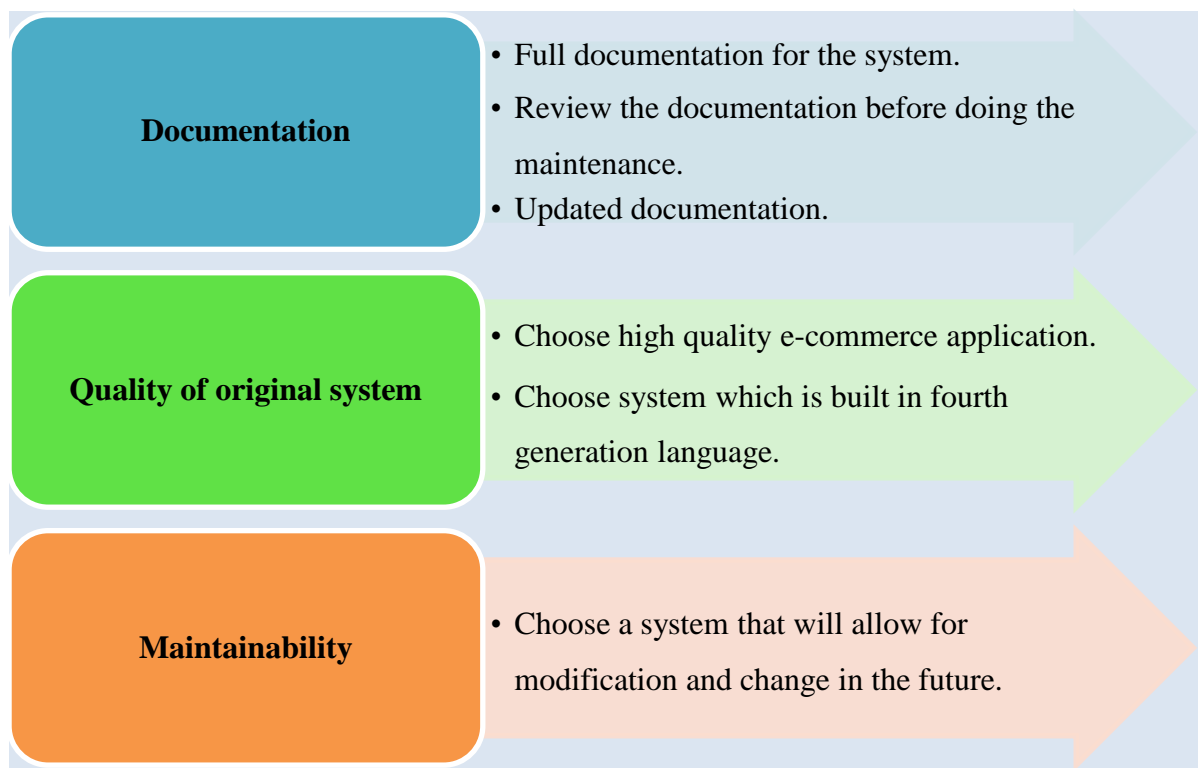
Figure 7.4: Framework illustrating the software characteristics issues

### 7.5 Issue 5: External Factors

This section discusses the external factors that happen out of the organisation and some of each out of organisation control and that affect software maintenance activities in e-commerce companies in Jordan. Moreover, the researcher will present some of the solutions that could

help to reduce the impact of each issue. The Figure 7.5 shows the proposed framework for all issues related to external factors.

### 7.5.1 Source of Software

The findings of the present study show that the source of software adopted in the company plays an important role in the software maintenance activities. Indeed, the majority of Jordanian e-commerce companies adopt outsource software and a small percentage of participating companies built the system in-house, while the companies who built the system in-house were not satisfied about the performance of the system (cf. 6.5.1). So, the researcher concludes from the findings and the literature that:

E-commerce applications for large systems need an effective team to build the system, while the majority of e-commerce companies in Jordan have one to two employees who work in the IT department.

So, the action that should be taken:

**When the company builds in-house software:**

- The company must have an effective team who has good experience in e-commerce applications, confirmed by the findings of Gewaltig and Cannon (2014) and Rata (2014).
- The company should adopt software standards when develop software.
- The company should adopt software maintenance methodology to deal with software maintenance. The methodology should cover the main tasks of software maintenance: understanding requirements, analysis, modification and testing.

**When the company outsources:**

- The company should choose high quality software.
- The reputation of the company that produced the system. By asking the company that produce the system about the companies who use the system, and if possible asking these companies about their experience of using the system.
- The system must be maintainable. The company should address the possibility of doing maintenance internally.

- The e-commerce companies should choose a well-known company in e-commerce applications, by collecting information and investigating different platforms, and search the best solution provider from different available sources.
- Contract between the two companies to document all issues related to the system and maintenance of the system.

### 7.5.2 Issue: Service Level Agreement

Service level agreement (SLA) in e-commerce companies is an agreement used between the e-commerce company and the external company. While the findings show that the majority of participants have used service level agreement in work, all of them stated that service level agreements are not clear (cf. 6.5.2).

So, the actions should be taken:

- The service level agreement should be clear and unambiguous.
- Service level agreements should explain everything related to the software and maintenance of the software, such as domain of maintenance and respondent time, whole process and rules and regulations.
- SLA should explain the contact channel between the two companies. The contact channels should be accepted from all the parties before proceeding.
- SLA should be signed by all parties.

### 7.5.3 Issue: Views of People about Software Maintenance Job

The findings of the study show that the views of people about software maintenance jobs affect software maintenance activities via increasing the motivation of employees at work (cf. 6.5.3). Thus, to improve the image of the people about significance of these jobs, the actions that should be taken are:

- Give more support to the employees who works in software maintenance. Financial support should be provided taking into account people factor issues. However the Government and the management should try to improve the image of software maintenance jobs in the community through organizing awareness seminars and events and workshops.
- Improve the salary of employees who work in software maintenance.

### 7.5.4 Issue: Outcomes of IT University Graduates

The findings show that there is a strong relationship between the skills of employees and the outcomes of university, so to make a stronger relationship and improve the skills of university outcomes in the IT field (cf. 6.5.4) the action should be:

- The need to communicate with those in charge of higher education institutions to determine the labour market in software and maintenance requirements.
- The decision makers or board of committee members in the higher education system should ensure that university IT degrees address the labour market requirement in all software.
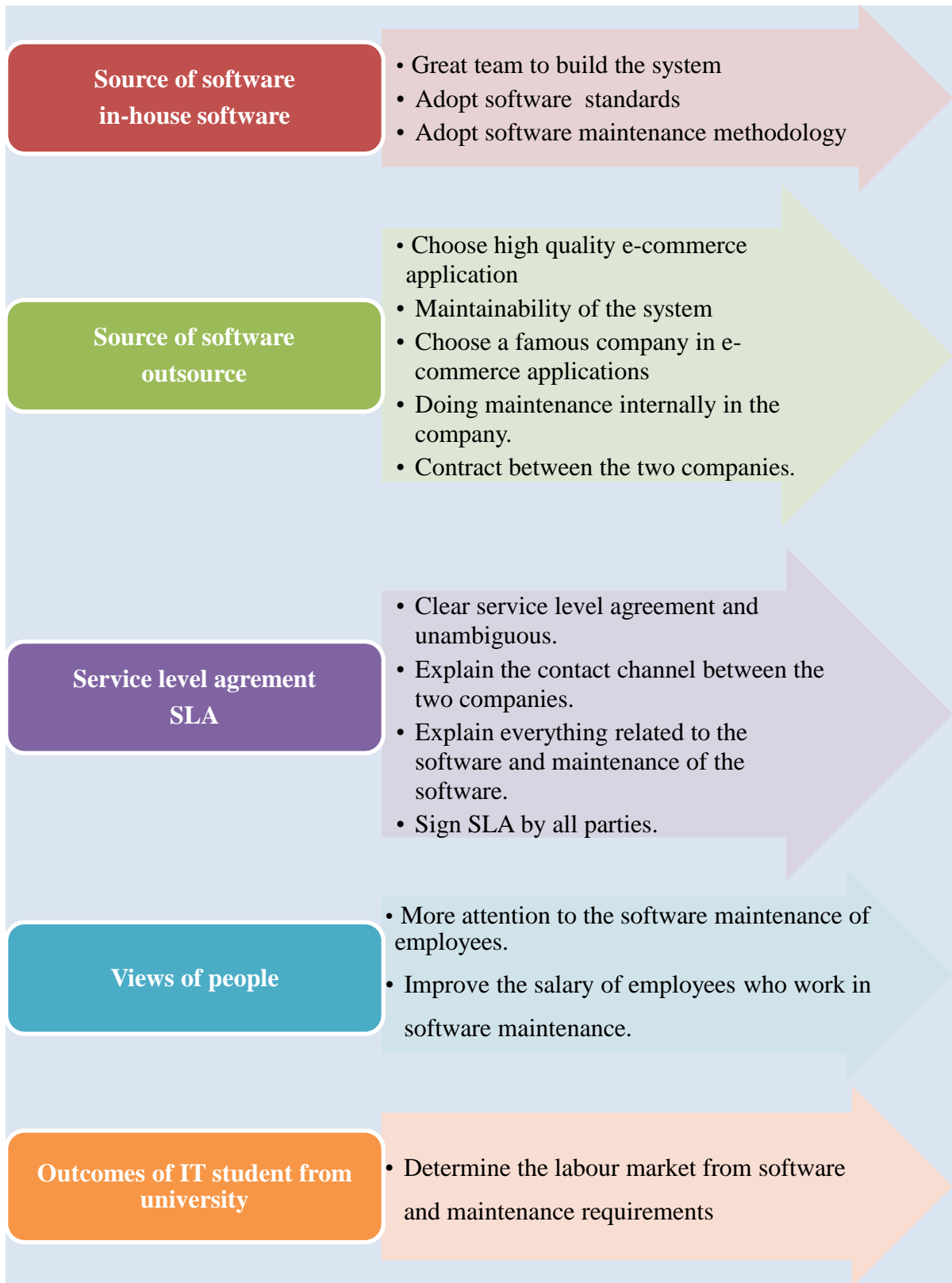
Figure 7.5: Framework illustrating the external issues impact on software maintenance

