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Usability Evaluation of SAP ERP System (UNRWA Case Study)

**تقييم سهولة استخدام نظام SAP ERP
(الأونروا كدراسة حالة)**

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إقرار

أنا الموقع أدناه مقدم الرسالة التي تحمل العنوان:

Usability Evaluation of SAP ERP System (UNRWA Case Study)

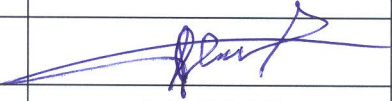
تقييم سهولة استخدام نظام SAP ERP (الأونروا كدراسة حالة)

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نتيجة الحكم على أطروحة ماجستير

بناءً على موافقة شئون البحث العلمي والدراسات العليا بالجامعة الإسلامية بغزة على تشكيل لجنة الحكم على أطروحة الباحث/ حسن فرج يوسف حبوب لنيل درجة الماجستير في كلية تكنولوجيا المعلومات برنامج تكنولوجيا المعلومات وموضوعها:

تقييم سهولة استخدام نظام SAP ERP (الأنروا كدراسة حالة)

Usability Evaluation of SAP ERP System (UNRWA Case Study)

وبعد المناقشة التي تمت اليوم الأربعاء 25 جمادى الأولى 1438هـ، الموافق 2017/02/22م الساعة الواحدة ظهراً، في قاعة مؤتمرات القدس، اجتمعت لجنة الحكم على الأطروحة والمكونة من:

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واللجنة إذ تمنحه هذه الدرجة فإنها توصيه بتقوى الله ولزوم طاعته وأن يسخر علمه في خدمة دينه ووطنه.

والله ولي التوفيق،،،

نائب الرئيس لشئون البحث العلمي والدراسات العليا

أ.د. عبدالرؤوف علي المناعمة

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

فَدَلَّ عَلَى الْإِيمَانِ وَالْإِسْلَامِ
بِإِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

صَدَقَ اللَّهُ الْعَظِيمُ

Abstract

SAP AG is one of the biggest enterprise resource planning (ERP) software corporations. As one of world's leading organization in the field of financial, logistic, procurement, human resource, distribution center and clinic supply, SAP Enterprise Resource Planning (ERP) UNRWA (United Nations Relief and Works Agency for Palestine Refugees) Reach Project has more than 1000 users working with SAP applications among five regions in which UNRWA operates: Jordan, Syria, Lebanon, West Bank and Gaza Strip. UNRWA is one of the biggest United Nations organizations in MENA (The Middle East and North Africa) region.

SAP ERP users in UNRWA often encounter challenges using the complex UNRWA SAP ERP interface, which contains many required frames and fields.

Therefore, there is a need to evaluate the usability of SAP ERP. In a usability evaluation, the problem is to predict what users face while using the system. A usability evaluation with representative users tells whether the predictions are valid or not.

The purpose of this thesis is to find an approach based on data mining to evaluate the usability of the current SAP application in several strategies in UNRWA Gaza Field Office.

There are many factors for usability evaluation. In this thesis, we focused on two main factors: human such as gender, education, and system such as presentation and customization.

The usability study consists of questionnaire and tasks scenario applied to some selected employees in different departments with different modules. The result based on manipulated data collections using data mining methods and special tools.

We conclude that most users with high-education, with high grade, with experience, with computer skills and good knowledge of English found the usability of the system is good. On the other hand, users with limited computer skills and limited English language faced some difficulties using the system. Finally, we gave some useful recommendations and future works.

Keywords: *Enterprise Resource Planning, ERP, systems applications and products, UNRWA SAP, Data Mining, Evaluation, Association Rules, Usability.*

ملخص الدراسة

تعتبر SAP AG واحدة من أكبر الشركات البرمجية في إصدار نسخ خاصة في تخطيط موارد المؤسسة (ERP) المختلفة. تعد وكالة الغوث وتشغيل اللاجئين الفلسطينيين (الأونروا) من أبرز المؤسسات الرائدة في المجالات المالية، اللوجستية، المشتريات، الموارد البشرية، ومراكز التوزيع والعيادات، حيث يبلغ عدد مستخدميها لنظام SAP ERP أكثر من 1000 مستخدم، والتي تغطي المناطق الخمس لعمليات الأونروا حيث تشمل: الأردن، سوريا، لبنان، الضفة الغربية وقطاع غزة. تعتبر الأونروا إحدى أكبر المنظمات التابعة للأمم المتحدة في منطقة الشرق الأوسط وشمال أفريقيا.

وغالبا ما يواجه مستخدموا نظام SAP ERP في الأونروا بعض التحديات والصعاب أثناء استخدامهم للبرنامج نظرا لإحتواء واجهته على العديد من الأطر والحقول الواجب تعبئتها. وعليه، وجب تقييم سهولة استخدام النظام. تكمن مشكلة التقييم في التوقع لما يمكن أن يواجهه المستخدم أثناء عمله على النظام. إن إختبار سهولة الاستخدام يوضح ما إذا كانت التوقعات صحيحة أم خاطئة.

تهدف هذه الدراسة إلى إيجاد منهجية لتقييم سهولة استخدام نظام SAP ERP المطبق في مكتب غزة الإقليمي التابع للأونروا اعتمادا على تقنية تنقيب البيانات. تتعدد مقاييس تقييم سهولة الاستخدام. اعتمدنا في هذه الدراسة على مقياسين رئيسيين: العوامل البشرية مثل الجنس والتعليم، ومعايير النظام مثل العرض والتخصيص.

تتألف هذه الدراسة من إستبانة وسيناريو لبعض المهمات الموجهة لعدد من الموظفين الذين تم إختيارهم من أقسام مختلفة، وقد تم استخراج النتائج على أساس تقنية تنقيب البيانات واستخدام بعض الأدوات الخاصة.

وقد أظهرت النتائج أن معظم المستخدمين الحاصلين على الدرجة الجامعية الأولى فأعلى، ودرجة وظيفية عالية، وذوي خبرة في العمل، ويمتلكون مهارات في الحاسوب، ولغتهم الإنجليزية جيدة إعتبروا أن سهولة استخدام النظام جيدة، في حين أن المستخدمين الأقل مهارة في الحاسوب ولغتهم الإنجليزية ليست جيدة واجهوا عدة صعوبات في استخدام النظام. وفي النهاية قدمنا بعض التوصيات.

كلمات مفتاحية: تخطيط موارد المؤسسة، نظام التطبيقات والمنتجات للأونروا، تنقيب البيانات، تقييم، قواعد الارتباط، سهولة الاستخدام.

Dedication

To my greate parents, the source of encouragement and strength, “Thank you” is a small phrase that will never describe my love and appreciation for all what you have done.

To my beloved wife, I will never forget your care, love, encouragement, and support through the preparation of my thesis. I am blessed by Allah to have you in my life.

To my hope and smile in my life, my children: Faraj and Yamen, I will never be able to express my feelings for having you in my life.

To my beloved sister and brothers, the symbol of love and giving.

To my Friends, who I am having a good life with them.

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Hasan Faraj Habboub

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List of Abbreviations

CRM	Customer relationship management
DM	Data Mining
ERP	Enterprise resource planning
FM	Financial Management
GFO	Gaza Field Office
HE	Heuristic Evaluation
HCM	Human Capital Management
KDD	Knowledge Discovery in Databases
PLM	Product lifecycle management
QUT	Qualitative Usability Testing
SCM	Supply Chain Management
SAP	System Applications and Products
SUS	System Usability Scale
MENA	The Middle East and North Africa
UNRWA	United Nations Relief and Works Agency for Palestine Refugees
UKG	Universal Knowledge Grid
UHMS	UsabAIPO Heuristic Management System
UsP	UsabAIPO Project
UE	Usability Engineering
WMS	Warehouse management systems

Chapter 1

Introduction

Chapter 1

Introduction

1.1 Background and Context

Information systems requirements are segregated on two bases: functional and non-functional. Non-functional requirements are more complex than functional requirements (SOMMERVILLE, 2007). Usability is one facet of non-functional specifications and is very significant in system development. As without usability, there is no guarantee for the successfulness system although if it functionally precise and accurate. Usability cannot be measured directly but can be quantified using attributes analysis. It discusses the objects that are related to humans' and evaluation methods such as; website, tool, machine, process, books and any things have an interface for humans (Faisal et al., 2012).

1.1.1 Usability

Software's using advanced technologies are developed to support the users' in various contexts where the usability is specifically used to evaluate these technologies. Thus; usability is defined by International Organization for Standardization (ISO 9241W11) in (Liu, 2014) as "The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.". Also, according to the usability expert Jakob Nielsen, in (NIELSEN, 2012) usability is composed of:

- *Learnability*: How easy is the design for fresh users to accomplish basic tasks?
- *Efficiency*: How quick can experienced users accomplish tasks with the design?
- *Memorability*: How easily can experienced users get back to the design after they are off for a period?
- *Errors*: How serious can the errors be and can users recover from the errors easily with the design?
- *Satisfaction*: How pleasant can users be when they achieve the tasks with the software?

1.1.2 Usability of ERP

Enterprise resource planning (ERP) systems are used to provide complex information in order to support the decision makers. However, human operators of these information systems are faced with an increasing amount of displayed information. Considering that these operators make the final decisions, they are required to use the appropriate information in the context of their goals. As an individual's information processing capacity is limited, receiving too much information may result in information overload, which impairs effectively and efficiency of the decision making process (Mittelstädt, Brauner, Blum, & Ziefle, 2015).

ERP systems endure several usability issues because these systems are typically complex and frustrating to use. Partially this is unavoidable because of the complex processes ERPs need to implement and support. However, there are other reasons and factors that have traditionally affected usability of such systems, such as the attempt of reusing, whenever possible, well-established templates of general user interfaces, even when they refer to systems targeting multiple and diverse industries (Veneziano, Mahmud, Khatun, & Peng, 2014).

Some studies such as (Mittelstädt et al., 2015) and (Scholtz, Calitz, & Cilliers, 2013) have identified various usability problems with ERP systems. Some of the researchers focused on specific human factors, but other factors that may affect the system usability were ignored and not inclusive in the studies. Other studies focused on the system attributes (criteria) that may affect the usability (Liu, 2014).

1.1.3 UNRWA SAP Usability

SAP AG is a German software corporation and a world leader in enterprise application software and related service. They claimed themselves providing functionality supporting to a global orientation, which lead to sustainable competitive advantage and growth for all size organizations. They are providing solutions for managing business and customer relations to over 335,000 customers in 190 countries (SE, 2017).

SAP stands for System, Application and Product in Data Processing. There are several applications suits produced by SAP AG, in the thesis, we investigate the following areas:

- Human Capital Management (HCM)

- Supply Chain Management (SCM)
- Financial Management (FM)

In 1992, SAP AG delivered SAP R/3, which is the third release of the software. It was renamed SAP ERP and some other names in the past years. The deployment of new architecture makes it possible to be compatible with multiple platforms, such as Microsoft Offices and it is the one used in UNRWA. This generation of SAP applications is always called SAP GUI transaction as well (Liu, 2014).

In our research, we have two contributions. First, the system is specialized in UNRWA Gaza Field Office locally SAP ERP system. Second, we find the main factors that affect the user usability of SAP ERP system and combine with system usability criteria.

User usability depends on a group of factors, which impact users to evaluate the usability of SAP ERP. Assessing what impact users (and their “cognitive” profile, mostly such as education and experience) might have on the perceived and actual usability of the system.

System usability evaluation criteria are:

1. *Navigation*: which aims to determine the ability to perceive and identify proper information and functionality correctly and effectively.
2. *Task support*: which aims to help users with an effective task support complete tasks efficient by an alignment between the systems and the real business processes.
3. *Presentation*: which aims to determine the degree of complexity of the interface’s layout and output of information for users to perceive and comprehend.
4. *Learnability*: which aims to determine required affordance of learning how to use the system.
5. *Customization*: which aims to determine the effort of customizing the system in order to increase the users’ productivity.

As a case study, we choose UNRWA SAP ERP System to evaluate. Previously UNRWA used RAMCO System and some tracking information of VLS - Vendor Logistic System; The main problem issue was the complete integration between divisions, especially the chain of correlated data. Another issue not all divisions were connected to the system,

each division had its own software; Also, each field (Gaza, West Bank, Syria, Jordan, and Lebanon) was not connected to the main software.

Therefore, this system was replaced with SAP ERP to meet the existing challenges of information era and for competitive advantages. UNRWA SAP ERP systems facilitate timely flow of Information among different parts of the organization freely, which consequently helps the management in making strategic decisions.

SAP ERP users (UNRWA employees), however, often encounter challenges using the typically complex UNRWA SAP ERP interface which contains many required frames and fields.

1.1.4 Data mining

In this thesis, we propose to automatically evaluate the system using data mining techniques. Data Mining (DM) is a discipline which involves the nontrivial extraction of implicit, previously unknown, and potentially useful information from data (Jiang, Tseng, & Liao, 1999). DM can be formalized as a process in which data are coming from (possibly) sources, in which features or attributes are identified.

In our work, we propose a usability evaluation approach on UNRWA SAP ERP using data mining methods that uses to achieve the best evaluation for the system by using data mining methods, In data mining we can get the best solutions to our problem for automatic usability testing for the system. This gives us a more accurate and fast performance, and with a little effort.

1.2 The problem statement

One of the most software failures is the system lacking to achieve user's satisfaction. The current UNRWA SAP ERP system endures several usability issues. It is complex, comprehensive, and disreputable problematic to use. ERP users (UNRWA employees), often encounter challenges using the typically complex UNRWA SAP ERP system that contains many required frames and fields. Because of its complexity, it needs more than one method to evaluate. The previous evaluation of SAP usability concentrate on either human factors or system criteria.

1.3 Objectives

1.3.1 Main objective

The main objective is to find and apply an approach to evaluate the usability of UNRWA SAP ERP system. It proposes data mining methods to find the relation between human and system usability factors.

1.3.2 Specific objectives

The specific objectives of the thesis / research are:

1. Determine the human factors that can affect the UNRWA SAP ERP system.
2. Determine the factors that affect the usability in of the system.
3. Design a questionnaire for users, on UNRWA SAP ERP system, based on the collected factors of the usability and the system.
4. Design tasks scenario on UNRWA SAP ERP system for testers.
5. Select users for the test from the previously selected users.
6. Investigate of data mining methods to extract useful knowledge from our data set (questionnaire and test) for a usability test of the UNRWA SAP ERP system.
7. Evaluation: Based on the result investigation results we can determine which are the most effective factor for usability of UNRWA SAP ERP system.
8. Conclude recommendations for using the UNRWA SAP ERP system.

1.4 Importance of research

One of the most obstacles that face SAP ERP system is to satisfy end user especially users with no programming and modeling skills, here with we focus the usability of SAP ERP system.

We consider UNRWA SAP ERP system as a case study for our research. UNRWA replaced the old system with new SAP ERP system. Despite the UNRWA employees undergone training courses for the SAP ERP system, they still encounter crucial dealing, unfriendly and time consuming with it.

In our research, we found an approach to evaluate the UNRWA SAP ERP system by using questionnaire and testing tools to improve its usability and user satisfaction.

Our approach will benefit UNRWA top management to deal with the problems facing the usage of SAP ERP system. Also, it may benefit the institute for future system. In addition, it may benefit any organization in evaluating the same system or other systems.

1.5 Scope and Limitations:

The outcome of the research found the main factors that affects the user usability of UNRWA SAP ERP system and then find an approach to evaluate the system to improve its usability and user satisfaction.

In the research, we have some of the limitations such as:

- Select employee UNRWA Gaza Field Office (GFO) for our research as a sample from five fields (Gaza, West Bank, Syria, Lebanon, Jordan).
- We use some built tools (if possible) for collecting data, preprocessing and data mining.
- Evaluation for UNRWA SAP ERP system according to the following criteria: Navigation, Task support, Presentation, Learnability and Customization.
- We cover different departments such as financial, logistic, procurement, human resource, distribution center and clinic supply.
- UNRWA SAP ERP System in a full management cycle. System implementation project has a defined 1-year implementation timeframe.

1.6 Research Methodology:

To accomplish the objectives of the research, the following methodology is followed:



Figure (1.1): The steps of implement the usability evaluation approach.

1.6.1 Determining the usability factors of UNRWA SAP ERP system

There are a large number of metrics for usability evaluating; These metrics may be user's metrics and technical metrics, for more focus on this research need to find the best metrics for the SAP ERP system.

The first metrics (Users metrics) will be used to ask the employee whose using the system to evaluate the usability, such as work area, education, English language, grade.

Usability evaluation methods that are conducted by human intervention (users and experts) can assess only the users attributes of the website (such as readability of the contents of the system).

The second metrics depend on the technical attributes that the users cannot evaluate such as (time of using the system, Number of mouse clicks, Number of the window open, Number of error).

1.6.2 Testing the system by a set of testers:

After determining the best metrics from a previous step, we have two approaches of the testing:

The first is designing and conducting questionnaire for the users (employees). The users answer the questions (as a simple and electronic question)

The second step is using some tools to test the technical metrics of the system that can measure tasks such as: time tasks, number of mouse clicks, etc.

1.6.3 Collect data set (the answers) from users, and from the tools

In the research, the data set that is needed to test the system is collected from the users' answers to the questions from previous step and the tools. These objectives answers are the main backbone of the research because the usability testing depends on the opinion of testers. This dataset will be inserted and automatic preprocessing operations applied such as:

- Select effective attributes.
- Replace missing values.
- Integration between (Questioners, Tool).

This preprocessing operation is very important to ensure the accurate of data set to reach accurate and effective results when applying data mining algorithms.

1.6.4 Investigating data mining methods for extracting useful knowledge from our data set to automatic usability test of the systems

Data mining methods are the backbone of our approach to the research, to extract the useful and meaningful knowledge about the usability evaluation from employees who test the usability of the system.

In the research, we try to find and implement some of the data mining methods; finally, after applying this method on our data set, we must extract useful and meaningful knowledge about the usability evaluation of the system.

1.6.5 Evaluations

In this phase, we analyze the achieved results and justify the viability of our approach.

1.7 Thesis Structure:

This thesis consists of six main chapters structured around the objectives of the research. The main points discussed throughout the chapters are listed below:

Chapter 1: Introduction

It gives a short introduction about usability evaluation for UNRWA SAP ERP, the thesis problem and objectives.

Chapter 2: Background and Theoretical Foundation

Presents Literature Review of usability evaluation for SAP ERP. In addition, this chapter presents details about data mining methods used in usability evaluation on SAP ERP using Data Mining Methods approach.

Chapter 3: Related Works

It presents other works related to the thesis.

Chapter 4: Research Methodology

Includes the methodology steps and the architecture of the usability evaluation of SAP ERP using Data Mining Methods approach. An explanation about the data-sets used in the experiments, preprocessing of these data set, and the experiment cases are included as well.