Based on the discussion above and on the frameworks of five issues regarding software maintenance in e-commerce companies in Jordan, Figure 7.6 shows the proposed framework for software maintenance practices in e-commerce companies in Jordan.
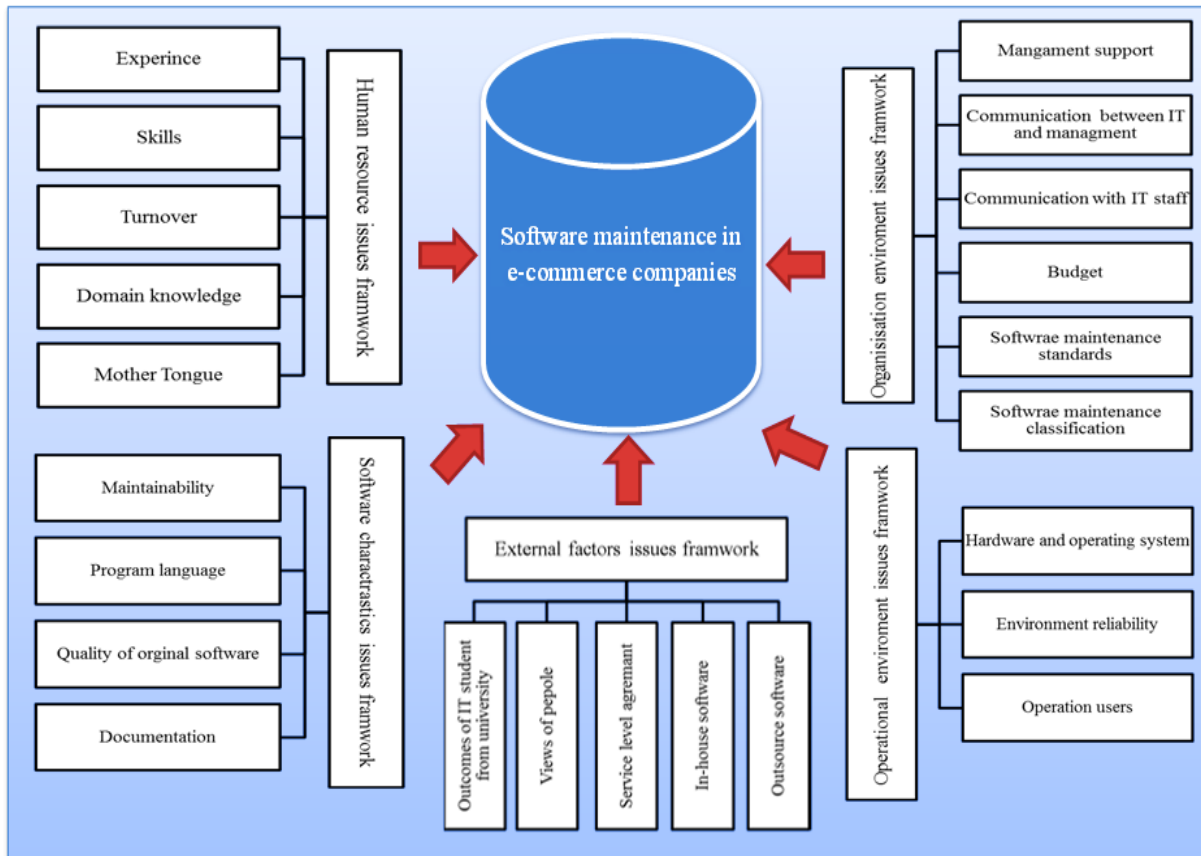


Figure 7.6: Proposed framework for software maintenance in e-commerce companies in Jordan.

## 7.6 Validity of Proposed Framework

This section deals with the validity of the proposed framework for software maintenance in e-commerce companies in Jordan.

The researcher must make sure the proposed framework achieves objective four of the study (cf. 1.4.2) and that it explores the validity and reliability of the proposed framework for software maintenance in e-commerce companies in Jordan. Thus, the proposed framework was sent via email to all six participating e-commerce companies in Jordan, and they were asked for their feedback and opinions regarding the framework. The participants were given one month to return the feedback and during this time the researcher welcomed any enquiries

about the proposed framework. Finally, feedback from four companies was received, as following:

**Feedback from Company One (C1)**

I think the proposed framework will help the company to deal with many issues in software maintenance. It is easy to deal with this framework and it is very clear. Moreover, we are interested at this time in the company in changing the software application adopted in the company and after I am looking to the proposed framework we can say it really needs more time before making a decision to change to new software. Moreover, to be more honest we did not give the training subject a high priority in the IT team in the company, but now after looking at what human resources have proposed I think it really needs to be given more priority and more attention in the IT team. Finally, we really thank the person doing this study and we are looking to cooperate more in the future for studies related to developing IT sectors in e-commerce companies.

**Feedback from Company Three (C3)**

First of all, I would like to thank the researcher for the great information that is introduced to software maintenance in e-commerce companies. This is first research that addresses the problems in software maintenance in real environments of e-commerce companies in Jordan.

From my experience in e-commerce management, I think the proposed framework covers all the important issues that may be faced in a software maintenance environment. The critical point of the proposed framework is that it is focused on technical issues and the managerial issues too. When the proposed framework comes out in the final version we will be very happy to adopt it in the company.

**Feedback from Company Five (C5)**

It is a positive step in the software development and software maintenance in the e-commerce environment. We urgently need a similar framework to organise, save time and cost in software maintenance activities. We are interested in the company in any proposed developments in this area. I have sent the proposed framework to the software maintenance team and they were happy with the vast majority of issues in the proposed framework. The software maintenance team is interested in issues of documentation, domain knowledge and communication channels. The management, however, are interested in issues of developing

the software maintenance team, support team, communication and improving the image of software maintenance functions. The proposed framework is characterised by ease of use and flexibility.

Finally, I would encourage all the e-commerce companies worldwide and particularly in the Middle Eastern countries to adopt the proposed framework in their companies.


**Feedback from Company Six (C6)**

The company sent the framework to the IT manager and the feedback came as below:

I have taken a quick look at the attached framework and it looks good and addresses many of the issues that we face in reality and the proposed solutions are in place, however, many of these solutions would require time and can only be taken in a phased approach taking into consideration the load of work and the continuous expansion we are going through.

Great effort, Wish you all the best.

We can observe that, the vast majority of participating e-commerce companies are interested in giving feedback about the proposed framework and stressed about its significance in software maintenance activities and in improving the e-commerce application adopted in the companies. Indeed, they are interested in adopting the proposed framework in their companies when the final version is launched.

Based on the feedback and discussion above regarding the opinions and feedback from e-commerce companies about the proposed framework we can confirm that the proposed framework developed in the present study is fit and applicable for e-commerce companies. Also, the proposed framework shows high levels of reliability and validity in software maintenance in e-commerce companies.

## 7.7 Chapter Summary

In this chapter, five issues of software maintenance activities in e-commerce companies in Jordan have been explained. Also, frameworks for five main issues in software maintenance have been developed. Moreover, the framework explains the sub-issues for each issue. The end of the chapter presents a validity of proposed framework.

The next chapter will describe the achievements of the research aim and objectives, the limitations of the study and the contribution to knowledge. The recommendations for e-commerce companies in Jordan, the employees working in software maintenance and for future research will also be presented.

# Chapter Eight: Conclusion, Contribution, Recommendations and limitations

## 8. Introduction

This final chapter of the thesis presents: conclusions, contributions to knowledge, recommendations and limitations of the study. The chapter begins by review of the study and revisiting the research aim, objectives and research questions. Then, the recommendations for e-commerce companies in Jordan, and for the employees who work in software maintenance will be presented as well as suggestions for future research. The limitations of the study and the contribution to knowledge will also be addressed.

## 8.1 Review of the Study

Despite the numerous publications and studies regarding software maintenance, there are none addressing the software maintenance in e-commerce companies. The vast majority of their studies address the problems of software maintenance in software development companies. Moreover, there are limited numbers of studies which address all issues related to software maintenance in general, and especially in Jordan.

The motivation of the study comes from the high cost of software maintenance in any software project (April and Abran, 2012; Dehaghani and Hajrahimi, 2013 and Islam and Katiyar, 2014). Furthermore, there is an urgent need to address the problems in software maintenance and its effect on developing e-commerce companies in Jordan.

A preliminary study has been conducted to gain a clear picture of the current situation of software maintenance in e-commerce companies in Jordan and to ensure the appropriateness of doing the study in context.

Therefore, the researcher has focused on covering all the factors (managerial and technical) that affect software maintenance in e-commerce companies in Jordan, as well as trying to develop a framework to address these factors.

Four research objectives are developed in the present research to meet the aim of the study (cf. 1.4.2), and also three research questions have been developed to achieve the research objective (cf. 1.4.3).

A conceptual framework has been developed in the present study (cf. 2.14) based on the literature review (Chapter 2) to guide the researcher during the study. Twenty factors were identified from the literature review that affect software maintenance.

Semi-structured face-to-face interviews as well as documents and archived records are used in the research to collect the data from six e-commerce companies in Jordan. To collect the data from multiple viewpoints the researcher divided the respondents in each company into two groups: senior management and software maintenance team.

The study contributes to knowledge by identifying the factors that affect software maintenance in e-commerce companies in Jordan, thus filling the gap in the previous studies, which addressed software maintenance problems in software development companies and only a limited number of factors.

Moreover, the significance and characteristics of the present study did not only identify the factors that affect software maintenance in e-commerce companies in Jordan but also proposed a framework to deal with all these factors and issues related to software maintenance in e-commerce companies. In addition, the proposed framework was accepted by the vast majority of participating e-commerce companies in Jordan (cf. 7.6).

## 8.2 Conclusions

This section demonstrates how the main aim and objectives of the study have been achieved. Moreover, answers to the research questions are provided.

### 8.2.1 Meeting the Aim and Objectives, And Answering the Research Questions

The aim of the study was "*to identify and investigate the key factors that influence the software maintenance relevant to e-commerce companies in the country of Jordan. Furthermore, it hopes to propose a framework to address factors that affect the context described*". This aim has been accomplished effectively by addressing the research objectives as follows:

**8.2.1.1 First Research Objective and Question**

Figure 8.1 shows the first research objective and research question and how the research objective has been achieved and the research question answered in the present study.

| Research Objective |
|---|
| • To review the relevant literature on software maintenance in order to understand software maintenance model, process, practices, and the factors which influence the software maintenance. |
| **Research Question** |
| • What are the internal and external factors that affect the efficiency of software maintenance within the context described? |
| **Achieved Research Objective and Answered Research Question** |
| • This objective was achieved through the extensive literature review (chapter two). The literature covers all issues related to software maintenance activities. It begins with e-commerce application components, software maintenance definitions, software maintenance classification, software maintenance process, software maintenance model, the reasons of doing maintenance, the cost of software maintenance, significance of the maintenance phase in software development life cycle (SDLA). Also, the factors that influence software maintenance related to human resources, organisation environment, operation environment, software characteristics and external factors have been defined and summarised. The conceptual framework for all issues influencing software maintenance has been developed (cf. 2.14). Therefore, the first objective of the study has been efficiently achieved through the extensive literature review related to software maintenance, which was presented in chapter two and the first research question has been answered. |

Figure 8.1: First research objective and research question.

### 8.2.1.2 Second Research Objective and Question

Figure 8.2 shows the second research objective and research question and how the research objective has been achieved and the research question answered in the present study.

**Research Objective**

- To conduct an empirical study within the e-commerce companies in Jordan in order to understand the factors influencing the cost-effectiveness of software maintenance.

**Research Question**

- How do these factors influence the effectiveness of software maintenance in the described context?

**Achieved Research Objective and Answered Research Question**

- In order to achieve the second research objective the researcher prepared a plan for the field study and plan for potential risks during the field study (cf. 4.2.10). A interview research strategy was adopted in order to address the issues in depth within its real-life context (e-commerce companies in Jordan). The study was conducted in six e-commerce companies in Jordan. One of the methods of data collection chosen was semi-structured face-to-face interviews; to address the problem of software maintenance from multiple views the interview questions were directed at two groups, namely the maintenance team and the senior management. An appropriately prepared interview protocol (cf.4.2.11) and interview questions (Appendices 2) were used. Documentation and archival records were then used to triangulate and support the interview findings, which improved the validity of this study. The results of the empirical study include a list of factors that affect software maintenance in e-commerce companies in Jordan and an explanation of the impact of each factor on software maintenance activites. Thus, the second research objective is met and the second research question is answered. It should be stated that meeting this objective was highly dependent on the first objective having been achieved.

Figure 8.2: Second research objective and research question.

### 8.2.1.3 Third Research Objective and Question

Figure 8.3 shows the third research objective and research question, how the research objective has been achieved and how the research question has been answered.

**Research Objective**

- To explore how and why these factors influence the software maintenance in Jordanian e-commerce companies.

**Research Question**

- Why do these factors influence the software maintenance in e-commerce companies in Jordan**?**

**Achieved Research Objective and Answered Research Question**

- The third objective was to explore and explain why these factors (the factors that were found in the literature review and the factors found from the field study) influenced software maintenance activities in e-commerce companies in Jordan. The researcher categorized these factors into five categories: Human resources, organisational environment, operational environment, software characteristics and external factors. In order to meet the third research objective the researcher use NVivo software to analyse the data. Explanation data analysis technique (cf. 4.2.15 ) was used to interpret the findings from the six organisations (chapter five and six). The reasons of why these factors affect software maintenance were explained in chapter (six). This meets objective three and answers the research question related to this objective.

Figure 8.3: Third research objective and research question.

### 8.2.1.4 Fourth Research Objective and Question

Figure 8.4 shows the fourth research objective and research question and how the research objective has been achieved and the research question answered.

**Research Objective**
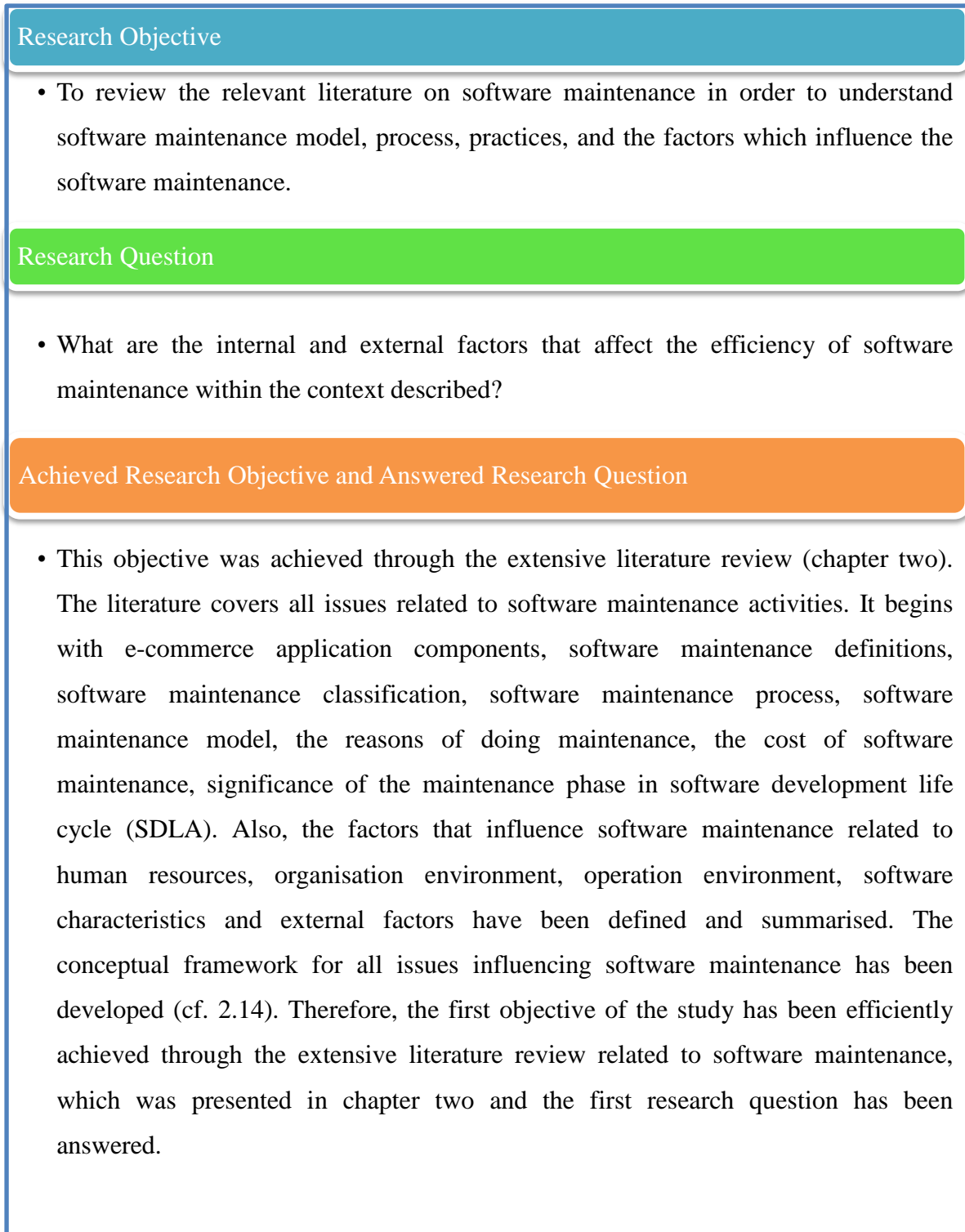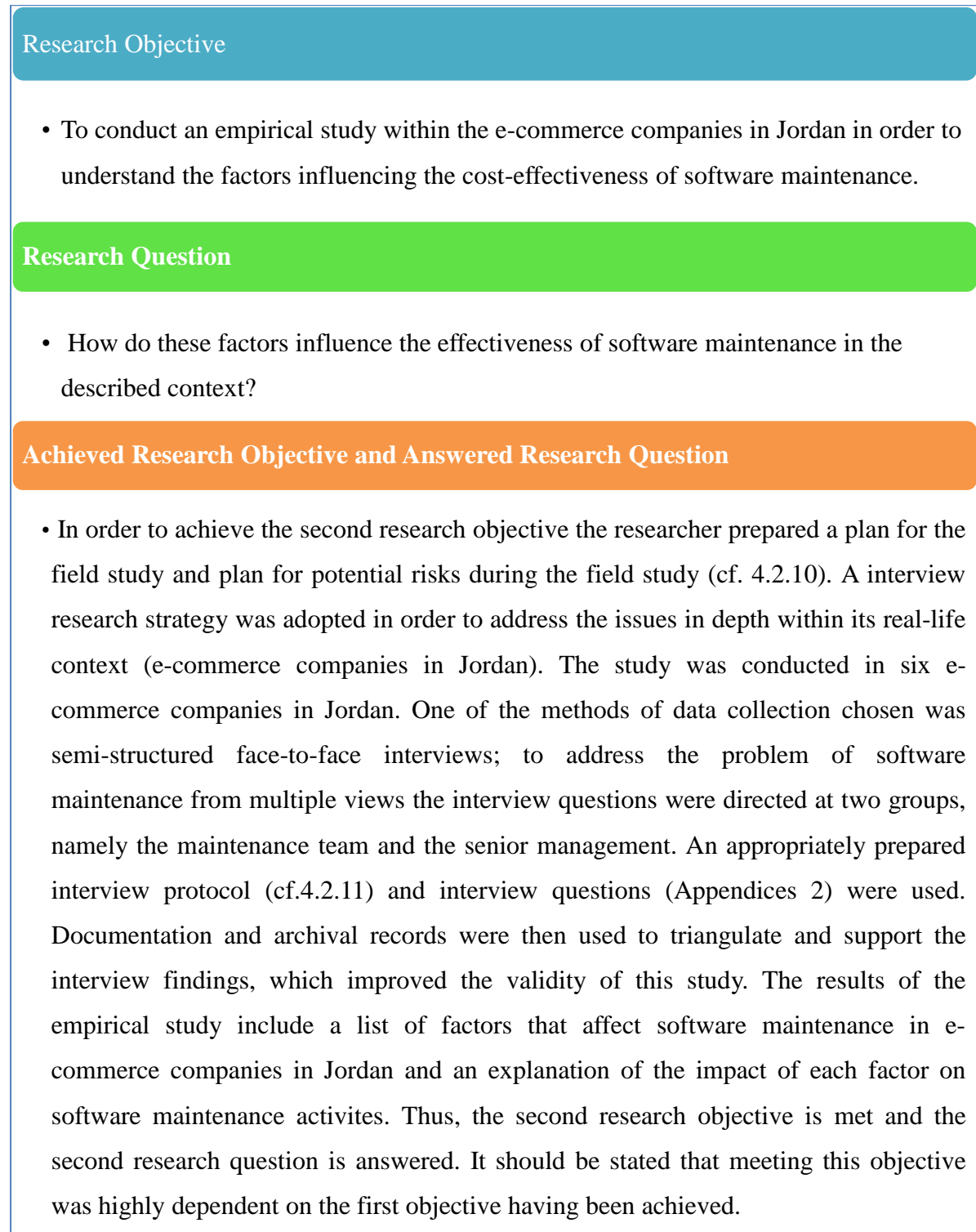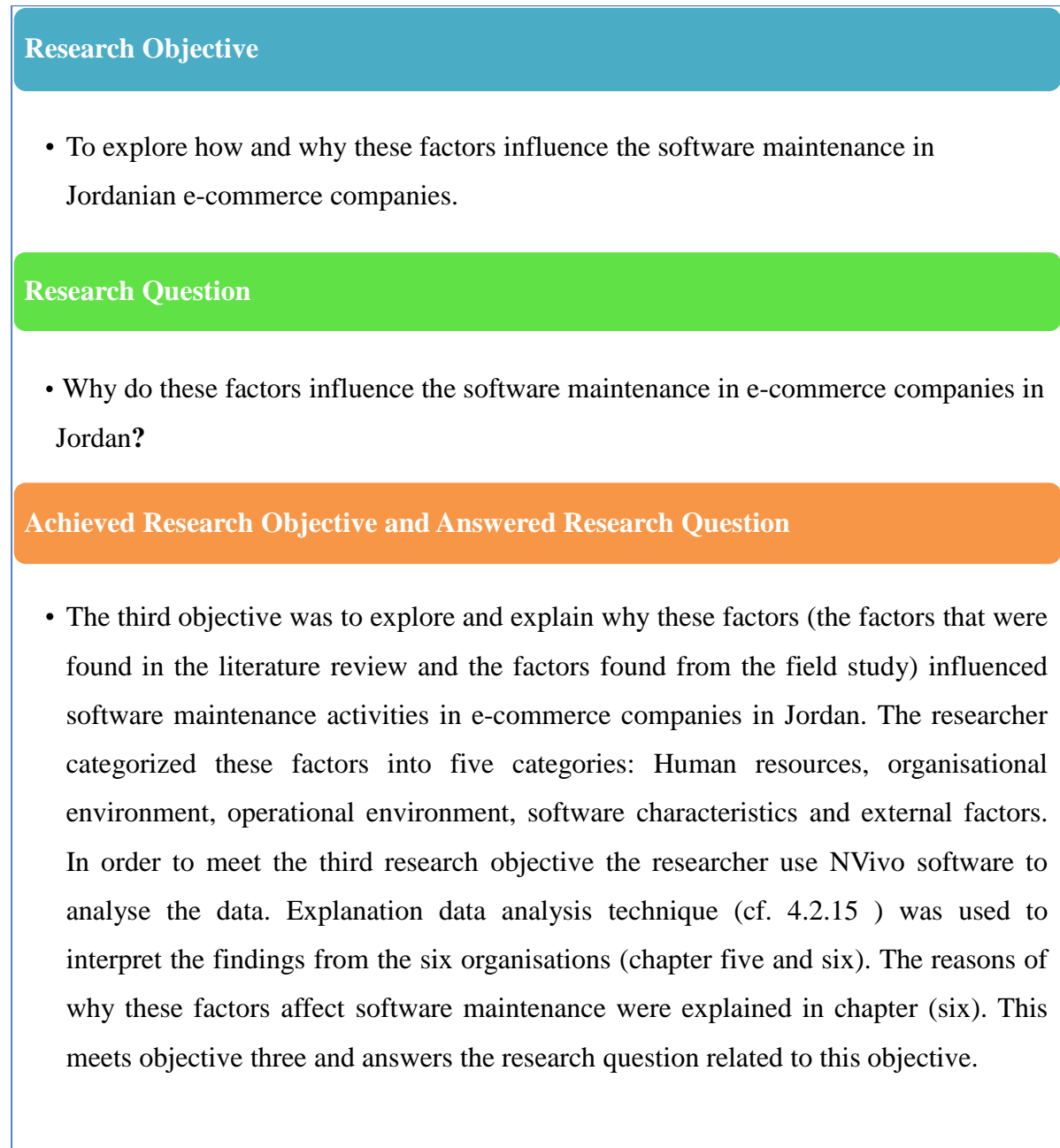
- To propose a framework to address the factors that influence software maintenance activities in e-commerce companies in Jordan.