Chapter 5: Results and Discussions:

Analyzes the experimental results. In addition, it gives a discussion for each of set experiments.

Chapter 6: Conclusion, Recommendations and Future Works:

It discusses the conclusions and presents possible future works. Finally, we gives some useful recommendations about the research.

Chapter 2

Background and Theoretical Foundation

Chapter 2

Background and Theoretical Foundation

The main categories for this thesis are ERP, SAP, usability and data mining, Therefore this chapter is divided into five main sections; the first section is ERP and ERP modules The second section is SAP and R/3 applications. The third section about usability includes its definition, purpose, evolution, usability issues of ERP systems, usability criteria and human factors in ERP implementation. The fourth section is about data mining that includes its definition, process, tasks and algorithm we used. The last section is a brief summary for the chapter.

2.1 ERP

ERP is an enterprise-wide information system that facilitates the flow of information and coordinates all resources and activities within the business organization (Njihia & Mwirigi, 2014). It enables decision-makers to have full control view of the information they need in a timely, reliable and consistent manner. In the recent years, ERP software has become widely used in almost all fields such as marketing, human resources, finance, manufacturing, transportation, education and others (Veneziano et al., 2014).

2.1.1 ERP modules

ERP system consists of many modules that are integrated with the major functional area of an organization. Each module is designed to interact with each other with easy accessing of information concerning a particular branch, section or department (Ahlawat, 2016).

Each ERP module focuses on one field of business processes. Here are some of the modules that are available in ERP system:

- ***Supply Chain Management (SCM)*** which deals with the movement of products, storing, managing, and controlling supplies
- ***Customer Relationship Management (CRM)*** that provides customer data integration and keeps track of customers across all the sales channels.
- ***Product Lifecycle Management (PLM)*** where the manufacturers can track the design and attributes of a product throughout its lifecycle.

- **Warehouse Management Systems (WMS)** which follows the distribution process involved with finished goods or materials from delivery into the warehouse. WMS modules also help synchronize and control stock.
- **Financial Management** that deals with financial transactions and data, such as handling functions for accounts payable and receivable, financial reporting and treasury management (TechTarget, 2017).

2.2 SAP

SAP stands for Systems, Applications and Products. SAP is a standard package and it can be configured in multiple areas and appropriate it for special needs. SAP includes a large number of business functions to enhance the business practice changes (Hernandez, 1999).

SAP AG is a German software corporation started operation in 1972 and became successful in the 1980s. After the introduction of SAP R/3 in 1992, SAP AG became the world's leading vendor of standard application software (Hernández Muñoz, Keogh, & Martínez, 2006).

2.2.1 R/3 Applications

The R/3 applications are classified into three main functional areas: financial, human resources, and logistics. There are many special set of modules to address all the needs of modern business applications (Hernández Muñoz et al., 2006):

- **Financial Applications:** Designed for automated management and external reporting. The financial area contains the following module groups:
 - *FI.* Financial accounting
 - *CO.* Controlling
 - *EC.* Enterprise controlling
 - *IM.* Capital investment management
 - *TR.* Treasury
- **Human Resources Applications:** it includes all necessary processes to manage all the needs of a company's human resource area. It takes care of payroll, time recording, applicant administration, and organization data. There are two module groups within the human resources applications:

- *PA*: Personnel administration
- *PD*: Personnel development
- ***Logistics Applications***: it manages the processes involved in the supply chain of goods. It contains extensive business processes for manufacturing and many tools for decision support.

The logistics applications include the following modules:

- *LO*. General logistics
- *MM*. Materials management
- *PM*. Plant maintenance
- *PP*. Production planning
- *PS*. Project system
- *QM*. Quality management
- *SD*. Sales and distribution

2.3 Software Usability

Software uses advanced technologies to support users' in various contexts where the usability is specifically used to evaluate these technologies to gather additional requirements that help to design them more useable (Faisal et al., 2012). It deals with the functional system specifications and discusses the emergent system properties, features, and interface. Usability helps the investigator to uncover the usability related issues and to improve the usability of any product.

2.3.1 Definition of Usability

The term usability was coined some ten years ago in order to replace the term “user friendly” which by the early 1980s had acquired a host of undesirable vague and subjective connotations.

The definition of usability or usability engineering by International Standardization Organization (ISO) 9241 and usability experts defined it as “the effectiveness, efficiency and satisfaction with which specified user can achieve the specified goals in particular environment” (ISO, 1998).

In usability three terms are used:

- **Effectiveness:** The accuracy and completeness with which users achieve specified goals.
- **Efficiency:** The resources expended in relation to the accuracy and completeness with which users achieve goals.
- **Satisfaction:** The comfort and acceptability of use.

Although the ISO 9241-11 recommendations have become the standard for the usability specialists' community, the usability definition most widely adopted is the one introduced by Nielsen. It provides a detailed model in terms of usability constituents that are suitable to be objectively and empirically verified through different evaluation methods. According to the Nielsen's definition (Nielsen, 1994), usability refers to five factors which are:

- **Learnability:** the ease of learning the functionality and the behavior of the system.
- **Efficiency:** the level of attainable productivity, once the user has learned the system.
- **Memorability:** the ease of remembering the system functionality, so that the casual user can return to the system after a period of non-use, without needing to learn again how to use it.
- **Few errors:** the capability of the system to feature a low error rate, to support users making few errors during the use of the system, and in case they make errors, to help them to easy recover.
- **User's satisfaction:** the measure in which the user finds the system pleasant to use.

2.3.2 Usability Purpose

The basic purpose of usability is to ensure that the end user is doing his work smoothly by using his average ability without any dissatisfaction. It applies to the design of system, applications and product. It also includes users interface and supporting documents, so the software is running efficiently. As functionality and usability both are tasks and user related terms. Functions need to match task requirements while the users need to understand the exact functionality of the system to meet their requirements. Grouping related commands into menus, other examples of good interface design and documentation help overcome the conflict between power and ease of use to enhance both usability and functionality (Scott, 2008).

2.3.3 Usability Measurement and Evaluation

Usability cannot be measured directly but can be quantified using attributes analysis. It discusses the objects that are related to humans' and evaluation methods such as; website, tool, machine, process, books and any things have an interface for humans.

Usability can be measured empirically or analytically through the use of inspection methods (Hollingsed & Novick, 2007) (Hornbæk, 2006).

Usability inspection is regarded as a cost-effective approach (to measuring usability) which relies on the review of usability experts. This is accomplished by having usability experts analyze a UI with a set of guidelines or questions.

The empirical approach tries to pick out the actual usability issues that are facing the real users.

Inspection techniques differ from empirical techniques by identifying potential usability issues, as opposed to actual usability issues. In our research we used both empirically and analytically measurement.

2.3.4 Common Usability Criteria

There is no standard way to determine the usability of an ERP system. Existing usability issues have been identified through the use of various criteria.

Studies of ERP system usability evaluations propose several usability criteria, which can be used in the evaluation process. Usability criteria can be used to analyze the user experience and can help reveal patterns that may be hard or even impossible to see.

Criteria for evaluating the usability of an ERP system are limited and varied. This makes comparing usability evaluation results for ERP systems a complex task. A common set of criteria needs to be established, against which all usability evaluations for ERP systems could be based (Singh & Wesson, 2009).

There are, however, some common criteria (Calisir & Calisir, 2004; Herbert, Ragsdale, & Gaynor, 2006):

- Ease of use.
- Usefulness (perceived).

- Task Support.
- Navigation.
- Guidance.
- Flexibility.
- Customization.
- Learnability.
- Memorability.
- Accuracy and Completeness.
- System Reliability.
- System Responsiveness.
- UI Presentation.
- Output Presentation.

2.3.5 Usability Criteria for ERP Systems

The most of the usability issues occur in terms of five criteria, which are frequently used to evaluate the usability of ERP systems; and which could classify the majority of usability issues with ERP systems. These criteria are (Calisir & Calisir, 2004), (Herbert et al., 2006), (Iansiti, 2007), (Matthews, 2008), (Wu & Wang, 2002):

- Navigation.
- Learnability.
- Task support.
- Presentation (input and output).
- Customization.



Figure (2.1): ERP Usability Criteria (Singh & Wesson, 2009).

2.3.5.1 Navigation

Navigation is a major design issue for most ERP systems; which aims to determine the ability to identify and access appropriate information, menus, reports, options and elements accurately and effectively.

This criterion aims to determine whether (Singh & Wesson, 2009):

- Information can be easily accessed.
- Functionality can be found quickly and easily.
- The system can guide the user through the correct sequence of transactions to complete a business process.
- The UI supports efficient and accurate navigation of the system.
- Functionality to search for information that is available.
- There is a correlation between the searched item and the required information.
- The system is capable of supporting the different interaction styles of the various users.
- The system supports alternative navigation metaphors.
- The system supports guidance-type information.
- There is clarity in terms of the next sequence of transactions of steps.

2.3.5.2 Presentation

One of the other major issues identified in the usability studies of ERP systems was that the screen display is complex and that output from the ERP system is often difficult to understand and interpret.

Presentation of screen and output criterion aims to determine the appropriateness of the layout of menus, dialog boxes, controls and information on the screen for data entry and output generation.

This criterion is used to determine whether (Singh & Wesson, 2009):

- The visual layout is fully designed.
- The information provided by the system is accurate, complete, timely and understandable.
- The output is easy to understand and interpret, whether the output is structured.
- The information presented supports informed decision making.
- The output provided provides clear visibility into the various other departments.
- The UI is intuitive.

2.3.5.3 Task Support

Often the misalignment between the ERP system and the business processes of an enterprise creates the greatest amount of complexity and resistance to using the ERP system.

Therefore, appropriateness of task support criterion aims to establish if there is an accurate alignment between the system and the real world, in order to ensure effective task support and efficient task completion.

Evaluating this criterion is done by determining if:

- The terminology used by the system is consistent with the terminology of the user.
- The information provided by the system is in real-time.
- The responses from the system are quick and efficient.
- The system supports efficient completion of tasks.
- The system improves user productivity.

- The system automates routine and redundant tasks.
- The system is easy to use.
- The system supports improved information flow between the various organizational departments.

2.3.5.4 Learnability

ERP systems are traditionally regarded as being complex to learn and use. To evaluate this intuitive aspect nature of system criterion is used to determine the degree of effort required to learn how to use the system efficiently.

This criterion is evaluated by determining whether:

- The user can learn how to use the system without a long preface.
- There is a suitable on-line help to support the learning process.
- The diverse functions of the system can be specified by exploration.
- It is easy to become skillful at using the system within a short amount of time.
- The system is intimidating and complex to learn and use.

2.3.5.5 Customization

A key aspect of any ERP system is that it should be customizable. The ability to customize criterion used to support the system needs. The aim of this criterion is to evaluate the ease of customizing the system in order to ensure accurate alignment between the system and the business processes, the system and the user as well as the system's involvement with the user and the business process.

Evaluating this criterion requires that the following be determined:

- The ease in which the system can be configured to a particular industry type.
- The capability of the system to support user-level customization.
- The capability of the system to support customization for the user at a transaction level.
- The alignment between the system and the business processes of the enterprise.

- The ability of the system to update existing business processes, and (or) to include new ones.
- The ability of the system to be re-configured over a period of time.
- The ability of the UI to be configured without affecting the underlying business logic of the system.

2.3.5.6 Human factors in ERP Implementation

Human factors are personal features used to collect and evaluate data on people in a given population. Typical factors include age, gender, education, residence area, computer skills, knowledge of English language, income and job title. Changes in human factors effect on the performance the system. The success of ERP implementation projects is highly dependent on the human factors that stem from the various participants in the implementation project (Vilpola & Väänänen-Vainio-Mattila, 2005).

2.4 Data Mining

Data mining is a methodology used for identifying, extracting and evaluating variables to find useful information. It allows the users to analyze data from different dimensions categorize and summarize the relationships, identified during the mining process. Different data mining techniques are used in various organizations and institutions like pharmaceutical, telecommunication, engineering, education, banking, marketing, and sale. It is very difficult to normalize data without using any sort of technique (Faridi & Mustafa, 2012).

2.4.1 Definition of Data Mining

Data mining derives its name from the similarities between searching for valuable information in a large database and mining a mountain information. Data mining can be defined as *the non- trivial extraction of implicit, previously unknown, and potentially useful information from data* (Agrawal, 2016).

2.4.2 Process for Data Mining

The following list describes the various phases of the process (Han, Pei, & Kamber, 2012):

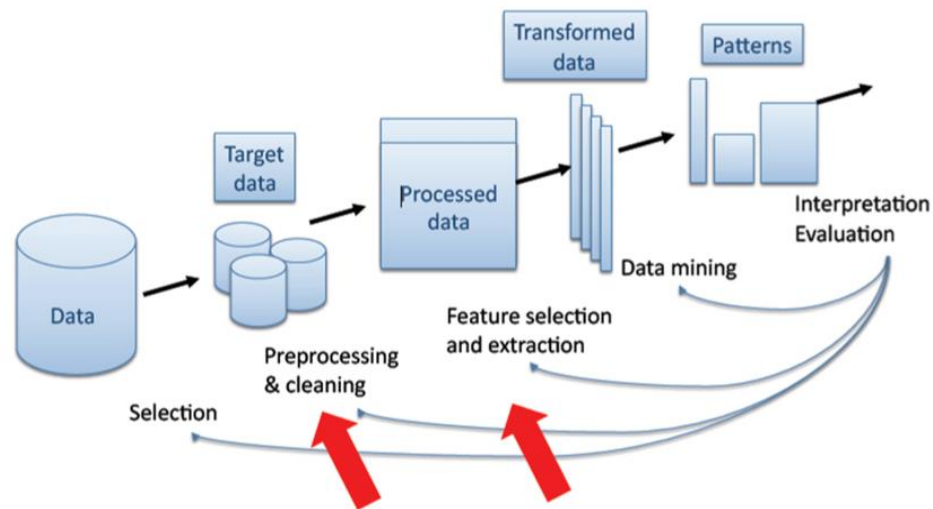


Figure (2.2): Data mining process (Fayyad, Piatetsky-Shapiro, & Smyth, 1996).

1. **Data cleaning:** in this phase, the following data are removed:
 - *incomplete:* lacking attribute values, lacking certain attributes of interest.
 - *noisy:* containing noise, errors, or outliers.
 - *inconsistent:* containing a difference in codes or names.
2. **Data Integration:** Data integration is the merging of data from multiple sources. These sources may include multiple databases, data cubes, or flat files.
3. **Data Selection:** Where data relevant to the analysis task are retrieved from the database. Therefore, irrelevant, weakly relevant or redundant attributes may be detected and removed.
4. **Data Transformation:** where data are transformed or consolidated into forms appropriate for mining by performing summary or aggregation operation (for example daily sales may be aggregated to monthly sales or annual sales), Generalization (for example, city may be generalized to country or age may generalize to young, middle-age, senior) .
5. **Data Mining:** An essential process where intelligent methods are applied on data to convert it to knowledge in for decision-making. A wide range of methods can be used in data mining such neural nets, decision tree and Association.

6. **Pattern Evaluation:** To identify the truly interesting pattern based on some interestingness measures. A pattern considers interesting if it is valid, Novel, Actionable, And Understandable.
7. **Knowledge Representation:** is the framework that converts a massive data into a certain data or procedure that user can figure out based on an intention. Visualization tools and knowledge representation techniques are used to present the mined knowledge to the user.

2.4.3 Data Mining Tasks

Several core techniques that are used in data mining describe the type of mining and data recovery operation. Data mining tasks are the kind of data patterns that can be mined. Data mining functionalities are used to specify the kind of patterns to be found in the data mining tasks.

In general, data mining tasks can be classified into two categories Descriptive and Predictive. Descriptive mining tasks characterize the general properties of the data such as association rule and clustering. Predictive mining tasks perform inferences on the current data in order to make predictions such as classification and prediction (Han & Kamber, 2000).

The most famous data mining tasks are:

1. Association Rules

Association is the most familiar data mining technique. Association rule mining finds interesting relationships among items in a given data set. The discovery of such relationships among transaction records is typically used in many business decision-making processes, such as catalog design and cross marketing. A typical example of an association rule mining is the so-called market basket analysis, where a company analyzes customer buying habits by finding associations between the different items that customers place in their “shopping baskets”. The discovery of such associations can help retailers to develop marketing strategies in which they identify which items are frequently purchased together by customers.

2. Classification

This technique has the capability to process a more extensive variety of data compared to regression and is therefore increasingly popular. Classification is the processing of finding a set of models (or functions) which describe and distinguish data classes or concepts, to be able to use the model to predict the class of objects whose class label is unknown. The derived model is based on the analysis of a set of training data (i.e., data objects whose class label is known).

The derived model may be represented in various forms, such as classification (IF-THEN) rules, decision trees, mathematical formulae, or neural networks.

3. Prediction

An accurate prediction can reduce the cost; optimize the sales and better utilization of available resources. If it can be predicted the future, it will boost the business and bring more profits. Although prediction may refer to both data value prediction and class label prediction, it is usually confined to data value prediction and thus is distinct from classification. Prediction also encompasses the identification of distribution trends based on the available data.

4. Regression

This is the most widely known and the oldest statistical technique that is utilized by the data mining community. Essentially, regression makes use of a dataset to develop a mathematical formula, which fits the data. Therefore, whenever it wanted to use the results for predicting future behavioral patterns, all that needed to do is just to take the new data, and apply it to the model that has been developed, and it will get the prediction. However, if the need to work with data that is categorical, where there is no significant order, such as gender, name, or color, it is better to use a different technique.

5. Clustering

Clustering analyzes data objects without consulting a known class label. The class labels are not present in the training data because they are not known to begin with. Clustering can be used to generate such labels. The objects are clustered or grouped based on the principle of maximizing the intra-class similarity and minimizing the interclass similarity.

2.4.4 Association Rules Method

Mining association rule method is a popular method for discovering relations between variables in large databases. Compared with existing approaches, association rules mining has the advantage of flexible application because no specified function and no dependent variables are a need in association rules mining. Based on the obtained association rules, countermeasures can be taken to break the associations in order to reduce the casualty risk for practical application (Weng, Zhu, Yan, & Liu, 2016).

2.4.5 Association Rules Metrics

An association rule is an $X \xrightarrow{s,c} Y$ expression where X and Y are item sets and they are disjoint, that is, $X, Y \subseteq I$, and $X \cap Y = \emptyset$. Let the item set $X \cup Y$ be denoted as XY.

Two important measures for association rules support (s) and confidence (α) can be defined as follows:

- **Support**

The *support* of the rule is the number of transactions in which both X and Y co-occur as subsets:

$$s = \text{sup}(X \longrightarrow Y) = |\mathbf{t}(XY)| = \text{sup}(XY) \quad (2.1)$$

where \mathbf{t} denotes transactions.