**Research Question**

- It should be stated that the research question to this objective was highly dependent on the first three research questions having been answered.

**Achieved Research Objective and Answered Research Question**

- The fourth objective was to propose a framework to address the factors that influence software maintenance activities in e-commerce companies in Jordan. The factors and activities were found from the literature review (chapter two) and from the study findings chapters (Five and Six). The researcher, based on the findings of this study, proposed a framework that covers all issues (internal and external) related to maintenance e-commerce application. The framework includes five main issues that affect software maintenance in e-commerce companies in Jordan and suggest solutions to avoid the negative impact of each issue on software maintenance activities and to save effort and maintain cost-effectiveness in software maintenance activities (chapter seven). This meets objective four and answers the research question related to this objective.
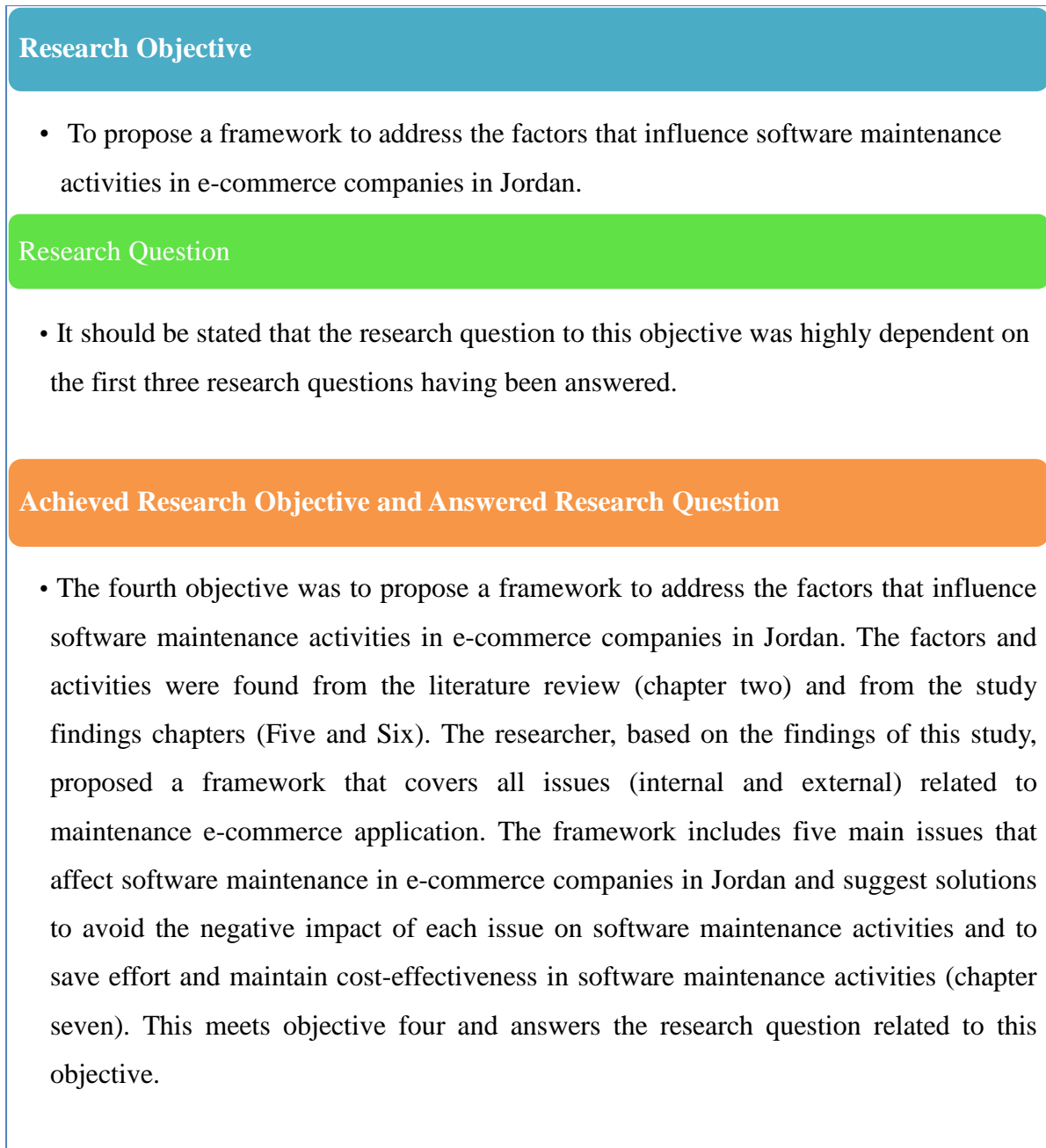
Figure 8.4: Fourth research objective and research question.

Finally, by meeting the four research objectives the aim of the present research (cf. 1.4.1) is achieved.

### 8.3 Contributions to Knowledge

The factors affecting software maintenance in e-commerce companies in Jordan are identified, and investigated in depth in this study. This makes significant original contributions to knowledge in the field of e-commerce maintenance applications.

This study makes a contribution to knowledge in the following ways:

- To the best of the researcher's knowledge, this study will be the first of its kind to be carried out in Jordan. The findings will enrich the existing literature on the software maintenance in e-commerce companies, and will fill the gap in knowledge in Jordanian studies in particular.

- Chapters two and three offer an extensive review of software maintenance literature, practices and processes and information about software maintenance activities and e-commerce companies in Jordan.

- It is the first academic study in the area of software maintenance in e-commerce companies in Jordan. Therefore, it provides a basis for the development of further scientific research in software maintenance in Jordan.

- This study has made another contribution to knowledge by emphasizing a number of factors that affect software maintenance such as human resources, software characteristics, organisational environment, operational environment and external factors. All these factors need to be taken into account when studying the phenomenon of software maintenance in developing countries.

- This study has made another contribution to knowledge by identifying new factors that affect software maintenance: the mother tongue for employees (Arabic language), operation users and the views of people about software maintenance jobs. This makes the study unique.

- This study offered a broad contribution to the area of software maintenance through identifying and analysing the barriers and the factors that affect software maintenance in e-commerce companies in Jordan. It results in a deep understanding of these factors and their impact on software maintenance activities in general, and Jordan in particularly.

- This study has generated a framework to deal with software maintenance activities and practices in e-commerce companies, and the framework helps to keep cost-effectiveness and save effort in software maintenance.

- This research also provides decision makers in the Ministry of Higher Education in Jordan with information about the effects of university education outcomes in the labour market, especially in the field of IT. These help to improve the higher education strategies to ensure the university outcomes meet the labour market needs in the field of software maintenance practices.

- This research also provides decision makers in IT sectors in Jordan with useful information about the existing situation of e-commerce applications in Jordan. This information helps to develop IT sector strategies in Jordan.

- The findings of this study are important to e-commerce companies in Jordan and the Middle East in general because they provide important information about software maintenance issues, and the solutions to recover and deal with these issues.

- The findings of this study have added to existing theories by extending the amount of knowledge about software maintenance practices, but in a new context. This context has a different culture from the other contexts of the previous studies and therefore, that is another major contribution that has been made in this study.

- Previous studies focused on the factors that affect software maintenance in IT companies by using quantitative approaches and so they did not study any of the issues in depth. This study, however, focuses on addressing the problems of software maintenance in-depth by using a qualitative approach in e-commerce companies, therefore filling a gap left by previous studies.

- This is the first study regarding the factors influencing software maintenance activities in e-commerce companies in Jordan, providing explanations of how and why these factors affect software maintenance activities. Therefore, this study has helped to fill the gap in the knowledge in general and particularly in Jordan and Middle East countries.

- The study is conducted in the real industry e-commerce companies to understand the problems of software maintenance in depth, and this supports the recommendations of the authors, Janczarek and Sosnowski (2015), who recommended doing the study in a real context in the industry (cf. 4.).

## 8.4 Recommendations of the Study

The findings of the study raised several significant issues related to software maintenance in e-ecommerce companies in Jordan (chapter six). Therefore, a number of recommendations are made for practitioners, higher education and the future research, which will now be explained.

### 8.4.1 Recommendations for Practitioners

The findings of the study (chapters five and six) revealed several important issues related to software maintenance in e-commerce companies. Therefore, the researcher in the present study has proposed a framework for software maintenance activities and practices that cover all issues related to software maintenance found from the six organisations (chapter seven). Accordingly, the framework provides the e-commerce sectors with useful information related to the maintenance of e-commerce applications and helps the e-commerce companies to improve their practices in software maintenance activities to avoid the problems and high cost of software maintenance. Moreover, the e-commerce companies should increase the number of software maintenance staff in order to reduce the workload and the stress in the work.

### 8.4.2 Recommendations for Decision Makers and Higher Education in Jordan

The study findings show that there is a strong relationship between the quality of software maintenance and the skills of the maintenance team; this is due to the skills acquired during the study at university. Indeed, all the knowledge that the people have acquired during the study reflects in their work. Thus, the decision makers in the Ministry of Education in Jordan should review the plans of teaching students in the field of IT at universities and community colleges. Moreover, it should focus on the practical side along with the theoretical side.

In addition, the decision makers in Jordan should encourage the development of the IT field and should focus on building e-commerce applications in Jordan, as the study revealed that there are no e-commerce systems built in Jordan. If this is achieved, it will support the Jordanian economy. In addition, the product can be used widely in Middle Eastern countries that share the same requirements for e-commerce applications. This recommendation confirms the view and recommendation of king Abdullah II King of Jordan about the future of IT in Jordan (Importance of Telecommunications Sector, 2015).

### 8.4.3 Recommendations for Further Research

There are a number of opportunities to extend this study in the future, so the researcher present a number of recommendations for further research in the area of maintenance e-commerce applications. The recommendations are as follows:

- The present study was conducted in six e-commerce companies in Jordan; it is recommended that future efforts should involve a larger number of e-commerce companies in Jordan to make the findings stronger.
- The researcher recommends further research to study in depth the impact of new factors that were found in the present research such as mother tongue and the views of people about software maintenance jobs.
- The researcher recommends further research to study the software maintenance phenomena from all directions (direct and indirect) related to the e-commerce applications such as the payment companies and IT support companies.
- The researcher recommends further research to study the phenomena of software maintenance in e-commerce companies in the new context of Arab countries to show the shared factors that affect software maintenance in e-commerce companies in Arab countries, which share the same characteristics of e-commerce applications. Also, it will add strength to the findings.

### 8.5 Limitations of the Study

Every research study is limited by the constraints placed upon the researcher (Yin, 2003), and this study is no exception. The present research has contributed to knowledge by understanding in depth the factors influencing the software maintenance activities in e-commerce companies. Whilst care was taken in conducting the study and collecting data in the filed study, as with any other research project, some limitations were identified. This section presents the major limitations faced in the study process.

- The study was conducted in only six e-commerce companies in Jordan.
- There was a lack of literature related to the factors affecting software maintenance in e-commerce companies.

- During the field study in all six organisations, the senior management refused to allow the researcher a copy of the documents and so, the researcher was only able to access available documents in the company.

- There was an absence of research studies that address the problems of software maintenance in e-commerce in the Middle East in general and in particular within Jordan. In order to understand the current situation and current problem of software maintenance in e-commerce companies in Jordan, the researcher conducted a preliminary study (cf. Appendix 1).

- The respondents in the study were the employees who work in software maintenance in the e-commerce companies or intermediaries who were responsible for outsourcing to maintenance companies.

- The present study addresses the external and internal factors affecting software maintenance from views of software maintenance employees and senior management, so there are other views related to software maintenance phenomena that also need to be addressed, for example, e-payment companies and IT support companies.

- During the field study the researcher observed that some of the respondents were afraid to give information related to relationships of employees and senior management, so to avoid a lack of information being given from respondents, the researcher developed interview protocol to keep good rapport with respondents to let them know that all answers would not be shared with a third party (cf. 4.2.11.4).

- During the fieldwork I led, some companies apologized for already scheduled appointments; the researcher avoided the impact of this by developing a plan study prior to the data collection process (cf. 4.2.10).

- Some of the respondents refused to have the interview recorded for private reasons. That may have led to the loss of some important information. So to avoid losing any information, the researcher gave more attention to the interviews and write as much as he could have during the interview.

**8.6 Chapter Summary**

The chapter has explained how the researcher in his study achieved the aim, objectives and answering the research questions. Moreover, the contribution to knowledge has been discussed. Also, the recommendations of the practices, decision makers, and further research have been explained and limitations of the study have been identified.

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# Appendices

**Appendix 1: Preliminary Study**

**A Preliminary Study of Software Maintenance in E-Commerce Companies in Jordan.**

**Abstract**

The software in e-commerce companies as in other software systems needs to be maintained every time problems occur and to ensure the system works properly. Moreover, Software maintenance has become over the past forty years an important part of software life cycle and it still until today the most important phase in software development life cycle. Numerous studies highlighted the significance of software maintenance in software life cycle

A preliminary study has been conducted in Jordanian e-commerce companies during the period of September to October 2013 in order to obtain preliminary data acquisition about current situation in software maintenance context. During the preliminary study formal interviews were completed with IT managers and senior management personnel. Through semi structured interviews the author was able to obtain a general idea of the state of software maintenance in e-commerce companies in Jordan.

From the findings of the preliminary study the author conclude that there was a complex maintenance activity in many of these companies.

Six E-commerce companies out of ten companies who were contacted in Jordan have participated in the preliminary study. The six participant companies showed an interest in analyzing and improving their maintenance activities and interest in participating in the main study.

**Keywords: Software, Software maintenance, Preliminary, E-commerce, Jordan.**

# I. INTRODUCTION

## A. Software Maintenance

The software engineering environment has made significant progress in the software industry. Software inefficiency is a major obstacle in the software industry, that is why regular software maintenance is required. Although the maintenance phase is the last phase in the software life-cycle, it is still a very key phase of the software engineering process, (IEEE STD, 1998).

Many scholars stressed the significance of the software maintenance phase in the software lifecycle (Lientz et al., 1978; Abran et al., 1995; Kajko-Mattsson et al., 2001; Abran et al., 2004; April and Abran, 2012; Dehaghani and Hajrahimi, 2013; Mallikarjuna et al., 2014). Furthermore software maintenance is a costly phase, the estimated cost of software maintenance phase is between 40% to 90% of the total budget of software projects (Dehaghani and Hajrahimi, 2013; Floris and Harald, 2010). Moreover, Abu-Shanab and Al-Saggar (2013) reported that one of the significant reasons of failure of IT projects in Jordanian IT companies are related to poor or lack of planning of project stages.