The *relative support* of the rule is defined as the fraction of transactions where X and Y co-occur, and it provides an estimate of the joint probability of X and Y (Zaki & Meira Jr, 2014):

$$\text{rsup}(X \longrightarrow Y) = \frac{\text{sup}(XY)}{|\mathbf{D}|} = P(X \wedge Y) \quad (2.2)$$

where \mathbf{D} denotes database, and P denotes probability.

Support is an important measure because a rule that has very low support may occur simply by chance. A low support rule is also likely to be uninteresting from a business perspective because it may not be profitable to promote items that customers seldom buy

together. Support is often used to eliminate uninteresting rules. Support has a desirable property that can be exploited for the efficient discovery of association rules (Tan, Steinbach, & Kumar, 2006).

- **Confidence**

The *confidence* of a rule is the conditional probability that a transaction contains Y given that it contains X:

$$c = \text{conf}(X \longrightarrow Y) = P(Y|X) = \frac{P(X \wedge Y)}{P(X)} = \frac{\text{sup}(XY)}{\text{sup}(X)} \quad (2.3)$$

A rule is frequent if the itemset XY is frequent, that is, $\text{sup}(XY) \geq \text{minsup}$ and a rule is *strong* if $\text{conf} \geq \text{minconf}$, where *minconf* is a user-specified minimum confidence threshold (Zaki & Meira Jr, 2014).

Confidence measures the reliability of the inference made by a rule. it also provides an estimate of the conditional property of the rule (Tan et al., 2006).

2.4.6 Association Rules Algorithms

Many algorithms for generating association rules were presented over time such as (Apriori algorithm, Partition algorithm, SETM algorithm, FP-growth algorithm), in this section, we will discuss the (FPgrowth algorithm) in details because we use it in our research.

2.4.6.1 FP-Growth algorithm

FP-growth uses a combination of the vertical and horizontal database layout to store the database in main memory. Instead of storing the cover for every item the database, it stores the actual transactions from the database in a tire structure and every item has a linked list going through all transactions that contain that item. This new data structure is denoted by FP-tree (Frequent Pattern tree)(Goethals, 2003).

FP-Growth frequent pattern mining is used in the development of association rule mining. FP-Growth algorithm overcomes the problem found in Apriori algorithm. The frequent item set generation process requires only two passes over the database there is no need for candidate generation process. By avoiding the candidate generation process and

fewer passes over the database, FP-Growth found to be faster than the Apriori algorithm (Divya, 2012; Zhang, Liao, & Zhao, 2008).

An FP-Growth is a prefix tree for transactions; every node in the tree represents one item and each path represents the set of transactions that involve with the particular item. All nodes referring to the same item are linked together in a list, so that all the transactions that are containing the same item can be easily found and counted (Divya, 2012).

FP- Growth algorithm involves the generation of frequent patterns using the frequent patterns generation process, which includes two sub processes:

- Constructing the FP- Growth.
- Generation of frequent patterns from the FP- Growth.

The process of constructing the FP-Tree is as follows (Divya, 2012):

1. The database is scanned for the first time, during this scanning the support count of each item is collected. As a result the frequent 1 - item sets are generated process is the same as in Apriori algorithm. Those frequent item sets are sorted in a descending order of their supports Also the head table of ordered frequent 1 -item sets is created.
2. Create the root node of the FP-Tree T with a label of Root. The database is scanned again to construct the FP-Tree with the head table, for each transaction the order of frequent items is resorted according to the head table.
3. The function Insertf [p j P]; Tg works as follows. If T has a child N such that N.item name= p.item-name then the count of N is increased by 1, else a new node N is created and N.item name= p.item-name with a support count of 1. Its parent link be linked to T and its node link is linked to the node with the same item name via a sub-link. This function Insert fP;Tg is called recursively until P becomes empty.

The FP-tree is mined by calling FP growth (FP tree, null), which is implemented as follows in figure (Bramer, 2007):

```

procedure FP_growth(Tree,  $\alpha$ )
(1)  if Tree contains a single path P then
(2)    for each combination (denoted as  $\beta$ ) of the nodes in the path P
(3)      generate pattern  $\beta \cup \alpha$  with support_count = minimum support count of nodes in  $\beta$ ;
(4)  else for each  $a_i$  in the header of Tree {
(5)    generate pattern  $\beta = a_i \cup \alpha$  with support_count =  $a_i$ .support_count;
(6)    construct  $\beta$ 's conditional pattern base and then  $\beta$ 's conditional FP-tree Tree $_{\beta}$ ;
(7)    if Tree $_{\beta}$   $\neq \emptyset$  then
(8)      call FP_growth(Tree $_{\beta}$ ,  $\beta$ ); }

```

Figure (2.3): Procedure FP growth (*Tree*, α) (Bramer, 2007).

The efficiency of FP-Tree algorithm account for three reasons(Divya, 2012):

1. FP-Tree is a compressed representation of the original database because only those frequent items are used to construct the tree, other irrelevant information is pruned. Also by ordering the items according to their supports the overlapping parts appear only once with different support count.
2. This algorithm only scans the database twice. The frequent patterns are generated by the FPgrowth procedure, constructing the conditional FPTree which contain patterns with specified suffix patterns, frequent patterns can be easy. In addition, the computation cost decreased dramatically.
3. FP-Tree uses a divide and conquer method that considerably reduced the size of the subsequent conditional FP-Tree; longer frequent patterns are generated by adding a suffix to the shorter frequent patterns.

“A study on the performance of the FP-growth method shows that it is efficient and scalable for mining both long and short frequent patterns, and is about an order of magnitude faster than the Apriori algorithm. It is also faster than a Tree-Projection algorithm, which recursively projects a database into a tree of projected databases” (Han & Kamber, 2006).

In our research, we will use FP-Growth algorithm for generating association rules for the following reasons:

- To study the relationships between the metrics in our experiments.
- It is quickly for extracting knowledge.
- The output rules are easy understood and definitions.
- It is no need high specifications of computer machine to implement the experiments.
- It is useful for a high number of metrics and records.

2.5 Summary

In this chapter, we presented the two main categories of background and theoretical foundation in our thesis, usability evaluation and data mining methods. In usability evaluation, we presented the main aspects and methods that we used in our research, in data mining we presented the algorithm that we used in our research.

Chapter 3

Related Works

Chapter 3

Related Works

In this chapter, different related works are studied and investigated. The related works are introduced and analyzed for ERP usability evaluation. The chapter is divided into four sections, in section 3.1, we give some related works about ERP usability, in section 3.2 we present some related works about usability and data mining, in section 3.3 we present ERP and data mining, finally in section 3.4 we give some conclusions about this chapter.

3.1 ERP Usability

([Scholtz et al., 2013](#)) reported on empirical research on the usability evaluation of a medium-sized ERP system. The study identified three categories of criteria and 10 criteria which can be used for usability evaluations of medium-sized ERP systems. The criteria were used in a case study to evaluate the usability of a medium-sized ERP system and to obtain qualitative feedback on the usability of the system. The most frequently reported positive usability features of the ERP system were the tree-structure of the menus and the grouping of logically related items. Negative features which were reported included the clutter of the user interface and difficulties with finding information and controls. These results can provide valuable insight into the ERP learning process for university educators and researchers.

The researchers conclude that the three categories of criteria of navigation, presentation and learnability, together with their related heuristics, can be used to evaluate instructional purposes in introductory ERP courses.

([Liu, 2014](#)) evaluated the current SAP application in Volvo Car Company. He proposed several strategies for a new interface. The usability study consisted of observation, interview and questionnaire. The result was based on a total number of eight interviews and twelve questionnaires.

Theses interviews and questionnaires were based on five essential criteria of ERP system, which are: Navigation, Task support, Presentation, Learnability and Customization.

A total number of eight end users have been interviewed for their experience and thoughts on SAP application. The participants' attributions were: Gender, Solution Experience, Skill level and Department.

Two questionnaires were used to extend the interviews and generate data. The first one with closed questions with Likert-scale items and was inspired and designed by the heuristics rules and ERP criteria. The other one is System Usability Scale (SUS).

The results showed that two of the five criteria (Task support and navigation) were on the average line or above, and the majority of the users think SAP applications do help their jobs. But the satisfaction has a large space to improve.

The researcher concluded that the simplest and lowest cost approach is introducing functions to the users. There should be more color in the interface to distinguish the key information. Another option is to provide some filter functions for the user to hide or fade the disturb information. To be more efficient, certain sorting functions should be provided within Favorites menu.

(Veneziano et al., 2014) investigated the influence of ERP users' demographic information like educational background and job experiences (as factors affecting users' cognitive performance) against the task of rating usability of the system. Survey questionnaire was used as a data collection method and regression testing was conducted to obtain the result of the impact. Several potential outputs were achieved and further explained.

In the research, it focused on how to determine whether (and under which conditions) ERP systems can be considered usable, given the specific social and cultural context of a Bangladesh industrial organization as a case study. The research question: "how user experience and educational background impact on perceiving and appreciating software usability?" Two simple hypotheses could be derived.

They found that there is a positive relation between user educational background and usability of ERP, and work experience has a positive impact on ERP usability

The interviews were for 76 SAP users' of different educational backgrounds. They applied a SUS questionnaire for participants' view of product usability.

They concluded that both independent variables (Education, Experience) were positively affecting the usability rating: users with more/higher education and longer experience rated the higher usability of SAP ERP.

(Mittelstädt et al., 2015) examined the effects of information complexity (data amount and task complexity) and visual presentation as a key aspect of usability and human factors on the decision efficiency and affectivity in MES and ERP systems. The purpose of the study was to investigate the interrelationship of these factors and to derive practical implication for the design of future MES and ERP systems. The findings showed that decision speed dropped with increasing data volume and task complexity. In addition, the negative impact of increasing data volume on decision speed was particularly large for tables with high task complexity. Furthermore, it was found that poor presentation decreased the decision speed. Individual differences in the form of perceptual speed also influenced decision speed and the study revealed that poor presentations especially impairs people with lower perceptual speed. Contrary, people with high perceptual speed can compensate poor presentations and achieved the same level of decision speed as individuals with low perceptual speed using good presentations.

The implication of the study were much folds. First, the study revealed that decision performance was influenced by human factors. The sample consisted of a homogeneous group of experienced and rather fast participants. Hence, further multi-factorial experiments with a more diverse sample that resembles the typical workforce (age, perceptual speed, motivation ...) are necessary to better understand the interrelationship of the investigated factors and to reveal possible interaction effects between these factors (e.g., perceptual speed, data amount, and task complexity).

Second, the study showed that people with a high perceptual speed are able to compensate negative effects of poor usability.

The researcher suggested that MES and ERP systems are systematically reengineered following the typical usability and that available guidelines for reducing complexity are systematically applied, which includes a consideration of different aspects of information.

(Oja & Lucas, 2010) developed an approach that extends existing ERP usability studies by examining problems encountered in actual usage from both the user and expert perspective. They focused on improving SAP ERP system usability by applying the human

computer collaboration paradigm to system design. A novel usability evaluation method called collaborative critique is being developed for evaluating the extent to which a system collaborates with its users in helping them achieve their system-related goals.

They concluded that the laboratory-based critical incidents approach, which draws on both user experience and expert analysis, provides valuable insights into the usability issues plaguing users of ERP systems. They planned on building on the study with additional participants for improving the repeatability of our findings and will ultimately test this approach in the workplace with ERP users.

(Ndung'u & Kyalo, 2015) investigated existing implementation of enterprise resource planning systems in public university management in Kenya and how they have influenced automation efforts in these institutions. The study established that public universities should prepare for implementation of ERP systems by aligning their functional areas to meet ease of automation and integration of their operations with implemented enterprise systems. This would help in choosing an ERP implementation type and customization that not only meets institutional functional needs but also budgetary constraints of the respective institution. The study recommended a continuous review of ERP implementation efforts in public universities.

(Faisal et al., 2012) proposed a usability heuristic for the appraisal to the context of ERP applications. The proposed heuristic for evaluation was based on a qualitative review of the previous literature. Beside literature the series of empirical studies were also conducted by segregating the user' on the bases of their roles in the organization. The evaluation was carried out using an automated assessment tool. The assessment tool was developed using oracle and integrate it with ERP system. They practically assess the ERP for decision marking capabilities especially for those who have strategic nature of the job.

They proposed usability heuristic with following assessment dimensions: Efficiency, satisfaction, a task supported, decision making, aesthetic sense/navigations, accuracy, learnability and knowledge ability.

3.2 Usability and Data mining

(García, Sicilia, González, & Hilera, 2003) focused on usability evaluation through

questionnaires, which are used to obtain information about users' likes, dislikes, needs, and understanding of the system by asking them about some concrete interface's aspects.

In consequence, if a 'questionnaire system' that uses current statistical techniques were developed, the system would not exhibit any kind of learning behaviour – even in the case of having collected a huge amount of useful data, since current analysis techniques don't take into account neither a priori knowledge (acquired from usability or domain experts), nor information extracted from the baseline of past evaluations as a result of some sort of machine learning or data mining process.

They worked to describe how some specific machine-learning algorithms could be used to obtain knowledge that will subsequently be used to implement some basic learning behaviours in a questionnaire design system.

They had chosen Apriori algorithm for the extraction of association rules between questions. They first changed the relational database format of evaluation facts to one in which each application of a questionnaire is represented in a tuple with questions as attributes. Then they needed to carry out a second transformation to extract instances that can be directly taken as inputs by Apriori. For each tuple, they extracted a set of 'boolean' tuples describing the different subsets of equal responses. The result of the data mining process contained association rules that have nothing to do with redundancy, and therefore, questionnaire designer opinion is needed to assess the nature of the inferred rules, giving him/her the opportunity to discard or store the dependency as useful metadata about the questionnaire.

They concluded that tested techniques described here only in a medium size repository, and, under this condition, they have obtained the awaited results. However, they can guess some possible constraints in the application of some algorithms on actual data repositories.

(González, Lorés, & Granollers, 2008) presented a new approach in which two data mining techniques: association rules as a descriptive technique that searches for interesting relationships among items in a given data set, and decision trees as a model for predictive usability problems. Data mining techniques were used to extend the existing Qualitative Usability Testing process in order to provide a general usability diagnosis of a given context of use from a qualitative viewpoint.

They proposed a novel characterization of the *Qualitative Usability Testing* (QUT) process based on the integration of the traditional approach. In their work, *Knowledge Discovery in Databases* (KDD) was used to gather common usability features of a large group of systems in order to achieve a general usability diagnosis as a whole. By performing the proposed QUT process, the members of the evaluation team will be able to formulate different queries to an underlying KDD engine, getting as an output additional, qualitative information that will condense usability problem patterns.

They analyzed the steps related to applying a QUT process to a given context of use as follows:

1. Planning the QUT process.
2. Collecting the QUT data.
3. Applying KDD techniques within the QUT process: they posted a starting query to detect the most relevant relationships (expressed as association rules) among the attributes in the database on the basis of a threshold value for support, confidence and a maximum number of rules to be computed.
4. Visualizing and Analyzing QUT results.
5. Reporting QUT conclusions.

The evaluation team was formed by three usability experts and two Computer Science advanced students with solid knowledge about *Usability Engineering* (UE) and usability. First, as established within the *UsabAIPO Project* (UsP), the web sites of the 69 universities listed in the *University* portal were considered as the sample of CUsP to be used. Second, *Heuristic Evaluation* (HE) was selected as the evaluation method to be applied. Since there was no suitable software package available for the application of the method (which involves the jointly HE of the 69 selected webpages on the basis of the 25 heuristic-related questions mentioned before), they developed a specialized software tool called *UsabAIPO Heuristic Management System* (UHMS). The UHMS provides a simultaneous visualization of the current website that is being evaluated. The evaluation team was divided into two sub-teams in order to carry out two independent usability evaluation.

They concluded that the integration of KDD-based techniques into the traditional QUT process allows that QUT capabilities go further than the testing of one individual system, making possible the qualitative usability estimation of a context of use as a whole.

3.3 ERP and Data Mining

(Amirthalingam & Shaheen, 2014) provided a comparison of benefits obtained by applying OLAP or data mining techniques and the effect of integrating the both approaches in ERP. They presented for integrating OLAP and data mining so that it can benefit from each other's advances for the ultimate objective of efficiently providing a flexible answer to data mining queries addressed either to a relational or to a multi-dimensional database.

Four major steps in integrating multi-dimension module in ERP:

1. Define the data mart of ERP.
2. Choices of fact.
3. Establishment of Dimension.
4. The design of aggregation.

Finally, they concluded that integration could help to increase customer's satisfaction, behavior and ultimately the growth of the organization and provide help for dealing with the customers in more efficient manner.

(Pawłoszek, 2015) presented an approach to analysis and assessment of benefits brought by an implementation of an ERP system. The research has been conducted on a sample of 10 Polish companies using the Xpertis software, which is one of the popular applications for supporting the business activities of small and medium companies. The approach presented hereby aims at elaboration of the assessment method, which can be easily applied by the software vendor.

Cluster analysis conducted through the Orange Data Mining tool was proposed as a technique of data analysis, through three important steps:

1. Selecting a distance measure
2. Choosing clustering method and tool.
3. Determining the number of clusters in a data set.

The researcher concluded that the cluster analysis is an easy to use and flexible method to discover structures in a data set however it does not provide any explanation itself. The semantic interpretation of clustering effects can be performed by combining the data of each cluster with the knowledge of experienced members of the implementation team. The

exploited tool – Orange Data Mining is easy to use because it is based on visual data modeling.

3.4 Conclusion

The researches on ERP systems cover several important topics such as the implementation of ERP, ERP optimization and management of ERP. However, little research has focused on ERP systems and user performance, which confirms the need for research in this area. Also, research in SAP does not use data mining tools. In addition, most evaluation concentrate on either human factors or system criteria. Our research uses both, and finds relation between two categories using data mining.

Chapter 4

SAP ERP Usability

Evaluation Approach

Chapter 4

SAP ERP Usability Evaluation Approach

This chapter explains our proposed approach for usability evaluation on UNRWA SAP ERP. To implement and evaluate this approach, various steps have to be performed. The main required steps, as shown in figure 4.1, are: first we determine the usability factors evaluation for UNRWA SAP ERP system, second we used the metrics for evaluating the system by set of users (employees) using questionnaire approach, third using other metrics for evaluating using some tools, fourth collecting data set (the answers) from testers, and from the tools, fifth we investigating of data mining methods for extracting useful knowledge from our data set to automatic usability of the systems, the final step is evaluation.

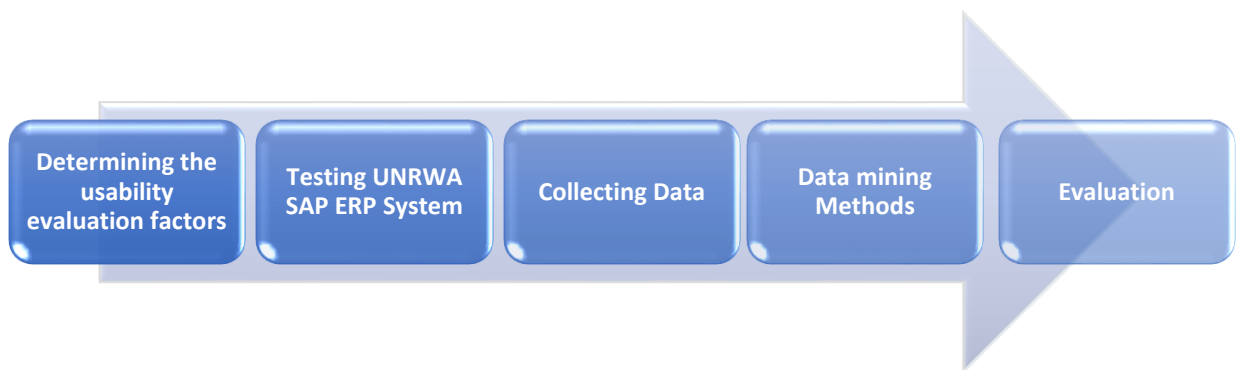


Figure (4.1): The steps of evaluation the system usability approach.

This chapter is organized into five sections. Section 4.1, presents estimating the usability of UNRWA SAP ERP system. Section 4.2 describes data acquisition; it gives a description of the collecting data sets for designing experimental data. Section 4.3 conducts the research a set of preprocessing operations on the data sets. Section 4.4 presents and determines data mining methods. Section 4.5 discusses the evaluation of the system.

4.1 Determining the usability factors of UNRWA SAP ERP system

There are many factors for usability. In this research, we focus on two main factors that need to evaluate the system, human and system factors.

4.1.1 Determining human factors

Human factors are different and various. Typical factors include age, gender, and income. In our research, we focused on the factors that need to evaluate SAP ERP system usability. We proposed thirteen factors may affect the user usability which are: gender, residence area, age, education, grade in UNRWA, department / office, work area, experience with UNRWA, SAP ERP experience, computer skills, knowledge of English language, training on SAP ERP and using software besides SAP ERP.

4.1.2 Determining usability system factors

In our research, we focused on the most frequent criteria used to evaluate the usability of ERP systems. These five criteria are navigation, learnability, task support, presentation and customization.

Navigation aims to determine the ability to identify and access appropriate information, menus, reports, options and elements accurately and effectively.

Learnability is used to determine the degree of effort required to learn how to use the system efficiently.

Task support criterion aims to establish if there is an accurate alignment between the system and the real world, in order to ensure effective task support and efficient task completion.

Presentation of screen and output criterion aims to determine the appropriateness of the layout of menus, dialog boxes, controls and information on the screen for data entry and output generation.

Customization aims to evaluate the ease of customizing the system in order to ensure accurate alignment between the system and the business processes, the system and the user as well as the system's involvement with the user and the business process (Singh & Wesson, 2009).

4.2 Testing UNRWA SAP ERP System

In the research, two datasets were collected from UNRWA Gaza field office to evaluate the system usability. We used two different methods to collect the data which are:

4.2.1 Design Questionnaire

Based on the estimated human factors and system criteria (as described in 4.1.1 and 4.1.2). We conducted Web application questionnaire that uses to collect the answers from users (UNRWA employees) (questionnaire is listed in Appendix 3). The questionnaire was sent by E-mail to every user who must answer all the questions to evaluate the system.

4.2.1.1 Users sample (Users)

The sample was chosen from employees according to the following criteria:

- The sample covered two genders (Male, Female).
- The sample covered all work areas in Gaza Strip (South Governorates, Middle Camps, Gaza Governorates, North Governorates).
- The sample covered all departments of the UNRWA (e.g. Health, Logistics, Procurement).
- The sample covered all grade of the UNRWA employees (3 – 16 and above).

4.2.1.2 Limitation of answers

The answers are limited to 5 choices:

- Strongly Disagree (0).
- Disagree (1).
- Neither Agree on Nor Disagree (2).
- Agree (3).
- Strongly Agree (4).

The employees must answer all the questions to complete the questionnaire.

4.2.1.3 The attribute of the questionnaire data set:

In this data set, we collected a number of attributes that is effective to evaluate the system as the table:

Table (4.1): The attributes of the questionnaire.

No.	Attribute Name	Description
1.	Gender	The employee gender
2.	Age	The employee age
3.	Education	The employee education level

No.	Attribute Name	Description
4.	Grade	The grade level in UNRWA
5.	Work Area	The employee work area
6.	Residence Area	The employee residence area
7.	department / office	The employee department / office
8.	Years of Experience with UNRWA	The employee experience with UNRWA
9.	SAP ERP Experience	The employee experience on SAP ERP
10.	Computer Skills	The employee computer skills
11.	Knowledge of the English language	The employee knowledge of the English Language
12.	Q1 ----Q 28	The questions of the questionnaire. (Appendex 3)

4.2.1.4 The Web application questionnaire

There are 28 different questions in the web application questionnaire, which organized into six categories based on the human factors and system criteria. We used Google forms and sent the online questionnaire link to each employee through his own UNRWA email.

4.2.1.5 Choosing the sample

In this research, we conduct the experiment on UNRWA Gaza Field Office SAP ERP system. UNRWA GFO includes 13 different department and it has 300 employees used SAP ERP. We ask statistical academic experts about the number of best sample to implement the experiment on UNRWA employees; they suggest we need sample more than 170 employees to ensure the results are covered the UNRWA, that's depending on the following formula:

Sample Size (Moore, McCabe, Duckworth, & Alwan, 2008)

$$n = \left(\frac{Z}{2m} \right)^2 \quad (4.1)$$

Where:

Z = Z value (e.g. 1.96 for 95% confidence level)

m = confidence interval (margin of error), expressed as decimal (e.g., .05 = ±5)

Correction for Finite Population

$$n_{\text{corrected}} = \frac{nN}{N + n - 1} \quad (4.2)$$

Where: N = Population size

Using Equation (4.1), the sample size is:

$$n = \left(\frac{1.96}{2 \times 0.05} \right)^2 \cong 384$$

Suppose that the population size is 300, the corrected sample size using equation (4.2) is:

$$n_{\text{corrected}} = \frac{384 \times 300}{300 + 384 - 1} \cong 168.68$$

Therefore, the minimum sample size required is at least 169.

Based on population size which is 300 employees (no. distributed questionnaire), in UNRWA GFO we collect 174 returned questionnaire as a sample for applying the experiment.

Questionnaire Evaluation

The questionnaire was evaluated by group of experts from different specialty and institutions, as shown in table 4.2.

Table (4.2): List of experts.

No.	Expert Name	Place	Specialization
1.	Prof. Samy Abu-Naser	AL-AZHER University – Gaza	Prof in Computer Science
2.	Dr. Ihab Zagout	AL-AZHER University – Gaza	PhD in Information Technologies
3.	Dr. Wael Al-Sarraj	Islamic University of Gaza	Assistant Professor of Computer Science
4.	Dr. Iyad Al-Agha	Islamic University of Gaza	Assistant Professor of Computer Science
5.	Dr. Mohammed Radi	ALAQSA University – Gaza	PhD in database systems
6.	Dr. Sameh Jabbour	UNRWA- Gaza	PhD in Computer security systems
7.	Mr. Mahmoud Al-Zarabi	UNRWA- Gaza	MBA

4.2.2 The tools (Tasks scenario)

In this research, we used tools to evaluate the usability of system. We measured and evaluated some metrics that cannot be measured by the user (employees) .We conduct seven

different (Tasks scenario) that are used to collect the data set from the employee by using (Morae Recorder tool and Morae Manager tool (TechSmith, 2016)). The advantage of Morae's tools is facilitating the usability process from study design to collecting data and analysis. The employee must conduct this scenario on the UNRWA SAP ERP.

In the research, we collect the data by using two tools as the follows:

4.2.2.1 The used scenario

We used the scenario shown in table (4.3): first, we asked the user to log into the UNRWA SAP ERP system using his username and password, and then we asked him to check the available budget for purchasing material for the department. Next, the user created a purchase request by filling some fields such as (material, quantity, etc.). Next, we asked the user to update the purchase request that he created earlier by editing some fields. Then, we asked the user to display the purchase request he created, and display all the purchase requests as a list. Finally, the user logged out from the system.

Table (4.3): List of tasks scenario.

Task no.	Task Description
Task 1	Login into UNRWA SAP ERP system
Task 2	Check available budget
Task 3	Create purchase request in the system
Task 4	Change purchase request in the system
Task 5	Display purchase requests
Task 6	Display purchase requests as a list
Task 7	Logout off the system

4.2.2.2 Morae Recorder tool

Recorder allows capturing audio and video. It can also record the user and his on-screen activity, including keyboard activity and mouse clicks.

With this application, you can perform the following tasks:

- Choose the recording, study and marker settings that best fit the parameters of your usability test.
- Test the audio and video recording equipment.

- Record a user's on-screen actions, keyboard and mouse activity during usability test.

When have finished using Recorder, then we import, analyze and graph the information in the Manager application.

This tool provides some of metrics; we select the best significant metrics, which has an impact on the appearance of results during the evaluation process of the tasks scenario experiment to evaluate the performance of the system because these metrics is important to measure the behavior of employees such as:

1. The number of mouse clicks

The number of mouse clicks of the (tasks scenario), we summarized the ranged into five ranges.

2. The number of Keystrokes

The number of Keystrokes of the (tasks scenario), we summarized the ranged into five ranges.

3. The number of Window Dialog open

The number of Window Dialog opens off the (tasks scenario), we summarized the ranged into five ranges.

4.2.2.3 Morae Manager Tool

Using the application the following can be done:

- View an existing user testing study.
- Create markers to note and code participants' behavior.
- Log, score, and make notes about tasks the participant has completed.
- Create graphs of your data.

Morae Manager allows you to organize information and create text or audio annotation for data. Manager performs data analysis, creates graphs and export study data to other programs (such as Excel or Numbers).

This tool provides some of metrics; we select the best significant metrics, which has an impact on the appearance of results during the evaluation process of the tasks scenario experiment to evaluate the performance of the system because these metrics is important to measure the behavior of employees such as:

1. Task time

The time of the (tasks scenario) by seconds, we summarized the ranged into five ranges.

2. Total time tasks/sec

The total time of seven (tasks scenario) for each employee, we summarized the ranged into five ranges.

3. Error Rate

The number of error of the (tasks scenario), we summarized the ranged into three ranges.

4. Task Scores

To ensure the task is complete easily (0), complete difficult (1), or incomplete (2), we summarized the ranged into three ranges.

4.3 Collect data set (the answers) from users, and from the tools

To get data that is ready to use in data mining, we conducted in the research a set of preprocessing operations on the data sets before conducting the final experiment. We conducted two set of operations on data collecting and data preprocessing.

4.3.1 Collecting data

In data collecting, we apply a set of important operations before implementing the final experiment including:

4.3.1.1 Select attributes

For more powerful results in the research, we chose attributes for our research, to ensure accurate, effective metrics and covered most issues of usability to evaluate the system, as shown in table 4.3:

Table (4.4): The selected attributes from the questionnaire and tasks scenario.

Name of data set	Attribute Name	Description
Questionnaire	Gender	The employee gender
	Age	The employee age
	Education	The employee education level
	Grade	The grade level in UNRWA

Name of data set	Attribute Name	Description
	Work area	The employee work area
	Years of experience with UNRWA	The employee experience with UNRWA
	SAP ERP experience	The employee experience on SAP ERP
	Computer skills	The employee computer skills
	Knowledge of the English language	The employee knowledge of the English Language
	Q1 ----Q 28	The questions of the questionnaire. (Appendex 3)
Tools (tasks scenario)	The number of mouse clicks	The number of mouse clicks of the (tasks scenario), we summarized the ranged into five ranges.
	The number of Keystrokes	The number of Keystrokes of the (tasks scenario), we summarized the ranged into five ranges.
	The number of Window Dialog open	The number of Window Dialog opens off the (tasks scenario), we summarized the ranged into five ranges.
	Task time	The time of the (tasks scenario) by seconds, we summarized the ranged into five ranges.
	Total time tasks/sec	The total time of seven (tasks scenario) for each employee, we summarized the ranged into five ranges.
	Error Rate	The number of error of the (tasks scenario), we summarized the ranged into three ranges.

Name of data set	Attribute Name	Description
	Task Scores	To ensure the task is complete easily (0), complete difficult (1), or incomplete (2), we summarized the ranged into three ranges.

4.3.2 Data preprocessing

Data preprocessing is a data mining technique that involves transforming raw data into an understandable format. Real-world data is often incomplete, inconsistent, and/or lacking in certain behaviors or trends, and is likely to contain many errors. Data preprocessing is a proven method of resolving such issues. Data preprocessing prepares raw data for further processing.

- **Remove missing data**

This operation is important to ensure the accurate input data to the experiment, remove missing record operation is remove the records that have a bad effect on the data to ensure extract accurate results from the experiment.

- **Remove identical answers**

In the questionnaire experiment, we have some identical answers for the same employees, for example when the employee choose the same answer for all questions in the questionnaire that mean he does not read all the questions, in this state we remove this record from the data set.

- **Data Reduction (Discretization)**

Discretization is very useful for generating a summary of data, it also called binning. Two ways, in which Binnig can be applied (Han & Kamber, 2006). In equal-frequency binning the range of X is divided into intervals that contain (approximately) equal number of points; equal frequency may not be possible due to repeated values (Zaki & Meira Jr, 2014). We applied the Equi-frequency binning in human and system factors attributes.

4.4 Data mining methods

Data mining methods are the backbone of our approach to the research, to extract the useful and meaningful knowledge about the usability testing from employees whose test the usability of the system.

In the research, we choose Associations rules method because association rule learning is a popular and well-researched method for discovering interesting relations between variables in large databases (Chen, Hang, & Zhang, 2006). That mean we can extract useful relations about our two experimental in the research. For example, we can extract relation between the computer skills of employees and use system in the questionnaire experiment. Also we can find a strong relation between the number of mouse clicks and the number of window dialog open in the tasks scenario experiment.

It is intended to identify strong rules discovered in databases using different measures of interestingness. For example, the rule (Onions, Potatoes) => (Burger) found in the sales data of a supermarket would indicate that if a customer buys onions and potatoes together, he or she is likely to also buy hamburger meat. Such information can be used as the basis for decisions about marketing activities such as e.g. promotional pricing or product placements. In addition to the above example from market basket analysis association rules are employed today in many application areas including Web usage mining, intrusion detection, Continuous production and bioinformatics. As opposed to sequence mining, association rule learning typically does not consider the order of items either within a transaction or across transactions (Han & Kamber, 2006).

- **FP-growth algorithm**

FP stands for the frequent pattern.

In the first pass, the algorithm counts the occurrence of items (attribute-value pairs) in the dataset, and stores them to “header table.” In the second pass, it builds the FP-tree structure by inserting instances. Items in each instance have to be sorted by descending order of their frequency in the dataset so that the tree can be processed quickly. Items in each instance that do not meet minimum coverage threshold are discarded. If many instances share most frequent items, FP-tree provides high compression close to tree root (Savasere, Omiecinski, & Navathe, 1995).

Recursive processing of this compressed version of the main dataset grows large item sets directly, instead of generating candidate items and testing them against the entire database. Growth starts from the bottom of the header table (having longest branches), by finding all instances matching given condition. The new tree is created, with counts projected from the original tree corresponding to the set of instances that are conditional on

the attribute, with each node-getting sum of its children counts. Recursive growth ends when no individual items conditional on the attribute meet minimum support threshold, processing continues on the remaining header items of the original FP-tree (Abu-Zaineh, Mataria, Luchini, & Moatti, 2008).

For example, in the questionnaire, we need to know the degree of relation between “Have you ever took training on SAP ERP” and “Presentation is agreed”, that is more important in evaluating the system.

Also in tasks, we need to know the degree of relation between “Number of clicks” and “Total time task”, which is more important in evaluating the system.

These extract relations are given from data mining method “Associations rule”, and we can extract a set of useful relations between all attributes in our research to ensure the accurate evaluation of the SAP ERP system.

The final results of our research are generating useful Association Rules; This operator generated a set of association rules for a given set of frequent itemsets.

In RapidMiner, the process of frequent itemset mining is divided into two parts: first, the generation of frequent itemsets and second, the generation of association rules from these sets. For the generation of frequent itemsets, we use for example the operator FP-Growth. The result will be a set of frequent item sets which could be used as input for this operator (Houtsma & Swami, 1995).

4.5 Evaluation

Several evaluation metrics were used in our thesis, as follows:

4.5.1 Statistics evaluation

This evaluation depends on the analysis of data on the use of descriptive analysis, which depends on the poll and use the main program (SPSS). In our research, we used data analysis both qualitative and quantitative data analysis methods. The Data analysis made utilizing (SPSS 23).

4.5.2 Personal evaluation

Based on the interview with the users, their views and observations were considered as recommendations to evaluate the system usability.

4.5.3 Association rules evaluation

We used two important measures to evaluate the metrics for association rules support (s) and confidence (c) as we declared in section 2.4.5.

Chapter 5

Results and Discussions

Chapter 5

Results and Discussions

In this chapter, we present our findings of usability evaluation for SAP ERP system and discuss the results. The chapter is about questionnaire and survey results. The results include six sections, in section 1 we present the human factors data collection, in section 2 we present the results for each one of the five system criteria, in section 3 we present the applied data mining method, in section 4 we present the results of the system criteria, in section 5 we summarized the system criteria results, finally, in section 6 we present the experimental tools for the tasks scenario.

5.1 Human factors

This section describes human factor. Factor that the sample size are 174 user, which has different characteristics in terms of gender, age, education, experience, Computer Skills and Knowledge of the English Language.

Various data had been gathered from the end users. Table 5.1 describes the quantitative results of the sample size.

Table (5.1): Quantitative results for questionnaire human factors.