Software systems have been updated to recognize the organization of the business. However, companies can't keep up with the rapid nature of software development due to the high cost of software and the scarce resources in organizations. So the perfect solution is to maintain and enhance the existing software giving greater attention to software maintenance rather than software replacement when a company is trying to improve and increase its business activity.

Consequently, exploring and analysing the factors that influence the cost of maintenance can help IT managers and decision makers to reduce the cost of maintenance by controlling the contributing factors.

## B. About Jordan

Officially called the Hashemite Kingdom of Jordan, Jordan is a country located on the east bank of the River Jordan. Almost half of Jordan is covered by the Arabian Desert. Amman is the capital city of the Kingdom of Jordan.

The official and the dominant religion of Jordan is Islam (Department of Statistics, Jordan, 2013). The official language in Jordan is Arabic language and English is the first foreign language (Department of Statistics, Jordan, 2013).

The country's official currency is the Jordanian Dinar. The Jordanian Dinar fluctuates; in June 2015 it was equal to 0. 0.93 GBP and equal to 1.41 (Currency Converter, June, 2015).

### C. E-Commerce in Jordan

Today, demand for e-commerce is growing exponentially across whole world, and the demand for software applications in e-commerce companies is increasing too. Software applications play an important role in e-commerce companies. Indeed, no one in this field of work can afford to ignore the significance of software systems and their maintenance.

In this study the author adopt Jackson's definition of e-commerce. He defined E-commerce as "*the type of business that delivers services and products over electronic based systems through marketing, distribution, buying, and selling.*" (Jackson, 2015, p.6)

The e-commerce trade is a new trend in Jordan; it has increased significantly in the last few years (The Ministry of Information and Communications Technology, MoICT; Al-Nawayseh, 2012). The number of e-commerce companies in Jordan, which according to the latest statistics, is above twenty companies (E-Commerce in Jordan, 2012). Although, Arab people in the Middle East are not interested in buying goods or shopping online for security reasons and the conviction that it is not a trusted method (Al-Nawayseh, 2012). The senior management in e-commerce companies are trying to persuade consumers to buy in safe manner, through adopted payment method "cash on delivery".

This paper will focus in obtain preliminary data acquisition about current situation in software maintenance in e-commerce companies in Jordan.

The content of this paper is organized into 8 sections as follows:
 In section 2, preliminary study overview and the aim are stated. Section 3 provides the literature review and the research background.   In section 4, the methodology of the study is proposed. Section 5 presents the findings. In section 6, the key findings are listed. In section 7 discusses the findings in light of the literature. Finally, section 8 concludes the paper and recommends future work.

## II.    PRELIMINARY STUDY OVERVIEW

A preliminary study may be defined as follows: "*Preliminary information is gathered by the researcher to narrow the broad problem area and to define specific problem statement*" (Uma Sekaran and Bougie, 2010, p50).

### A. **Preliminary Study Aim**

The main aim for the Preliminary study is to prepare the companies and the author for the main study (which is the next stage of this research) and gather information to support the preparation of the plan for the main study.

### B. Preliminary Study Objectives

- ➢ Check the availability of the companies for participation in the research.
- ➢ To clarify the confidentiality needs and requirements of the participants and any other considerations.
- ➢ To explore the major problems experienced by these companies in relation to software maintenance
- ➢ To understand the relationships between e-commerce companies and other kinds of companies like finance companies, that relate to E-commerce applications.
- ➢ To determine the main types of factors that affect software maintenance in organisations.
- ➢ To identify the sources of software applications that are used in Jordanian e-commerce companies.

## III.    LITERATURE REVIEW

Many scholars discuss the factors affecting the software maintenance process and the effect of these factors in in relation to cost and complexity in software maintenance, and they recommended addressing these factors. Some of these factors are: Human resources, software maintenance standards, source of software, and service level agreement.

A. **Human Resources**

Despite advances in technology and major shifts in economy, human resources remain an organization's most valuable resource (Saraswathy et al., 2011).

An organization maturity term refers to the level and the quality of the organization. High level organizations have expert teams and seek to improve the skills of staff who deal with the development and the maintenance of the system (Islam and Katiyar 2014).

Sneed and Opferkuch (2008), showed that software maintainers' experience is very important in software maintenance and plays an important role in reducing the time, effort, and cost of software maintenance. Often there is a lack of clear practice and domain knowledge as poor technical expertise in software maintenance leads to increased errors and more likelihood of new errors, this then affects the development of software maintenance. In order to improve efficacy of software maintainers, there should be more software maintenance training in this industry. Furthermore, Islam and Katiyar (2014) affirm the significance of experts in software maintenance work, they noted that the prior experiences of employees in software maintenance affect the maintenance activity in a positive way in.

Colomo-Palacios et al. (2013) stressed there is a high employee turnover in the field of software engineering. Furthermore, Yang et al. (2008) report that the turnover and expertise play an important role in software maintenance and productivity. A high turnover rate tends to slow down software maintenance productivity, and they recommended addressing these factors when making planning decisions. Moreover knowing about these factors helps project managers to make plans to increase the likelihood of project success. Islam and Katiyar (2014) also confirm that a high turnover of employees increases the effort and cost in software maintenance.

B. **Software Maintenance Standards**

Today, software has become increasingly complex requiring a team of specialised people to build the software. Standards therefore are necessary in order to determine common approaches. Furthermore, a standard allows harmonisation practices among deferent countries. Standards include: language, documentation, methods, test plans and errors reporting (Rata, 2014). April and Abran (2012) reported that it is necessary to use standards in software maintenance to improve software maintenance activities. Software maintenance is a specific domain and sometimes is linked to other software organisations, so this needs specific

terminology and standards to communicate to other software organisation. Robillard et al. (2007) argue that the standards are very important to every organization using software to organise its maintenance process.

In particular, Standards can help reduce the risks in software maintenance, for example ISO 9001 helps organizations to understand the quality process, ISO/IEC deals with tasks to maintain and develop software products (Robillard et al., 2007).

### C. Source of Software

Sources of software can be divided into two types; in-house and outsourced.

Koskinen et al. (2015.p137) defines outsourcing as *"using factors which are external to an organization to perform its functions whereas offshore outsourcing relies on using foreign resources to perform those functions."* On the other hand, in-house means developing software internally by the IT team in the organisation (Ahmed, 2006).

Several companies are outsourcing the software product to reduce costs and to improve efficiency, also because the technical resources are scarce in some companies (Ahmed, 2006). Moreover, (Jiménez et al. 2009) stressed that many companies tend to outsource maintenance to reap the benefits and reduce the cost and effort of maintenance, especially when a consumer company lacks the technical expertise.

On the other hand, there are many risks of maintenance outsourcing, which should be addressed in project planning (Ahmed, 2006; Bennett and Rajlich, 2000), such as:

• Cost and time over-run for maintenance activities.

• Lack of expertise in company selection .

• Culture mismatch, like language issues.

### D. Service Level Agreement

SLA is a legal contract between participants to ensure that their Quality of Service (QoS) requirements are met and if any party violates the SLA terms, the defaulter has to pay a penalty according to the clauses defined in the SLA (Wu, 2014. p.465).

If the company decided to conduct maintenance via outsourcing, many issues must be addressed in advance before starting the contract of maintenance, including: risk analysis; service level agreement (SLA) and quality of outsourcing organizations. If the software

product development outsourcing is in a single organization then the same organization is a good candidate for the maintenance of the same project. This practice should be recommended (Ahmed, 2006).Bennett and Rajlich ( 2000) argue  that the major challenge  in outsourcing is the  lack of the  liaison  between company  using  software ( software consumer/ software user ) and the  software  development teams  in  vendor/service  company. Furthermore, sometimes there is a lack of initial requirements definition; this leads to lack of understanding of the maintenance needs.

McCracken (2002), states that one of the challenges of providers of outsourced service maintenance is the service level agreement (SLA). Approximately 50% outsourcing companies provide maintenance service that lacks prototyping and clarity of the service level agreement.

## IV.     Research Methodology

A case study research strategy is adopted to investigate a phenomenon in depth and within its real-life context (Yin, 2003). An inductive research approach is adopted to build a clear picture about the existing situation of software maintenance in e-commerce companies in Jordan.  To study the phenomena in depth, semi-structured face-to-face interviews were used in the study to make interviews flexible to allow the respondents to raise aspects that the researcher may not have thought about prior to the interviews. The interviews were conducted in the presence of the researcher, IT supervisor or manager of each company.

### A.  Population of Study

As mentioned previously in section (E-commerce in Jordan) the number of e-commerce companies in Jordan, according to the statistic 2012, is approximately twenty companies. However, the researcher observed when conducting the preliminary study in e-commerce companies in Jordan, there were only ten established office-based companies. The other companies were smaller businesses possibly based from home, although they were registered in the Ministry of Industry and Trade (MIT). The study is focused on office based e-commerce companies. The researcher did approach the managers of all ten office-based e-commerce companies in Jordan, but only six of them agreed to participate. Four companies expressed their apologies for not participating in the study for confidential reasons.

B. **Sample of Preliminary Study**

Six participants (IT supervisors and senior managers) from six e-commerce companies in Jordan including one participant from each company.

C. **The Interview**

The main source of evidence of the case study strategy is the interviews (Yin, 2003) as interviews study the problem in depth and in specific details (Oates, 2005 and Saunders et al., 2007).

The author generated sixteen questions that were asked to interviewees during the interviews. The researcher focused on open ended questions, because these types of question allow the interviewee to give more information about the situation (Jacob and Paige Furgerson, 2012).

## V. FINDINGS ANDANALYSIS

A. **Interview Questions**

Sixteen questions were discussed in the interviews. This section will present the findings of six cases for each question in detail.

To maintain the anonymity of the participating companies, the author use characters to label the companies as follows:

A: company 1, B: company 2, C: company 3, D: company 4, E: company 5 and F: company 6.

**Q1: What does the term "maintenance" mean from e-commerce company perspective?**

A common response from the interviewees was: maintenance means to maintain everything related to IT department like hardware, software, network, internet line and communications.