Personal data (N=174)		Frequency	Percent
Gender	Male	117	67.2
	Female	57	32.8
Residence Area	South Governorates	19	10.9
	Gaza Governorate	109	62.6
	Middle Camps	33	19.0
	North Governorates	13	7.5
Age	20 -Less than 25	4	2.3
	25 - Less than 30	22	12.6
	30 - Less than 35	36	20.7
	35 - Less than 40	37	21.3
	40 - Less than 45	21	12.1
	45 - Less than 50	21	12.1
	50 - Less than 55	21	12.1
	55 and above	12	6.9
Education	Secondary Certificate	-	-
	Diploma Degree	11	6.3
	Bachelor Degree	113	64.9
	Master Degree	48	27.6
	PhD Degree	2	1.1

Personal data (N=174)		Frequency	Percent
Grade in UNRWA	3-7	28	16.1
	8-12	99	56.9
	13-15	23	13.2
	16 and Above	24	13.8
Department / Office	Director of UNRWA Operations (DUO)	8	4.6
	Program Delivery \ Community Mentality Health	2	1.1
	Program Delivery \ Education	6	3.4
	Program Delivery \ Health	7	4.0
	Program Delivery \ Infrastructure & Camp Improvement Program (ICIP)	6	3.4
	Program Delivery \ Project Office	1	0.6
	Program Delivery \ Relief & Social Services	7	4.0
	Program Integration \ Job Creation Program (JCP) UNIT	1	0.6
	Program Integration \ Monitoring & Evaluation	1	0.6
	Program Integration \ Public Information Office	1	0.6
	Support \ Administration Office	2	1.1
	Support \ Finance Office	23	13.2
	Support \ Head Quarter Gaza Field Office	16	9.2
	Support \ Human Resources Office	30	17.2
	Support \ Information Systems Office (ISO)	6	3.4
	Support \ Logistics Office	44	25.3
Support \ Procurement Office	11	6.3	
Support \ Security and Safety Department (SSD)	2	1.1	
Work Area	South Governorates	4	2.3
	Gaza Governorate	156	89.7
	Middle Camps	8	4.6
	North Governorates	6	3.4
Years of Experience with UNRWA (Per Years)	1 - Less than 5	26	14.9
	5 - Less than 10	39	22.4
	10 - Less than 15	41	23.6
	15 and Above	68	39.1
SAP ERP Experience (Per Months)	1- Less than 3	36	20.7
	3 - Less than 6	15	8.6
	6 - Less than 9	18	10.3
	9 - Less than 13	36	20.7
	13 and above	69	39.7
Computer Skills	Beginner	3	1.7
	Medium	80	46.0
	Advanced	91	52.3
Knowledge of the English Language	Poor (Less than 50%)	-	-
	Medium (50% - Less than 70%)	25	14.4
	Good (70% - Less than 80%)	68	39.1
	Very Good (80% and above)	81	46.6
Have you ever took training on SAP ERP?	Yes	156	89.7
	No	18	10.3

Personal data (N=174)		Frequency	Percent
Does SAP ERP replaced the old software on your P.C., or you are still using that software besides SAP ERP?	Yes	138	79.3
	No	36	20.7

In the table, we can noticed that, from the total set of 174 user providing answers, 67.2% are male (117). The most frequently stated Governorates are Gaza Governorate (62.6% as Residence Area, 89.7% as Work Area). The most frequently stated Education are Bachelor Degree are 64.9% (113). The average age of the user between the range (35 - Less than 40) (37 users, 21.3%), the Grade in UNRWA basis for subsequent analysis. 13.2% of them are between Grade (13-15) 23 users, 13.8% of them are between Grade (16 and above) 24 users, 16.1% of them are between Grade (3-7) 28 users, The most frequently stated is 56.9% of them are between Grade (8-12) 99 users, 52.3% A broad range of Computer Skills are advanced (91), 46% of Computer Skills are medium (80), The most frequently stated Knowledge of the English Language 46.6% are Very Good (80% and above) (81 users), 39.1% are Good (70% - Less than 80%) (68 users), 89.7% take a training on SAP ERP (156 users), 10.3% does not take a training on SAP ERP (18 users), the most frequently stated Years of Experiences with UNRWA are 15 and Above (Per Years) 39.1% (68 users). The most frequently stated SAP ERP Experience are 13 and above (Per the months) 39.7% (69 users). 79.3% (138 users) are replaced the old software with SAP ERP. The most frequently stated Department are Support \ Logistics Office 25.3% (44 users).

5.2 System criteria

The five usability evaluation criteria for the SAP system are Navigation, Task support, Presentation, Learnability and Customization.

The calculated score for these criteria and the results are presented in table 5.2 (in descending order):

Table (5.2): Scores for usability system criteria.

No.	Criteria	Sum	Mean	Median
1.	System Presentation	458	2.63	3.00
2.	System Learnability	442	2.54	3.00
3.	System Navigation	433	2.49	3.00
4.	System Customization	423	2.43	3.00
5.	System Support	414	2.38	3.00

The total number of samples is 174 and 4 are used as the best points in the survey, so 348 points are consider at the average point. All the five criteria are above the average line.

The analysis of results comprises the assessment of Quantitative analysis and Data mining analysis.

5.3 Applying data mining method

In the questionnaire experiment we applied FP-Growth algorithm, this learner efficiently calculates all frequent item sets from the given data, after that we extract the useful rules by *Create Association Rules* that operator generated a set of association rules for a given set of frequent item sets (Dunham, Xiao, Gruenwald, & Hossain, 2001).

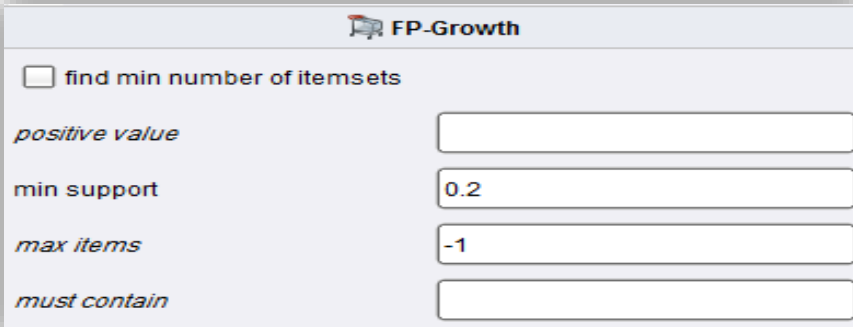
1. FP-Growth setting for experiment

A. Min support and min confidence setting

In questionnaire experiment we selected the best value of *min-support* of FP-Growth algorithm and *min-confidence* of Create Association Rules by a set of tests and analyzes conducted on the experiment (Jiang et al., 1999) (Chen et al., 2006).

The best value of *min-support* and *min-confidence* means there are strong relations between attributes in data set experiment, and large number of relations between them (Han & Kamber, 2006), the settings are shown in figures 5.1, 5.2:

1. FP-Growth



FP-Growth	
<input type="checkbox"/> find min number of itemsets	
positive value	
min support	0.2
max items	-1
must contain	

Figure (5.1): The value of min support.

2. Create Association Rules

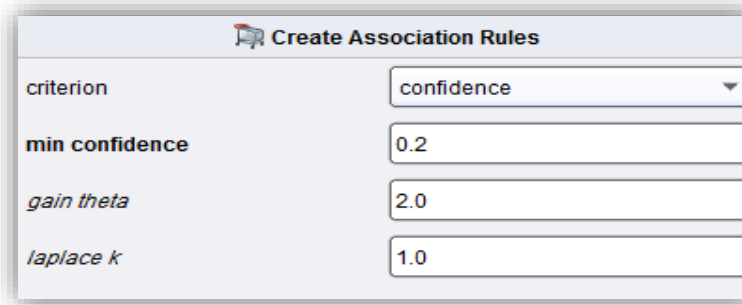


Figure (5.2): The value of min confidence.

From previous figures, we can see the best value of *min-support* of FP-Growth algorithm is 0.2, and the best value of *min-confidence* of Create Association Rules is 0.2, because there are strong relations between the experiment attributes in data set, and large number of relations between them.

B. The process of FP-growth method

The figure 5.3 shows the main process of the FP-growth method that we applied on the questionnaire experiment, this method is implemented via RapidMiner tools:

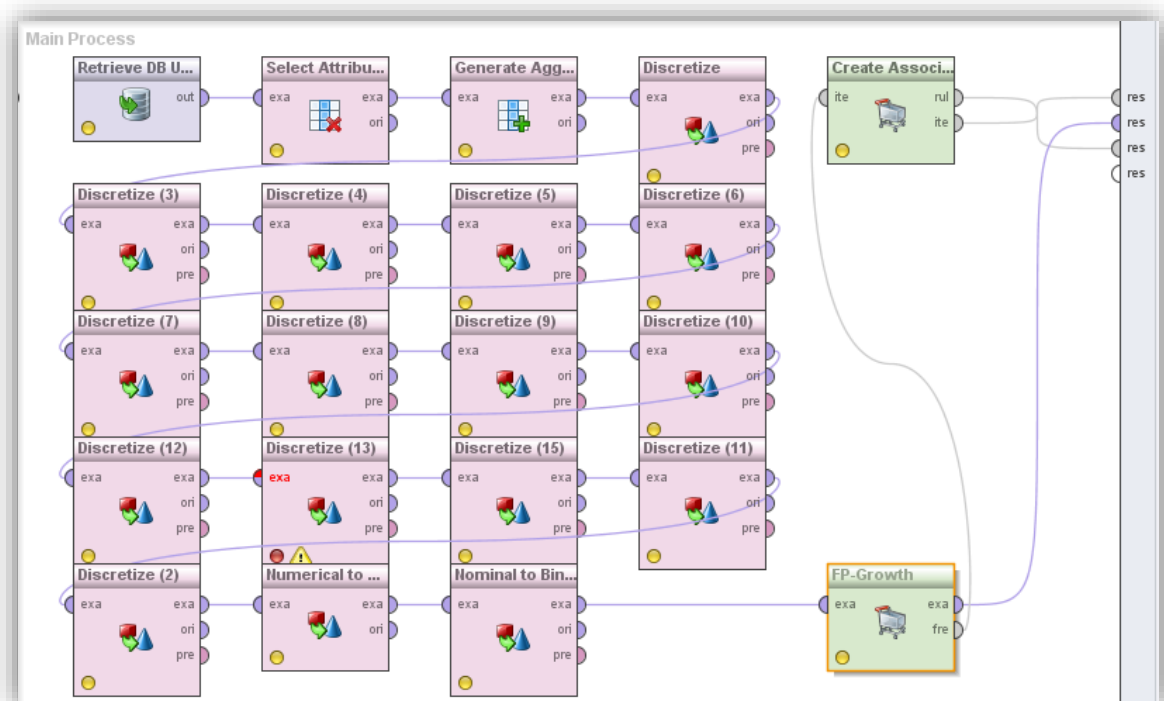


Figure (5.3): The main process of FP-growth method in RapidMiner tool for questionnaire.

The previous figure 5.3 includes the following steps:

- 1- **Retrieve DB UNRWA:** this step for choosing the data set input (Excel file) to the FP-growth method; it is the collected data from answers of the questionnaire.
- 2- **Select attribute:** this step for choosing specified questions for each system criterion.
- 3- **Generate Aggregation:** this step for aggregation the group of questions (attributes) for each criteria to a single attribute using the average function.
- 4- **Discretize by Frequency:** This operator discretizes all numeric attributes in the dataset into nominal attributes. This discretization is performed by equal frequency binning. In our experiment, we discretized the attributes of human factors, as we mentioned previously in table 4.3
- 5- **Nominal to Binominal:** This operator maps the values of all nominal values to binary attributes.
- 6- **FP-Growth:** This operator calculates all frequent items sets from a data set by building a FPTree data structure on the transaction database. This is a very compressed copy of the data, which in many cases fits into main memory even for large databases. From this FPTree all frequent item set are derived. A major advantage of FP-Growth compared to Apriori is that it uses only two data scans and is therefore often applicable even on large data sets (Divya, 2012).
- 7- **Create Association Rules:** This operator generates association rules from frequent item sets. In RapidMiner, the process of frequent item set mining is divided into two parts: first, the generation of frequent item sets and second, the generation of association rules from these sets. For the generation of frequent item sets, we used the operator FP-Growth. The result will be a set of frequent item sets, which could be used as input for this operator (Houtsma & Swami, 1995).

5.4 System criteria results

5.4.1 System Presentation results

In this survey, this criterion occupies the best position among the others (458 points). The points are illustrated in figure 5.4:

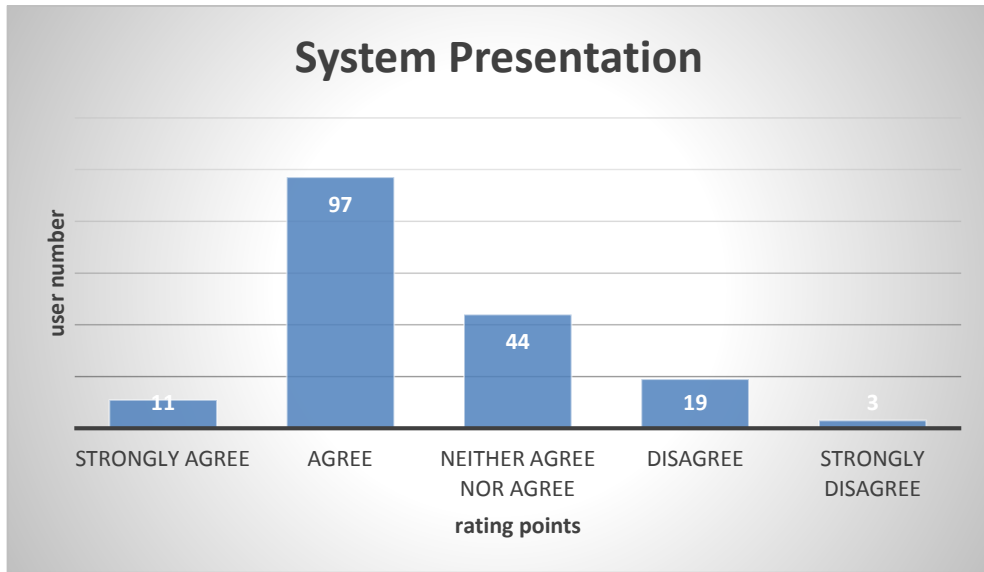


Figure (5.4): System presentation points.

Generally, from this survey, we can found that most users sees that system presentation is good; others see that it is neither good nor bad.

Using data mining techniques, the results are presented in the following rules:

Rule (1)	<p>Presentation = Agree</p> <p>Have you ever took training on SAP ERP? = Yes, Knowledge of the English Language = Very Good (80% and above)</p> <p>(Confidence: 0.45)</p>
Description	<p>IF</p> <p>The answer to question Have you ever took training on SAP ERP? = Yes</p> <p>And the answer of Knowledge of the English Language = Very Good (80% and above)</p> <p>THEN</p> <p>The Employee's acceptance for Presentation = Agree</p>

Rule (2)	<p>Presentation = Agree</p> <p>Work Area = Gaza Governorate, Does SAP ERP replaced the old software on your P.C., or you are still using that software besides SAP ERP? = Yes, Education = Bachelor Degree</p> <p>(Confidence: 0.42)</p>
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Description	<p>IF</p> <p>The answer of Work Area = Gaza Governorate</p> <p>And the answer of question Does SAP ERP replaced the old software on your P.C., or you are still using that software besides SAP ERP? = Yes</p> <p>And the answer of Education = Bachelor Degree</p> <p>THEN</p> <p>The Employee's acceptance for Presentation = Agree</p>
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Rule (3)	<p>Presentation = Agree</p> <p>Work Area = Gaza Governorate, SAP ERP Experience (Per Months) = 13 and above, Years of Experience with UNRWA (Per Years) = 15 and Above</p> <p><i>(Confidence: 0.27)</i></p>
Description	<p>IF</p> <p>The answer of Work Area = Gaza Governorate</p> <p>And the answer to question SAP ERP Experience (Per Months) = 13 and above</p> <p>And the answer of Years of Experience with UNRWA (Per Years) = 15 and Above</p> <p>THEN</p> <p>The Employee's acceptance for Presentation = Agree</p>

Rule (4)	<p>Presentation = Agree</p> <p>Work Area = Gaza Governorate, Knowledge of the English Language = Very Good (80% and above), Computer Skills = Medium</p> <p><i>(Confidence: 0.28)</i></p>
Description	<p>IF</p> <p>The answer of Work Area = Gaza Governorate</p> <p>And the answer of Knowledge of the English Language = Very Good (80% and above)</p> <p>And the answer of Computer Skills = Medium</p> <p>THEN</p> <p>The Employee's acceptance for Presentation = Agree</p>

Rule (5)	<p>Presentation = Agree</p> <p>Education = Bachelor Degree, Grade in UNRWA = 8-12, SAP ERP Experience (Per Months) = 13 and above</p> <p><i>(Confidence: 0.25)</i></p>
Description	<p>IF</p> <p>The answer of Education = Bachelor Degree</p> <p>And the answer of Grade in UNRWA = 8-12</p> <p>And the answer of SAP ERP Experience (Per Months) = 13 and above</p> <p>THEN</p> <p>The Employee's acceptance for Presentation = Agree</p>

Rule (6)	<p>Presentation = Disagree</p> <p>Work Area = Gaza Governorate, Have you ever took training on SAP ERP? = Yes</p> <p><i>(Confidence: 0.6)</i></p>
Description	<p>IF</p> <p>The answer of Work Area = Gaza Governorate</p> <p>And the answer to question Have you ever took training on SAP ERP? = Yes</p> <p>THEN</p> <p>The Employee's acceptance for Presentation = Disagree</p>

So, the results of the collected data can be concluded as follows:

- **Agree**
The staff that see presentation is good mostly from Gaza, they don't use old software, take training on SAP, had at least BSc, their computer skills are medium, their experience with UNRWA more than 15 years, their SAP ERP experience more than 13 months, their grade between 8-12, and have a very good English language.
- **Disagree**
The staff that sees presentation is not good mostly from Gaza, and take training on SAP.

5.4.2 System Learnability results

The total points of this category is 442 are shown in the figure 5.5:

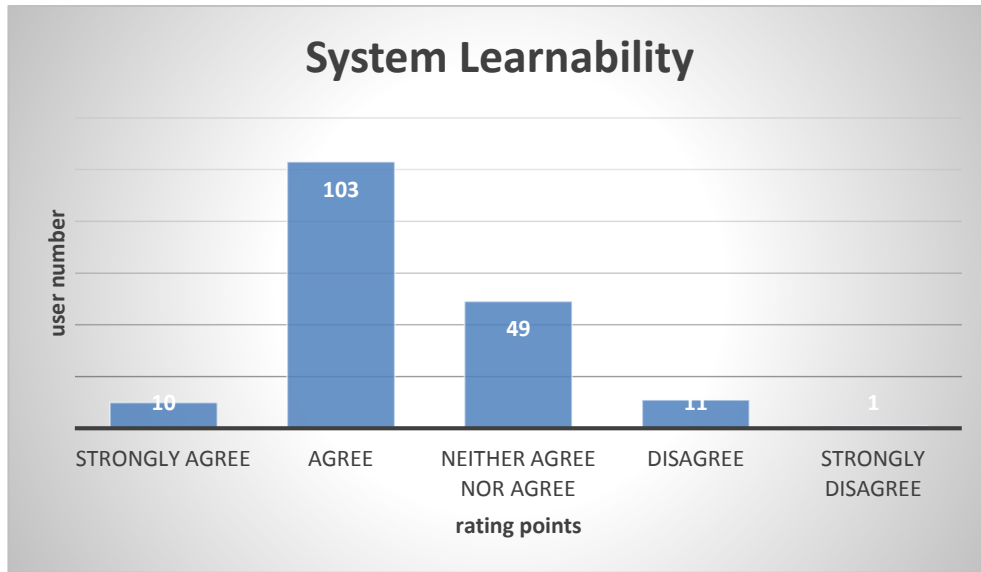


Figure (5.5): System learnability points.