**Q2: What are the types of software applications used in the e-commerce company; outsource and/or in-house?**

Four companies (A, B, C, D) used outsourced applications (global software for e-commerce companies), and two companies (E and F) built the system in-house and had resident developer employees to develop the system.

**Q3: Does the company have IT department? If yes, what is the responsibility of the IT department?**

All participant companies had an IT department with different numbers of employees, ranging between one to twenty with four employees on average.

All interviewees stated that the IT department is responsible for everything that is related to technology (hardware, software, internet, and communication tools).

**Q4: How could the software application help the company meet its business goals?**

All respondents from six case studies said that there is no e-commerce business without software application which confirms that software application is at the heart of work that enables e-commerce to operate.

**Q5: What does the term "software maintenance" mean for e-commerce company?**

Two companies (A, C) said that software maintenance means development of software applications, fixing errors, and the need to switch to another system if it's necessary and related to the software maintenance.

One company (B) said that software maintenance" means just fix errors and bugs in the system.

Three companies (D, E, and F) said that software maintenance term means maintaining the software application when any errors occurred and maintaining any tools related to software like (Hardware, platform, and network)

**Q6: What are the actions taken when problems occur in the software applications?**

Companies A, B, C, D explained that when a problem occurs in the system, the alert system sends notification to the system administrator about the problem. The problem is then analysed and resent to internal IT department to solve it within a limited time. If the problem still occurs and wasn't solved by the internal IT, then the senior management takes the decision to consult an external IT support companies. IT support companies are always the provider of the system applications.

Two companies (E, F) solve the problems internally/in-house with the help of the IT department which developed the system from scratch, but sometimes require consultation with external IT support companies.

**Q7: Are there any methodology or standard used in e-commerce Company to deal with software maintenance?**

Most companies don't use any standard or methodology for software maintenance.

The researcher observed that some companies used part of software maintenance standard such as ISO, IEEE but don't have complete knowledge of the standards.

**Q8: Is there any emergency plan for software maintenance?**

All companies have an emergency plan for software maintenance. They have a disaster recovery system. They switch the system to disaster recovery when all the systems are down.

The researcher observed that the system is divided into modules and the problems are module-based.

One of the companies has contracts with external IT support companies to deal with emergency application system.

**Q9: When you take a decision to buy the software application, what is most important from your perspective, the cost or the quality of software and maintenance?**

Two companies (A, B) said that at the beginning of e-commerce business the cost is very important especially if the company is operating on a low budget.

Two companies (C, D) think that it depends not only on the cost of the software but also the quality of the software product and its maintenance requirement.

Other two companies (E, F) stated that they have internal IT department and the cost of the system is related to the salary of the employee who develops and maintains the system internally.

**Q10: What are the most important factors that affect software applications especially in the maintenance phase?**

Two companies (A, B) said that the quality of the system, age of the system, mother tongue of employees, and employees experience and turnover are the factors that most affect the software maintenance.

The companies (C and D) stated that the factors that most affect the system applications and its maintenance are the system quality, hardware, employees experience, internet speed, platform quality, operating system used, proliferation of system, software tools like browser applications, lack of service level agreement, and employee turnover stability.

The companies (E and F) said that the factors are the platform, hardware and employee turnover.

**Q11: IS there any process for monitoring the health of e-commerce software application?**

The majority of the participating companies (B, C, D, E, and F) said that they do not have a process for monitoring the health of e-commerce software application.

Company (A) has a process for monitoring the health of e-commerce software application

**Q12: Does the processes of e-commerce depend on other systems in other companies, if yes, how does the company deal with other systems when problems occur?**

Three of the companies (A, B, and C) said that e-commerce software application depends indirectly on the finance payment and the two systems (finance and e-commerce communicate together via service tools). They also have service level agreement between two companies to deal with problems when they occur in the service tools from both sides.

The software application in three companies (D, E, and F) does not depend on another system like finance system because they use just "cash on delivery" method.

**Q13: How does the senior management deal with enhancement and maintenance of software applications in the company?**

All participants stressed that the senior management in their respective companies seek to improve the software maintenance in the company through facilitating training for employees,

better employee turnover and enhancing the environment which may affect software applications.

**Q14: If possible, how much is the estimated budget for software maintenance as a percentage of company budget?**

All the companies concealed the estimate budget of software application and software maintenance because they said it is "confidential".

**Q15: Do you have a desire to participate in the main study?**

All six companies who took part in the preliminary study we happy to participate in the main study

**Q16: Are there any requirement or confidentiality and any other considerations for participating in the main study?**

All the companies have confidentiality about the budget of IT department, the cost of software application, budget for software maintenance, and sales volume. Also the name of the software manufacturer is confidential

## VI.    THE KEY FINDINGS OF THE PRELIMINARY STUDY

In this section the author focus on extracting the main findings from the data obtained from the six participants.

- ❖ The e-commerce companies are in infancy stage in Jordan.

- ❖ The respondents' feedback revealed that the software maintenance is very costly.

- ❖ E-commerce companies have increased over the last four years.

- ❖ Six companies desired to participate in the main study.

- ❖ Four of the participating companies use outsourced applications and two develop software in-house.

- ❖ Two of the companies that use outsourced applications have full permission to update the application and maintain it.

❖ All the companies have IT departments with varied employee number, the average of IT employees in the participating e-commerce companies is four.

❖ Only two of the companies don't have any relationships with external IT support companies, and four companies have contracts with external IT support companies although they have their own IT department.

❖ Different people within the participating companies have different understanding of what maintenance means.

❖ None of the companies use software maintenance standards or methodology.

❖  All the companies seek the development and enhancements of software applications.

❖ The budget of the IT department, cost of software, cost of software maintenance, salary of IT employees, sales volume, and the name of the software manufacturer are confidential in all participating companies.

❖ The factors   that most   affect software and its maintenance from participants' perspective are:

- The budget of IT department and the budget of the company in general.

- The age of software application.

- The experience of employees in the IT department.

- The Mother tongue of  employees who work in software maintenance

- The employee turnover.

- Software tools like browser application.

- Platform and hardware.

- Global proliferation of the e-commerce application.

❖ Lack of clear service level agreements. The payment method which is used in e-commerce companies in Jordan is "cash on delivery". The use of e-payment method is used in three out of the six participating companies.

# VII.    DISCUSSION

In this section, the author discusses findings from the six case study companies in the light of the literature reviewed.

➢ The respondents' feedback revealed that software maintenance is very costly. This finding is consistent with the following studies: Islam and Katiyar (2014); Dehaghani and Hajrahimi (2013); Floris and Harald (2010); Lientz et al. (1978), who report that software maintenance is costly.

➢ Expertise and turnover of employees were the main factors affecting software maintenance according to the respondents.  This confirms the finding by  Islam and Katiyar (2014); Yang et al. (2008) and Sneed and Opferkuch (2008), who report that major problems in software maintenance field are due to lack of expertise and turnover of the staff who work in software maintenance.

➢ Two-thirds of participants use outsourced software. The respondents' feedback revealed some problems which face the company when it depends on outsourced software. Such as loss of control of software and sometimes culture mismatch especially when outsourcing from another country with different culture. This corresponds with the Ahmed (2006) and Bennett and Rajlich (2000), who believe that there are many risks of maintenance outsourcing, which should be addressed in project plan.

➢ The author observed from the interviews that none of the participant companies in the study used any methodology or standards of software maintenance. This finding is not in line with findings from Rata (2014), April and Abran (2012), and Robillard et al. (2007), who reported the significance of using software maintenance standards in maintenance process.

➢ The respondents who have contracts with external IT support companies reported that the service level agreement (SLA) was not clear   and was sometimes costly. This finding agrees with findings   by  Ahmed's (2006) and McCracken's (2002) studies where they found that service level agreements in software maintenance sector was not clear in most cases.

> ➤ The senior management in most companies sought to use systems that were most widely used in companies around the world, because they believed it had less potential for problems. This finding is supported by the Jiménez et al. (2009) who noted that many companies tend to outsource maintenance to reap the benefits and reduce the cost and effort of the maintenance.

## VIII.    CONCLUSION AND FUTURE WORK

The study describes the current situation and problems facing Jordanian e-commerce companies with regards to software maintenance activities. Employees' experiences, employee turnover, service level agreement (SLA) and the source of software are the main factors that influence software maintenance. The majority of e-commerce companies in Jordan do not have any link with finance companies as they use "cash on delivery". Further, the study shows that six e-commerce companies in Jordan desire    to participate in the main study. Furthermore, financial issues and some documentation are confidential at e-commerce companies in Jordan.

The results presented here are preliminary information for a wider main study investigation of the factors affecting software maintenance in e-commerce companies in Jordan.

- The author concluded that there is a real problem in e-commerce companies and the problem is vague and needs to be addressed in depth. Hence, the main study will take a qualitative approach. The participating companies have a small number of employees who work in the IT department, so face-to face interviews will be adopted in the main study as the main source of data.

- To examine the factors affecting software maintenance from a variety of views, the participants from each company will be divided into two groups: Group A represents employees who work in software maintenance; Group B represents senior management of e-commerce companies.

- The majority of senior managers have a lack of knowledge about the characteristics of software applications used in the company. So, the main study will not ask the senior management any question related to characteristics of software adopted in the company.

- The findings show the majority of participants' companies did not use electronic payment method, so in the main study. the researcher will not focus on the factors affecting software maintenance related to the payment gateway

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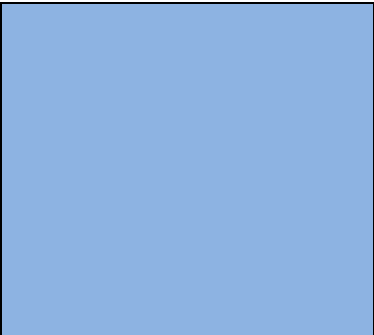Yin, R. K. (2003). *Case study research: design and methods.* (3rd ed.). Thousand Oaks, Calif, Sage Publications.