Also, from system learnability, many users see that system learnability is good, others mostly sees that it is neither good or bad.

Using data mining techniques, the results are presented in the following rules:

Rule (1)	<p>Learnability = Agree</p> <p>Have you ever took training on SAP ERP? = Yes, Does SAP ERP replaced the old software on your P.C., or you are still using that software beside SAP ERP? = Yes (Confidence: 0.76)</p>
Description	<p>IF</p> <p>The answer to question Have you ever took training on SAP ERP? = Yes And the answer to question Does SAP ERP replaced the old software on your P.C., or you are still using that software beside SAP ERP? = Yes</p> <p>THEN</p> <p>The Employee's acceptance for Learnability = Agree</p>

Rule (2)	<p>Learnability = Agree</p> <p>Work Area = Gaza Governorate, SAP ERP Experience (Per Months) = 13 and above, Years of Experience with UNRWA (Per Years) = 15 and Above (Confidence: 0.25)</p>
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Description	<p>IF</p> <p>The answer of Work Area = Gaza Governorate</p> <p>And the answer of SAP ERP Experience (Per Months) = 13 and above</p> <p>And the answer of Years of Experience with UNRWA (Per Years) = 15 and Above</p> <p>THEN</p> <p>The Employee's acceptance for Learnability = Agree</p>
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Rule (3)	<p>Learnability = Agree</p> <p>Education = Bachelor Degree, Grade in UNRWA = 8-12, SAP ERP Experience (Per Months) = 13 and above</p> <p><i>(Confidence: 0.27)</i></p>
Description	<p>IF</p> <p>Answer of Education = Bachelor Degree</p> <p>And answer of Grade in UNRWA = 8-12</p> <p>And answer of SAP ERP Experience (Per Months) = 13 and above</p> <p>THEN</p> <p>The Employee's acceptance for Learnability = Agree</p>

Rule (4)	<p>Learnability = Agree</p> <p>Computer Skills = Advanced, Knowledge of the English Language = Very Good (80% and above)</p> <p><i>(Confidence: 0.3)</i></p>
Description	<p>IF</p> <p>The answer of Computer Skills = Advanced</p> <p>And the answer of Knowledge of the English Language = Very Good (80% and above)</p> <p>THEN</p> <p>The Employee's acceptance for Learnability = Agree</p>

Rule (5)	<p>Learnability = Agree</p> <p>Grade in UNRWA = 8-12, Computer Skills = Advanced, SAP ERP Experience (Per Months) = 13 and above</p> <p>(Confidence: 0.27)</p>
Description	<p>IF</p> <p>Answer of Grade in UNRWA = 8-12</p> <p>And answer of Computer Skills = Advanced</p> <p>And answer of SAP ERP Experience (Per Months) = 13 and above</p> <p>THEN</p> <p>The Employee's acceptance for Learnability = Agree</p>

So, the results of the collected data can be concluded as follows:

- **Agree**

The staff that see system learnability is good mostly from Gaza, take training on SAP, they don't use old software, had at least BSc, their computer skills are advanced, have a very good English language, their SAP ERP experience more than 13 months, their experience with UNRWA more than 15 years, and their grade between 8-12.

5.4.3 System Navigation results

The total points of this category is 433 are shown in the figure 5.6:

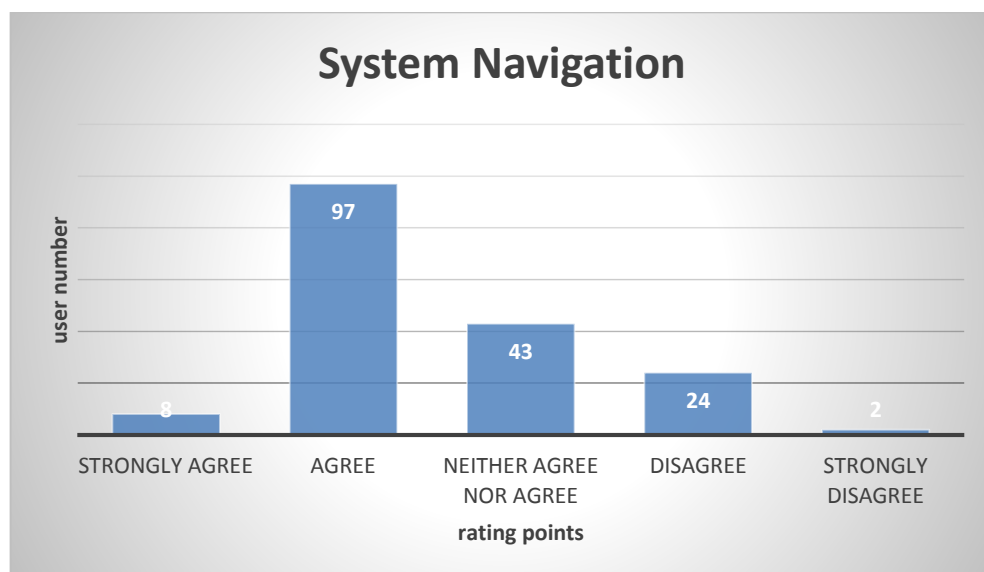


Figure (5.6): System navigation points.

Many users agree that system navigation is acceptable, other neither agree on nor disagree.

Using data mining techniques, the results are presented in the following rules:

Rule (1)	<p>Navigation = Agree</p> <p>Work Area = Gaza Governorate, Have you ever took training on SAP ERP? = Yes, Grade in UNRWA = 8-12</p> <p><i>(Confidence: 0.51)</i></p>
Description	<p>IF</p> <p>The answer of work area =Gaza Governorates</p> <p>And the answer to question Have you ever took training on SAP ERP? = Yes</p> <p>And the answer of Grade in UNRWA = 8-12</p> <p>THEN</p> <p>The Employee's acceptance for Navigation = Agree</p>

Rule (2)	<p>Navigation = Agree</p> <p>Education = Bachelor Degree, Computer Skills = Advanced</p> <p><i>(Confidence: 0.37)</i></p>
Description	<p>IF</p> <p>Answer of Education = Bachelor Degree</p> <p>And answer of Computer Skills = Advanced</p> <p>THEN</p> <p>The Employee's acceptance for Navigation = Agree</p>

Rule (3)	<p>Navigation = Agree</p> <p>Work Area = Gaza Governorate, Have you ever took training on SAP ERP? = Yes, Does SAP ERP replaced the old software on your P.C., or you are still using that software beside SAP ERP? = Yes, Years of Experience with UNRWA (Per Years) = 15 and Above</p> <p><i>(Confidence: 0.32)</i></p>
Description	<p>IF</p> <p>The answer of work area = Gaza Governorates</p>

	<p>And the answer to question Have you ever took training on SAP ERP? = Yes</p> <p>And the answer to question Does SAP ERP replaced the old software on your P.C., or you are still using that software beside SAP ERP? = Yes</p> <p>And the answer of Years of Experience with UNRWA (Per Years) = 15 and Above</p> <p>THEN</p> <p>The Employee's acceptance for Navigation = Agree</p>
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Rule (4)	<p>Navigation = Agree</p> <p>Have you ever took training on SAP ERP? = Yes, SAP ERP Experience (Per Months) = 13 and above</p> <p><i>(Confidence: 0.33)</i></p>
Description	<p>IF</p> <p>The answer to question Have you ever took training on SAP ERP? = Yes</p> <p>And the answer of SAP ERP Experience (Per Months) = 13 and above</p> <p>THEN</p> <p>The Employee's acceptance for Navigation = Agree</p>

Rule (5)	<p>Navigation = Disagree</p> <p>Work Area = Gaza Governorate, Have you ever took training on SAP ERP? = Yes, Knowledge of the English Language = Very Good (80% and above)</p> <p><i>(Confidence: 0.54)</i></p>
Description	<p>IF</p> <p>The answer of Work Area = Gaza Governorate</p> <p>And the answer to question Have you ever took training on SAP ERP? = Yes</p> <p>And the answer of Knowledge of the English Language = Very Good (80% and above)</p> <p>THEN</p> <p>The Employee's acceptance for Navigation = Disagree</p>

Rule (6)	<p>Navigation = Disagree</p> <p>Does SAP ERP replaced the old software on your P.C., or you are still using that software beside SAP ERP? = Yes, Computer Skills = Advanced</p> <p><i>(Confidence: 0.54)</i></p>
Description	<p>IF</p> <p>The answer to question Does SAP ERP replaced the old software on your P.C., or you are still using that software beside SAP ERP? = Yes</p> <p>And the answer of Computer Skills = Advanced</p> <p>THEN</p> <p>The Employee's acceptance for Navigation = Disagree</p>

So, the results of the collected data can be concluded as follows:

- **Agree**
The staff that see navigation is good mostly from Gaza, they don't use old software, take training on SAP, had at least BSc, their computer skills are advanced, their experience with UNRWA more than 15 years, their SAP ERP experience more than 13 months, and their grade between 8-12.
- **Disagree**
The staff that sees navigation is not good mostly from Gaza, they don't use old software, take training on SAP, their computer skills are advanced, and have a very good English language.

5.4.4 System Customization results

The total points of this category is 423 are shown in figure 5.7:

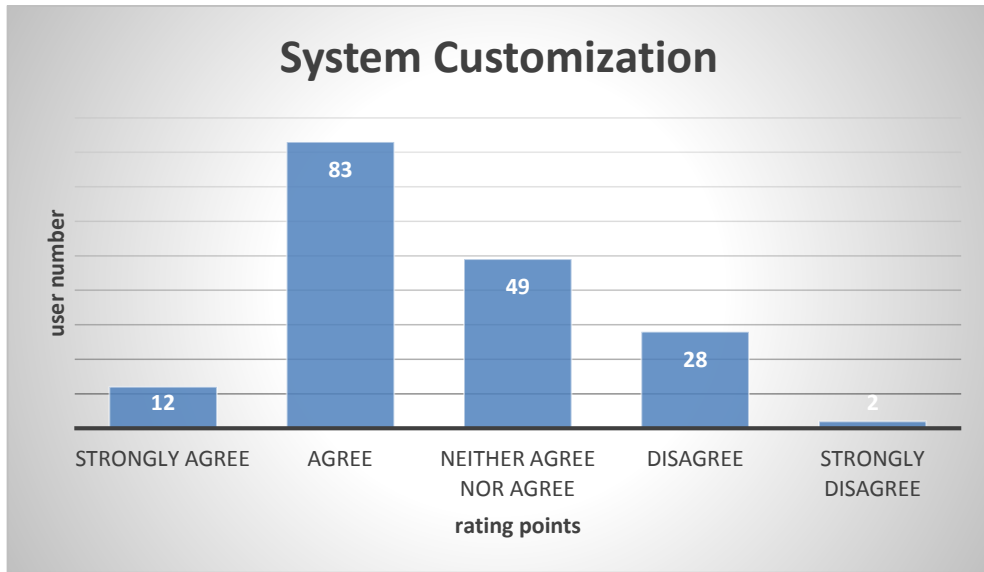


Figure (5.7): System customization points.

From figure 5.4, we can conclude that about 20% of people see the system has acceptable system customization, about 10% see it is neither good nor bad, and about 7% see it is bad which the largest number of staff disagree among all systems factors.

Using data mining techniques, the results are presented in the following rules:

Rule (1)	<p>Customization = Agree</p> <p>Computer Skills = Advanced, SAP ERP Experience (Per Months) = 13 and above (Confidence: 0.3)</p>
Description	<p>IF</p> <p>The answer of Computer Skills = Advanced</p> <p>And the answer of SAP ERP Experience (Per Months) = 13 and above</p> <p>THEN</p> <p>The Employee's acceptance for Customization = Agree</p>

Rule (2)	<p>Customization = Agree</p> <p>Does SAP ERP replaced the old software on your P.C., or you are still using that software beside SAP ERP? = Yes, Education = Bachelor Degree, Grade in UNRWA = 8-12 (Confidence: 0.4)</p>
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Description	<p>IF</p> <p>The answer to question Does SAP ERP replaced the old software on your P.C., or you are still using that software beside SAP ERP? = Yes</p> <p>And the answer of Education = Bachelor Degree</p> <p>And the answer of Grade in UNRWA = 8-12</p> <p>THEN</p> <p>The Employee's acceptance for Customization = Agree</p>
--------------------	--

Rule (3)	<p>Customization = Agree</p> <p>Education = Bachelor Degree, Computer Skills = Advanced, Knowledge of the English Language = Very Good (80% and above)</p> <p><i>(Confidence: 0.28)</i></p>
Description	<p>IF</p> <p>The answer of Education = Bachelor Degree</p> <p>And the answer of Computer Skills = Advanced</p> <p>And the answer of Knowledge of the English Language = Very Good (80% and above)</p> <p>THEN</p> <p>The Employee's acceptance for Customization = Agree</p>

Rule (4)	<p>Customization = Agree</p> <p>Have you ever took training on SAP ERP? = Yes, Computer Skills = Medium</p> <p><i>(Confidence: 0.4)</i></p>
Description	<p>IF</p> <p>The answer to question of Have you ever took training on SAP ERP? = Yes</p> <p>And the answer of Computer Skills = Medium</p> <p>THEN</p> <p>The Employee's acceptance for Customization = Agree</p>

Rule (5)	<p>Customization = Agree</p> <p>Knowledge of the English Language = Very Good (80% and above), Years of Experience with UNRWA (Per Years) = 15 and Above</p> <p><i>(Confidence: 0.22)</i></p>
Description	<p>IF</p> <p>The answer to question of Have you ever took training on SAP ERP? = Yes</p> <p>And the answer of Computer Skills = Medium</p> <p>THEN</p> <p>The Employee's acceptance for Customization = Agree</p>

Rule (6)	<p>Customization = Disagree</p> <p>Grade in UNRWA = 8-12, Years of Experience with UNRWA (Per Years)= 15 and Above, Computer Skills= Medium</p> <p><i>(Confidence: 0.45)</i></p>
Description	<p>IF</p> <p>The answer of Grade in UNRWA = 8-12</p> <p>And the answer of Years of Experience with UNRWA (Per Years)= 15 and Above</p> <p>And the answer of Computer Skills = Medium</p> <p>THEN</p> <p>The Employee's acceptance for Customization = Disagree</p>

Rule (7)	<p>Customization = Disagree</p> <p>Knowledge of the English Language = Very Good (80% and above), Computer Skills = Medium, Have you ever took training on SAP ERP? = Yes, Education = Bachelor Degree</p> <p><i>(Confidence: 0.5)</i></p>
Description	<p>IF</p> <p>The answer of Knowledge of the English Language= Very Good (80% and above)</p> <p>And the answer of Computer Skills = Medium</p>

	<p>And the answer to question of Have you ever took training on SAP ERP? = Yes</p> <p>And the answer of Education = Bachelor Degree</p> <p>THEN</p> <p>The Employee's acceptance for Customization = Disagree</p>
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So, the results of the collected data can be concluded as follows:

- **Agree**

The staff that sees system customization is good mostly take training on SAP, they don't use old software, had at least BSc, have a very good English language, their computer skills are advanced, their SAP ERP experience more than 13 months, and their grade between 8-12.

- **Disagree**

The staff that sees system customization is not good mostly take training on SAP, had at least BSc, their computer skills are medium, their experience with UNRWA more than 15 years, and their grade between 8-12.

5.4.5 System Support results

The total points of this category is 414 are shown in figure 5.8:

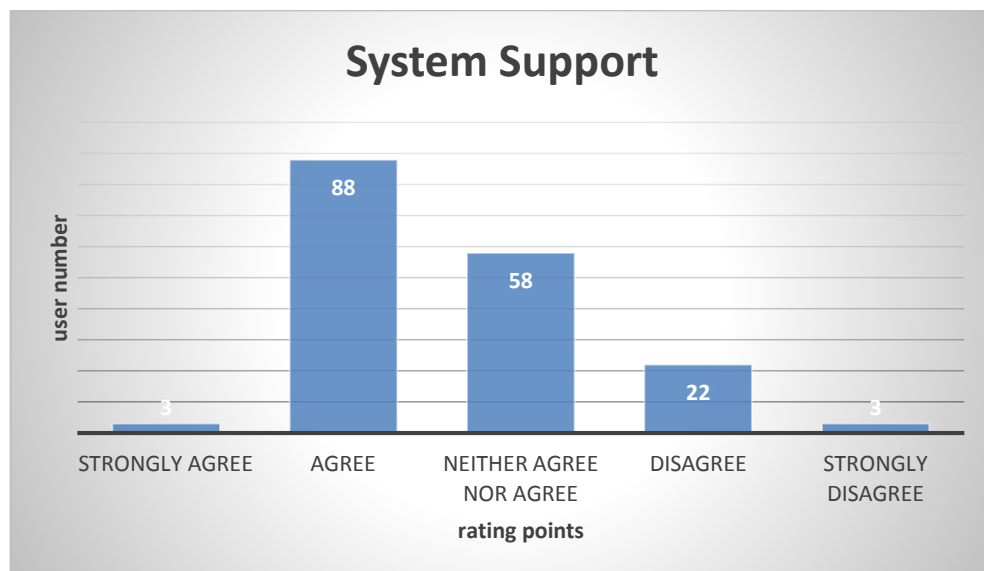


Figure (5.8): System support points.

Many users agree that system support is acceptable, other neither agree on nor disagree.