**Appendix 2: Interview Questions**

Grope A: Employees Working in Software Maintenance

| Category | Interview Questions |
|---|---|
| **Human Resources** | 1. Please, tell me about your work experience?<br>2. What level of education have you obtained?<br>3. What is your specialty in your study?<br>4. What is your mother tongue?<br>5. Do you face any problems related to your mother tongue as regards your work?  If yes, how?<br>6. How many years have you been working in this company?<br>7. Are you working just in software maintenance or do you have other work in the company? If yes, explain the other work.<br>8. Do you attend any training courses for software engineering? If yes, what is the course and when was it last attended? If no, why not?<br>9. Do you have any plan or system to save the domain knowledge that deals with maintenance processes in the system? If yes, explain. If no, why not? |
| **Organisational Environment** | 1. Does the senior management support the IT department and give the department attention? If yes, how?<br>2. Do you get involved in the decisions related to software maintenance? How? |

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| | 3. Do you have regular meetings with the software maintenance team? If yes, how many times a month? |
| | 4. Do you have regular meetings with the IT department team? If yes, how many times a month? Why? If no, why not? |
| | 5. Do you have regular meetings with the senior management? If yes, how many times a month? Why? If no, why not? |
| | 6. Are there any obstacles in software maintenance that make the maintenance complex? If yes, explain. |
| | 7. Do you use any approaches or methodology in software maintenance? If yes, describe the approach? If no, why not? |
| | 8. Do you use any standard in the software maintenance process? If yes, what is the standard? |
| | 9. Does your company have any plan to deal with software maintenance processes? If yes, what is it? Why? If no, why not? |
| | 10. Do you face any barrier(s) to communicating with senior management? If yes, why? How? |
| **Operational Environment** | 1. Do you face problems related to system compatibility with another system in the same e-commerce application? If yes, what is the source of the problem? How do you deal with it? |
| | 2. Do you think that change of hardware or operating system will increase the maintenance efforts? If yes, how? Why? |
| | 3. What are the most common problems to be handled in software maintenance in your work? |
| | 4. What are most the common reasons for the maintenance? |
| | 5. What are the most common factors affecting software maintenance from your perspective? How does it |

| | |
|---|---|
| | affect it? |
| | 6. Do you think lack of understanding of the system by the operation user causes increasing maintenance problems? If yes, how? If no, why? |
| **Software Characteristics** | 1. Do you think the quality of the original software products like system structure, and programme language affects the maintenance? If yes, how? Why? |
| | 2. Do you think software maintenance in e-commerce application differs from other types of software? If yes, why? If no, why not? |
| | 3. Does the software application adopted in the company have any documentation? If yes, what do the documents include? If no, why not? |
| | 4. Do you refer to the documentation before you do maintenance to the system? If yes, why? If no, why not? |
| | 5. Do you update the documentation when you update the software application? If not, why not? |
| **External Factors** | 1. From your perspective, what is the perfect choice in developing in-house software or outsource? Why? |
| | 2. Do you use service level agreements (SLA) to deal with IT support companies? If yes, are there any problems with it? If no, why not? |
| | 3. If you want to adopt the outsourcing of software in the company, do you obtain any information about the software before buying it? If yes, describe the information you were interested in obtaining? If not, why not? |

| | 4. Do you have any external contract in software maintenance? If yes, why? How do you choose the external support company? |
| | 5. What is the view of people as regards to the software maintenance job? Do you think it affects your work? If yes, why? |

Group B: Senior Management in E-Commerce Company.

|  | Interview Questions | Explanation |
|---|---|---|
| General Information | 1. When was the company established?<br><br>2. How many employees are working in the company?<br><br>3. How many employees are working in the IT department?<br><br>4. How many employees are working in the software maintenance?<br><br>5. Are you the owner of the company and the manager too? | The purpose of the information in this section was to validate the responses and to give general information about e-commerce companies and the IT sector in e-commerce companies in Jordan. |
| Category Factor | Interview Questions |  |
| Human Resources Factors | 1. Do you think there is a lack of employee experience in system maintenance especially in e-commerce applications in Jordan?<br><br>2. Do you face problems with employee turnover in software maintenance? If yes, how do you deal with it? If no, what do |  |

| | you do to reduce the employee turnover? | |
|---|---|---|
| | 3. Are there any criteria that help to select employees in software maintenance? If yes, what are these criteria? | |
| | 4. Are you interested in improving the skills of employees in software maintenance? If yes, how? If no, why not? | |
| | 5. Do you think the mother tongue of the employees affect their work? If yes, how? | |
| **Organisational Environment** | 1. Do you have separate sections in the IT department? If yes, what are the sections? If no, why not? 2. Are the IT employees involved in making decisions in respect to the software or software maintenance? 3. Do you think the budget of IT department affects the software maintenance? If yes, how? If no, why not? 4. Do you have regular meetings with the software maintenance team? | • To analyse the policy and practice of e-commerce company managers in Jordan in dealing with software maintenance in the company. |

| | | |
|---|---|---|
| **Operational Environment** | 1. Have you changed the e-commerce application used in your company? If yes, how many times? Why?<br>2. Have you changed the hardware or operating system in the organisation? Why? When?<br>3. What are the most common factors affecting software maintenance from your own perspective? How do they affect it? Why? | • To analyse the policy and practice of e-commerce company managers in Jordan in dealing with software maintenance in the company. |
| **Software Characteristics** | | The researcher observed that when conducting the preliminary study in an e-commerce company that the senior management have less information about technical issues. So, the researcher did not ask the respondents from senior management about software characteristics. |

| | | |
|---|---|---|
| **External Factors** | 1. Do you adopt outsourcing or in-house software in your company? Why?<br><br>2. From your perspective, what is the perfect choice to develop in-house software or outsourced so<br><br>3. From your perspective, what is the perfect and cheapest choice: software maintenance In-house or with outsource support companies? Why?<br><br>4. What are the most common problems you face when you adopting outsourcing software? Why?<br><br>5. How do you deal with partners related to software application in the company like e-payment partners?<br><br>6. How you deal with software maintenance if you bought software that is outsourced? Why? | • To analyse the policy and practice of e-commerce company managers in Jordan in dealing with software maintenance in the company. |

## Appendix 3: Ethical Approval for the Preliminary Study

**Academic Audit and Governance Committee**

**College of Science and Technology Research Ethics Panel (CST)**

University of
**Salford**
MANCHESTER

| | | |
|---|---|---|
| To | Reyad Salameen and Prof Grahame Cooper | |
| cc: | Prof Sunil Vadera, Head of School of CSE | |
| From | Nathalie Audren Howarth, College Research Support Officer | MEMORANDUM |

Date    16 September 2013

Subject:    Approval of your Project by CST

Project Title:    Software maintenance in E-commerce companies in Jordan

REP Reference:    CST 13/98

Following your responses to the Panel's queries, based on the information you provided, I can confirm that they have no objections on ethical grounds to your project.

If there are any changes to the project and/or its methodology, please inform the Panel as soon as possible.

Regards,

Nathalie Audren Howarth
College Research Support Officer

For enquiries please contact:
College of Science and Technology
College Research Support Officer
The University of Salford
Maxwell building, (7th floor, room 721)
Telephone: 0161 295 5278
Email: n.audren@salford.ac.uk

# Appendix 4: Ethical Approval for the Main Study

**Academic Audit and Governance Committee**

**College of Science and Technology Research Ethics Panel (CST)**

University of
**Salford**
MANCHESTER

| | |
|---|---|
| **To** | Salameen, Reyad (and Prof Grahame Cooper) |
| **cc:** | Prof Sunil Vadera, Head of School of CSE |
| **From** | Nathalie Audren Howarth, College Research Support Officer |

MEMORANDUM

**Date**      14 April 2014

**Subject:**      Approval of your Project by CST

**Project Title:**      Investigation of the factors affecting software maintenance in Ecommerce companies in Jordan

**REP Reference:**      CST 14/11

Following your responses to the Panel's queries, based on the information you provided, I can confirm that they have no objections on ethical grounds to your project.

If there are any changes to the project and/or its methodology, please inform the Panel as soon as possible.

Regards,

Nathalie Audren Howarth
College Research Support Officer

**Appendix 5: The Evidence Used to Collect the Data From Six Organisations.**

| Category Num # | Category | Factors | Factor Component | Evidence used | |
|---|---|---|---|---|---|
| | | | | Interviews | Documents and archival records |
| 1 | Human resources | Human resources | Lack of employee experience in software maintenance | Yes | Yes/ high |
| | | | Skills of maintainers | Yes | Yes |
| | | | Employee turnover | Yes | Yes |
| | | | Domain knowledge | Yes | No |
| | | | Mother tongue | Yes | NO |
| 2 | Software | Product quality | Documentation | Yes | Yes/ high |

| | | | Quality of original system (structure, hierarchical). | Yes | Yes |
|---|---|---|---|---|---|
| | characteristics | | | | |
| | | | Programing language. | Yes | No |
| | | | Maintainability of the system. | Yes | No |
| 3 | Organisational environment | Managerial issues | Management support | Yes | Yes |
| | | | Communication with management. | Yes | Yes |
| | | | Communication with IT staff. | Yes | Yes |
| | | | Budget of the system and maintenance. | Yes | No |
| | | Standards and maintenance classifications | Standard and methodology of software maintenance adopted. | Yes | No |
| | | | Classification of software maintenance problems. | Yes | No |

| 4 | Operational environment | System reliability | Hardware and operating system  reliability | Yes | No |
|---|---|---|---|---|---|
| | | | Environment reliability | Yes | No |
| | | Operation users | Operation users | Yes | No |
| 5 | External factors | Source of software application | Outsource | Yes | No |
| | | | In-house | Yes | No |
| | | Service level agreement(SLA) | Lake of service level agreement (SLA) | Yes | Yes |
| | | Other external factor | Outcomes of IT students in the university | Yes | Yes |
| | | | Views of People about Software Maintenance Job | Yes | No |
| | | | | | |
| General Information about participant's | | General information about e-commerce companies, software maintenance team, and the IT sector in e-commerce companies in Jordan. | | Yes | Yes/ high |