Using data mining techniques, the results are presented in the following rules:

Rule (1)	<p>Support = Agree</p> <p>Work Area = Gaza Governorate, Have you ever took training on SAP ERP? = Yes, Grade in UNRWA = 8-12</p> <p><i>(Confidence: 0.55)</i></p>
Description	<p>IF</p> <p>The answer of Work Area = Gaza Governorate</p> <p>And the answer to question Have you ever took training on SAP ERP? = Yes</p> <p>And the answer of Grade in UNRWA = 8-12</p> <p>THEN</p> <p>The Employee's acceptance for Support = Agree</p>

Rule (2)	<p>Support = Agree</p> <p>Work Area = Gaza Governorate, SAP ERP Experience (Per Months) = 13 and above, Years of Experience with UNRWA (Per Years) = 15 and Above</p> <p><i>(Confidence: 0.25)</i></p>
Description	<p>IF</p> <p>The answer of Work Area = Gaza Governorate</p> <p>And the answer to question SAP ERP Experience (Per Months) = 13 and above</p> <p>And the answer of Years of Experience with UNRWA (Per Years) = 15 and Above</p> <p>THEN</p> <p>The Employee's acceptance for Support = Agree</p>

Rule (3)	<p>Support = Agree</p> <p>Education = Bachelor Degree, Knowledge of the English Language = Very Good (80% and above)</p> <p><i>(Confidence: 0.25)</i></p>
Description	<p>IF</p> <p>The answer of Education = Bachelor Degree</p> <p>And the answer of Knowledge of the English Language = Very Good (80% and above)</p>

	<p>THEN</p> <p>The Employee's acceptance for Support = Agree</p>
--	--

Rule (4)	<p>Support = Agree</p> <p>Does SAP ERP replaced the old software on your P.C., or you are still using that software beside SAP ERP? = Yes, SAP ERP Experience (Per Months) = 13 and above</p> <p><i>(Confidence: 0.34)</i></p>
Description	<p>IF</p> <p>The answer to question Does SAP ERP replaced the old software on your P.C., or you are still using that software beside SAP ERP? = Yes</p> <p>And the answer of SAP ERP Experience (Per Months) = 13 and above</p> <p>THEN</p> <p>The Employee's acceptance for Support = Agree</p>

Rule (5)	<p>Support = Agree</p> <p>Computer Skills = Advanced, Age = 30 - Less than 35</p> <p><i>(Confidence: 0.27)</i></p>
Description	<p>IF</p> <p>The answer of Computer Skills = Advanced</p> <p>And the answer of Age = 30 - Less than 35</p> <p>THEN</p> <p>The Employee's acceptance for Support = Agree</p>

Rule (6)	<p>Support = Disagree</p> <p>Education = Bachelor Degree, Computer Skills = Medium, Years of Experience with UNRWA (Per Years) = 15 and Above</p> <p><i>(Confidence: 0.54)</i></p>
Description	<p>IF</p> <p>The answer of Education = Bachelor Degree</p> <p>And the answer of Computer Skills = Medium</p>

	<p>And the answer of Years of Experience with UNRWA (Per Years) = 15 and Above</p> <p>THEN</p> <p>The Employee's acceptance for Support = Disagree</p>
--	---

So, the results of the collected data can be concluded as follows:

- **Agree**
 The staff that see system support is good mostly from Gaza, take training on SAP, had at least BSc, their computer skills are advanced, their experience with UNRWA more than 15 years, their SAP ERP experience more than 13 months, their grade between 8-12, have a very good English language, and their age between 30 – 35 years.
- **Disagree**
 The staff that sees system support is not good had at least BSc, their computer skills are medium, and their experience with UNRWA more than 15 years.

5.5 Summary of system criteria results

The following table summarizes all the five criteria rules:

Table (5.3): The five system criteria rules.

Human Factors	System Criteria	Navigation		Presentation		Support		Learnability		Customization	
		Agree	Disagree	Agree	Disagree	Agree	Disagree	Agree	Disagree	Agree	Disagree
Residence Area	Gaza	√	√	√	√	√		√			
	Middle										
	North										
	South										
Education	Diploma										
	Bachelor	√		√		√	√	√		√	√
	Master										
Grade in UNRWA	3-7										
	8-12	√		√		√		√		√	√
	13-15										
	16 and Above										
Work Area	Gaza	√		√	√	√		√			
	Middle										
	North										
	South										
Years of Experience with UNRWA (Per Years)	1 - Less than 5										
	5 - Less than 10										
	10 - Less than 15										
	15 and Above	√		√		√	√	√			√
SAP ERP Experience (Per Months)	1- Less than 3										
	3 - Less than 6										
	6 - Less than 9										
	9 - Less than 13										
	13 and above	√		√		√		√		√	
Computer Skills	Beginner										
	Medium			√			√				√
	Advanced	√	√			√		√		√	
Knowledge of the English Language	Good										
	Medium										
	Very Good		√	√		√		√		√	
Have you ever took training on SAP ERP?	Yes	√	√	√	√	√		√		√	√
	No										
Does SAP ERP replaced the old software on your P.C., or you are still using that software beside SAP ERP?	Yes	√	√	√				√		√	
	No										

From table 5.3 we can concluded that:

1. The residual area mostly does not affect the system criteria because most of staff from Gaza.
2. The employees with BSc education mostly like the system.
3. Staff grade from 8-12 motley like the system.
4. The working area mostly does not affect the system criteria because of staff working in the Gaza office.
5. The most experience staff like the system.
6. Staff who has advance computer skills like the system; on the other hand, staff of medium computer skills does not like the system.
7. The staff of good knowledge of English likes the system more.
8. Staff who has training like and dislike the system almost equally.
9. Mostly people who replace the SAP system like the system.

5.6 Experimental for using the tools for the (Tasks scenario)

In the research, we conducted seven different Tasks scenario that are used to collect the data set from employee by using (Morae Recorder tool and Morae Manager tool). The employee must conduct theis scenario on the UNRWA SAP ERP (REACH), that he evaluate his SAP ERP, the Tasks scenario are predefined in Chapter 4.

In the Tasks scenario experiments, we selected some important attributes to evaluate the behavior of employees, which cannot be measured through the questionnaire such as:

5.6.1 The number of mouse clicks

Table 5.4 describes the number of mouse clicks of the tasks scenario, we summarized the ranged into three ranges:

Table (5.4): The number of mouse clicks.

Task 1						Task 2						Task 3					
Range 1		Range 2		Range 3		Range 1		Range 2		Range 3		Range 1		Range 2		Range 3	
From	To	From	To	From	To	From	To	From	To	From	To	From	To	From	To	From	To
3	6	7		8	13	3	8	9	13	20	55	14	32	33	52	94	442
No. Of Users						No. Of Users						No. Of Users					
4		5		2		4		4		3		4		4		3	

Task 4						Task 5						Task 6					
Range 1		Range 2		Range 3		Range 1		Range 2		Range 3		Range 1		Range 2		Range 3	
From	To	From	To	From	To	From	To	From	To	From	To	From	To	From	To	From	To
3	5	6	18	27	40	1	4	6	14	16	68	0	5	7	11	44	127
No. Of Users						No. Of Users						No. Of Users					
4		5		2		4		4		3		4		4		3	

Task 7					
Range 1		Range 2		Range 3	
From	To	From	To	From	To
2	3	4	5	7	9
No. Of Users					
4		4		3	

Considering range 1 is slow, range 2 is average and range 3 is fast. From the table we can conclude that most users are either slow or average, fast is least one.

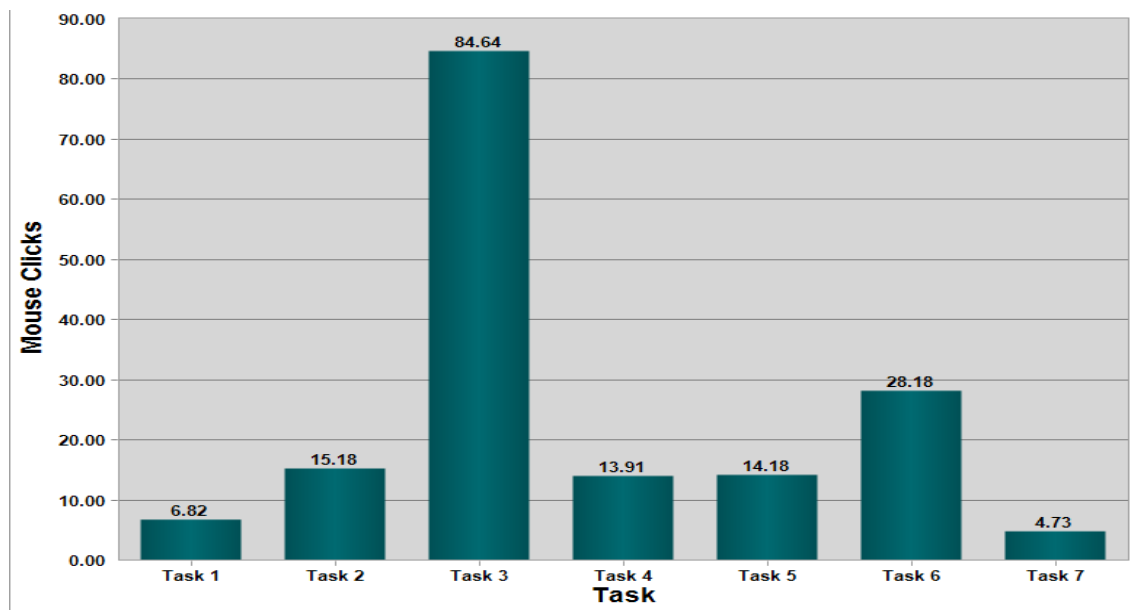


Figure (5.9): Average number of mouse clicks.

From figure 5.9, we can conclude that task three which is the most difficult task and task 7 is the easiest.

5.6.2 The number of Keystrokes

Table 5.5 describes the number of Keystrokes of the tasks scenario, we summarized the ranged into three ranges:

Table (5.5): The number of keystrokes.

Task 1						Task 2						Task 3					
Range 1		Range 2		Range 3		Range 1		Range 2		Range 3		Range 1		Range 2		Range 3	
From	To	From	To	From	To	From	To	From	To	From	To	From	To	From	To	From	To
19	20	21	38	50	63	2	11	24	28	31	43	38	62	66	82	99	221
No. Of Users						No. Of Users						No. Of Users					
4		4		3		4		4		3		4		4		3	

Task 4						Task 5						Task 6					
Range 1		Range 2		Range 3		Range 1		Range 2		Range 3		Range 1		Range 2		Range 3	
From	To	From	To	From	To	From	To	From	To	From	To	From	To	From	To	From	To
0	3	8	27	30	36	0	1	6	12	19	0	7	11	17	44		
No. Of Users						No. Of Users						No. Of Users					
4		4		3		5		4		2		4		4		3	

Task 7			
Range 1		Range 2	
From	To	From	To
0	1	1	3
No. Of Users			
9		2	

From the table we see that some users used fewer keystrokes, some other with average and other are the most number of strokes with almost the same frequency.

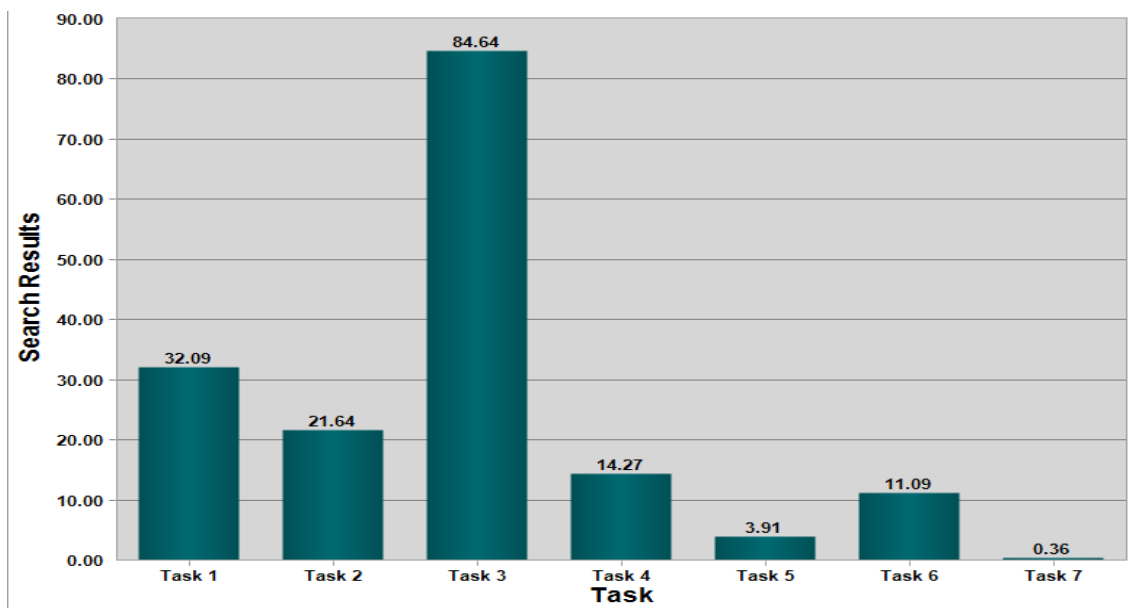


Figure (5.10): Average number of keystrokes.

It is clear that task three the most used keystrokes and task 7 is the less used.

5.6.3 Task time

The time of the tasks scenario by seconds, we summarized the ranged into three ranges:

Table (5.6): The task time.

Task 1						Task 2						Task 3					
Range 1		Range 2		Range 3		Range 1		Range 2		Range 3		Range 1		Range 2		Range 3	
From	To	From	To	From	To	From	To	From	To	From	To	From	To	From	To	From	To
17	43	52	58	98	124	29	48	55	70	82	247	100	153	166	251	306	592
No. Of Users						No. Of Users						No. Of Users					
4		4		3		4		4		3		4		4		3	

Task 4						Task 5						Task 6					
Range 1		Range 2		Range 3		Range 1		Range 2		Range 3		Range 1		Range 2		Range 3	
From	To	From	To	From	To	From	To	From	To	From	To	From	To	From	To	From	To
29	45	55	69	90	152	12	30	38	52	72	116	10	33	49	84	111	159
No. Of Users						No. Of Users						No. Of Users					
4		4		3		5		4		2		5		3		3	

Task 7					
Range 1		Range 2		Range 3	
From	To	From	To	From	To
9	12	13	27	34	39
No. Of Users					
5		4		2	

Staff users distrusted almost equally between fast, average and slow, except for task 6 and 7 the largest number are fast and least are slow.

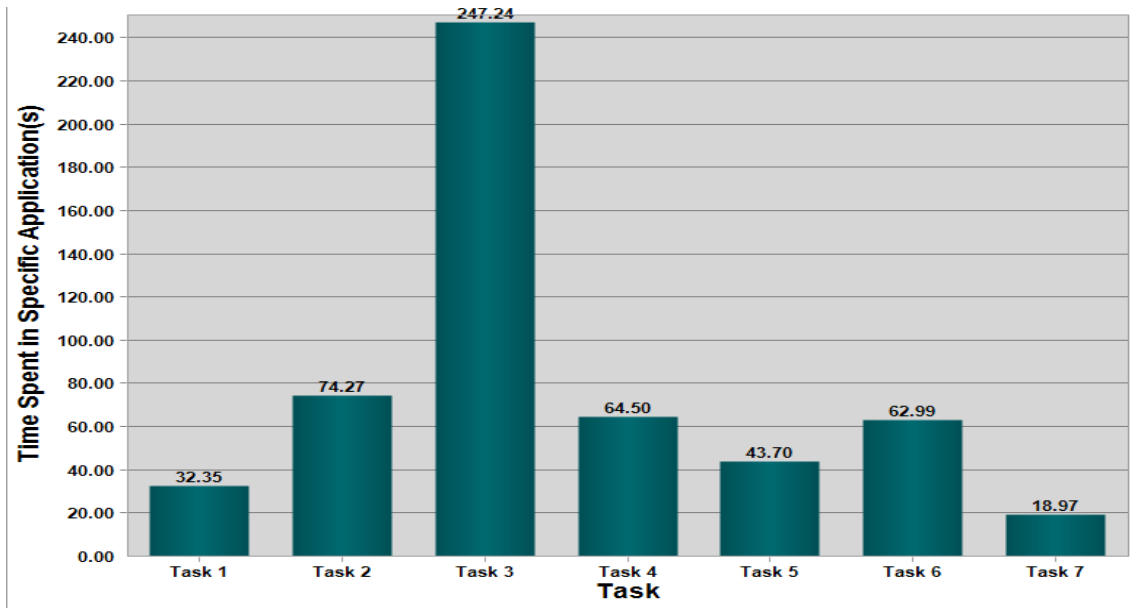


Figure (5.11): Average number of task time.

Also, it is clear that task 3 takes too long time, task 2, 4, 5, and 6 take a considerable amount of time.

5.6.4 Total time tasks/sec

The total time of seven tasks scenario for each employee, we summarized the ranged into three ranges:

Table (5.7): The total tasks' time.

4.Total tasks					
Range 1		Range 2		Range 3	
From	To	From	To	From	To
300	475	520	725	769	905
No. Of Users					
4		4		3	

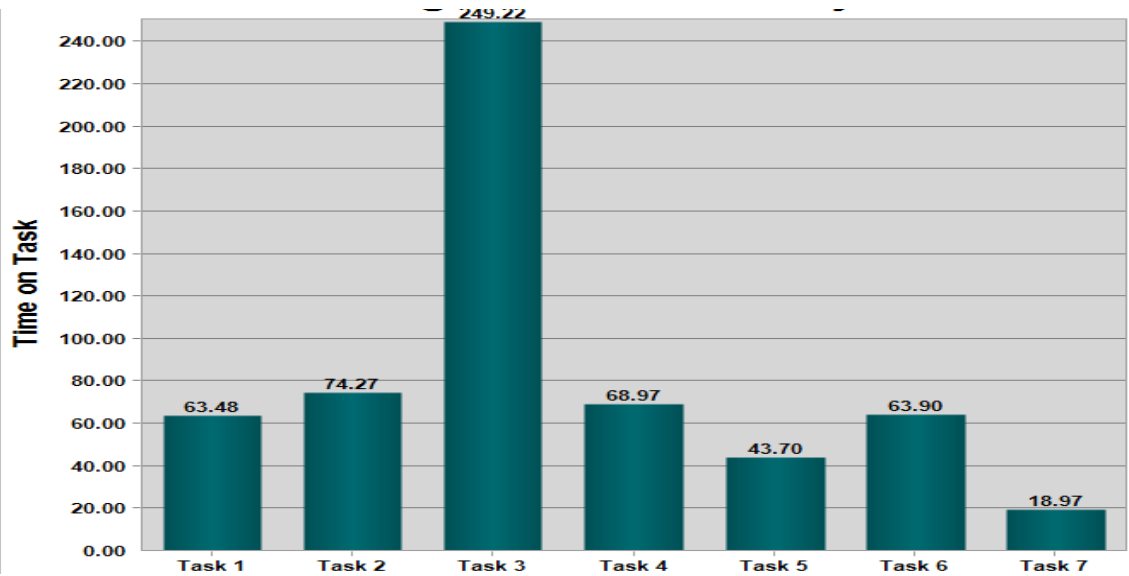


Figure (5.12): Average total tasks' time.

5.6.5 The number of window dialog open

The number of window dialog open of the tasks scenario, we summarized the ranged into three ranges:

Table (5.8): The number of window dialog open.

Task 1						Task 2						Task 3					
Range 1		Range 2		Range 3		Range 1		Range 2		Range 3		Range 1		Range 2		Range 3	
From	To	From	To	From	To	From	To	From	To	From	To	From	To	From	To	From	To
6	9	11	12	14	17	0	4	5	7	10	17	10	16	24	52	62	164
No. Of Users						No. Of Users						No. Of Users					
3		4		4		4		4		3		4		4		3	

Task 4						Task 5						Task 6					
Range 1		Range 2		Range 3		Range 1		Range 2		Range 3		Range 1		Range 2		Range 3	
From	To	From	To	From	To	From	To	From	To	From	To	From	To	From	To	From	To
2	3	4	17	18	60	1	4	6	13	14	23	0	3	6	7	14	63
No. Of Users						No. Of Users						No. Of Users					
4		4		3		5		4		2		4		4		3	

Task 7					
Range 1		Range 2		Range 3	
From	To	From	To	From	To
1	1	2	10	16	21
No. Of Users					
5		4		2	

Also, Staff users who open windows dialogue distrusted almost equally between small, average and large, except for task 6 and 7 the largest number are small and least are large.

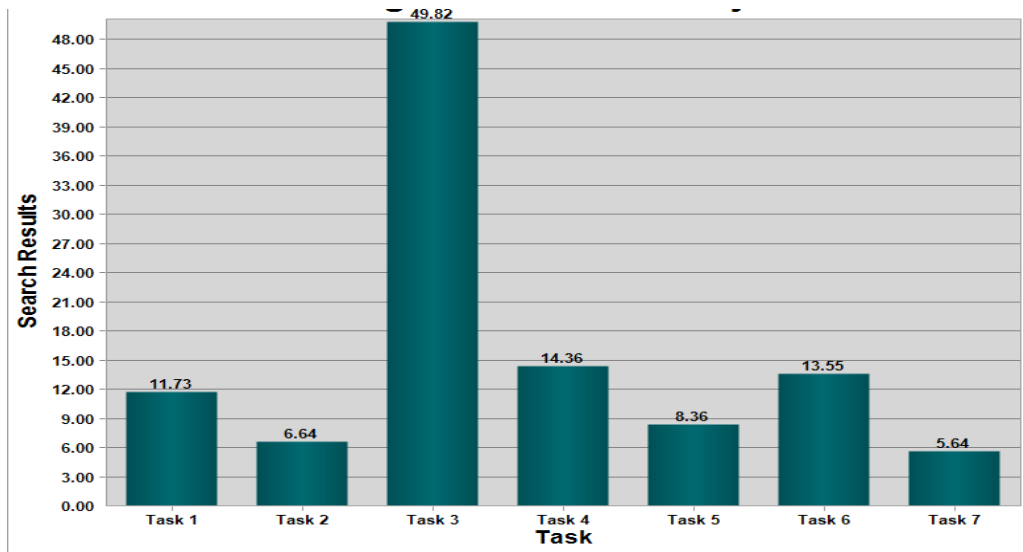


Figure (5.13): Average number of window dialogues open.

5.6.6 Error Rate

The number of error of the tasks scenario, we summarized the ranged into three ranges:

Table (5.9): The number of error rate.

Task 1		Task 2				Task 3					
Range 1		Range 2		Range 1		Range 1		Range 2		Range 3	
From	To	From	To	From	To	From	To	From	To	From	To
0		2		0		0	4	5	6	8	10
No. Of Users		No. Of Users				No. Of Users					
10		1		11		5		3		3	

Task 4			Task 5				Task 6				
Range 1		Range 2		Range 3		Range 1		Range 1			
From	To	From	To	From	To	From	To	From	To	From	To
0		2		4		0		0			
No. Of Users			No. Of Users				No. Of Users				
9			1		1		11				

Task 7	
Range 1	
From	To
0	
No. Of Users	
0	

Most of the staff users do not have any error.

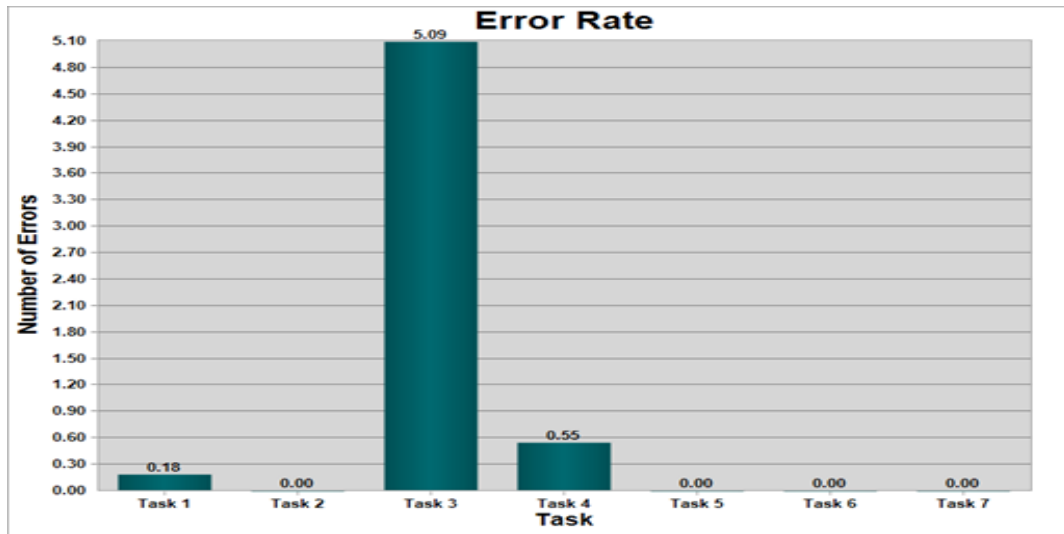


Figure (5.14): Average number of error rate.

It is clear that errors are very small amount. However, task 3 has the most error rate, but task 4 has bigger error rate compare it to size.

5.6.7 Tasks Scores

To ensure the task in complete easily (0), complete difficult (1), or incomplete (2), we summarized the ranged into three ranges:

Table (5.10): The tasks scores.

Range	Scores	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7
Range 1	0	10	10	6	9	8	9	11
Range 2	1	1	1	4	1	3	2	0
Range 3	2	0	0	1	1	0	0	0

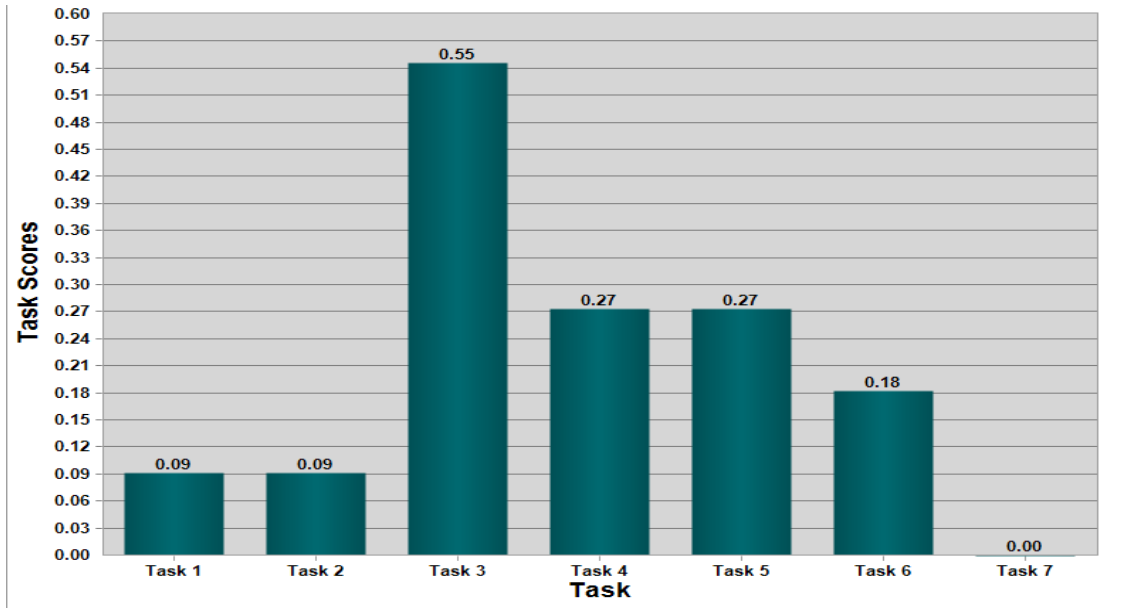


Figure (5.15): The tasks scores.

Most tasks completed easily, some mostly task 3 difficult, and only 1 does not complete task3 and 1 for task 4.

5.6.8 Tasks scenario experiment in SAP ERP Gaza

In this section, we present the results of tasks scenario experiment in UNRWA SAP ERP Gaza that is applying our approach based on data mining to evaluate the usability of UNRWA SAP ERP system.

5.6.8.1 Applying data mining method

In the tasks scenario experiment, we applied FP-Growth algorithm, this learner efficiently calculates all frequent item sets from the given data, after that we extract the useful rules by *Create Association Rules* that operator generated a set of association rules for a given set of frequent item sets (Dunham et al., 2001).

2. FP-Growth setting for experiment

As shown previously in figures 5.1 and 5.2, the best value of *min-support* of FP-Growth algorithm is 0.2, and the best value of *min-confidence* of Create Association Rules is 0.2.

3. The process of FP-growth method

The figure 5.3 is the main process of the FP-growth method that we applied on the questionnaire experiment, this method is implemented via RapidMiner tools:

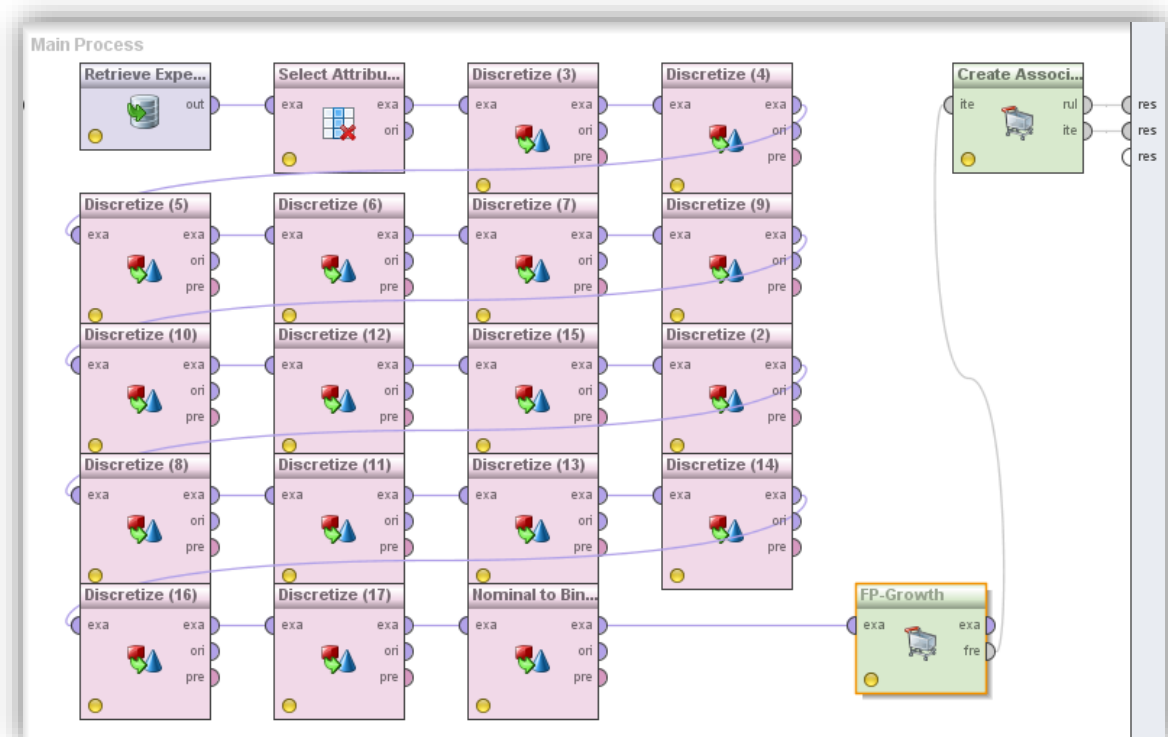


Figure (5.16): The main process of FP-growth method in RapidMiner tool for tasks scenario.

The previous figure 5.16 includes the following steps:

- 1- **Retrieve Experimental DB:** this step for choosing the data set input (Excel file) to the FP-growth method; it is the collected data from tasks scenario experiment, that's by using (Morae Recorder tool and Morae Manager tool).
- 2- **Select attribute:** this step for choosing specified tasks for each attribute of the tasks scenario.
- 3- **Discretize by Frequency:** This operator discretizes all numeric attributes in the dataset into nominal attributes. This discretization is performed by equal frequency binning. In our experiment, we discretized the attributes of tasks scenario, as we mentioned previously in table 4.3
- 4- **Nominal to Binominal:** This operator maps the values of all nominal values to binary attributes.
- 5- **FP-Growth:** This operator calculates all frequent items sets from a data set by building a FPTree data structure on the transaction database. This is a very compressed copy of the data, which in many cases fits into main memory even for large databases. From this

FPTree all frequent item set are derived. A major advantage of FP-Growth compared to Apriori is that it uses only two data scans and is therefore often applicable even on large data sets (Divya, 2012).

6- Create Association Rules: This operator generates association rules from frequent item sets. In RapidMiner, the process of frequent item set mining is divided into two parts: first, the generation of frequent item sets and second, the generation of association rules from these sets. For the generation of frequent item sets, we used the operator FP-Growth. The result will be a set of frequent item sets, which could be used as input for this operator (Houtsma & Swami, 1995).

5.6.8.2 Data mining analysis

The results of data mining methods are presented in the following rules:

Rule (1)	SAP ERP Experience (Per Months) = 13 and above , Grade in UNRWA = 8 - 12 , Education = Bachelor Degree] --> Total tasks (Total tasks time) = Range 2 (Confidence: 0.36)
Description (1)	<i>IF</i> The total time of all task's in Range 2 <i>Then</i> The employee's SAP ERP Experience (Per Months) = 13 and above, Grade in UNRWA = 8-12 and Education = Bachelor Degree.
Description (2)	The employees those have experience in SAP ERP 13 Month and above, there Grade between 8 - 12 and there education is Bachelor the time to finish all tasks will be in range 2.

Rule (2)	Education = Bachelor Degree , Knowledge of the English Language = Very Good (80% and above) --> Task 2 (Keystrokes) = Range 3 , Task 3 (Keystrokes) = Range 1 , Task 4 (Keystrokes) = Range 3 , Task 5 (Keystrokes) = Range 1 , Task 6 (Keystrokes) = Range 3 , Task 7 (Keystrokes) = Range 1 (Confidence: 0.27)
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Description (1)	<p><i>IF</i></p> <p>Task 2 (Keystrokes) = Range 3</p> <p>And Task 3 (Keystrokes) = Range 1</p> <p>And Task 4 (Keystrokes) = Range 3</p> <p>And Task 5 (Keystrokes) = Range 1</p> <p>And Task 6 (Keystrokes) = Range 3</p> <p>And Task 7 (Keystrokes) = Range 1</p> <p><i>Then</i></p> <p>The employee's Education = Bachelor Degree, Knowledge of the English Language = Very Good (80% and above).</p>
Description (2)	<p>The employees those education Bachelor degree and English language is very good the number of keystrokes to complete task 2 will be in range 3</p> <p>And the number of keystrokes to complete task 3 will be in range 1</p> <p>And the number of keystrokes to complete task 4 will be in range 3</p> <p>And the number of keystrokes to complete task 5 will be in range 1</p> <p>And the number of keystrokes to complete task 6 will be in range 3</p> <p>And the number of keystrokes to complete task 7 will be in range 1.</p>

Rule (3)	<p>Work Area = Gaza Governorate, Years of Experience with UNRWA (Per Years) = 1 - Less than 5 --></p> <p>Task 1 (Mouse Clicks) = Range 1, Task 2 (Mouse Clicks) = Range 1, Task 3 (Mouse Clicks) = Range 3, Task 4 (Mouse Clicks) = Range 2, Task 5 (Mouse Clicks) = Range 1, Task 6 (Mouse Clicks) = Range 1, Task 7 (Mouse Clicks) = Range 2</p> <p><i>(Confidence: 0.27)</i></p>
Description (1)	<p><i>IF</i></p> <p>Task 1 (Mouse Clicks) = Range 1</p> <p>And Task 2 (Mouse Clicks) = Range 1</p> <p>And Task 3 (Mouse Clicks) = Range 3</p> <p>And Task 4 (Mouse Clicks) = Range 2</p>

	<p>And Task 5 (Mouse Clicks) = Range 1</p> <p>And Task 6 (Mouse Clicks) = Range 1</p> <p>And Task 7 (Mouse Clicks) = Range 2</p> <p><i>Then</i></p> <p>The employee’s Work Area = Gaza Governorate, Years of Experience with UNRWA (Per Years) = 1 - Less than 5.</p>
Description (2)	<p>The employees those Work Area in Gaza and Years of Experience with UNRWA Less than 5 years the number of mouse clicks to complete task 1 will be in range 1, the number of mouse clicks to complete task 2 will be in range 1, the number of mouse clicks to complete task 3 will be in range 3, the number of mouse clicks to complete task 4 will be in range 2, the number of mouse clicks to complete task 5 will be in range 1, the number of mouse clicks to complete task 6 will be in range 1, the number of mouse clicks to complete task 7 will be in range 2.</p>

5.6.9 Summary of tasks scenario results

From the above task experiments in both statistics and data mining, we can conclude that:

1. In average staff take many mouse clicks, especially who has less work experience, to reach their goals.
2. However, most of the staff, especially who has good and better English language; take fewer number of keystrokes to reach their goal.
3. The users mostly take average time (not fast or slow) in their tasks especially the most experienced and graded staff.
4. Most staff almost does not any errors during conducting the tasks.
5. The asked tasks mostly completed by staff.

Chapter 6
Conclusion,
Recommendations and
Future Works

Chapter 6

Conclusion, Recommendations and Future Works

In this chapter, we have four sections, in section 6.1 we present research summary, in section 6.2 we present the useful conclusions and discussion about the research, in 6.3 section we present useful recommendation that we extract from thesis about the system usability, and finally in section 6.4 we present possible directions of future works.

6.1 Summary

In our research, we proposed an approach for usability evaluation for UNRWA SAP ERP system. The proposed approach used usability evaluation using Data Mining methods. We applied two different experiments the first was questionnaire experiment and the second was tasks scenario experiment, we applied the experiments UNRWA Gaza field office, the main goal of our research is finding an approach based on data mining to evaluate the usability of UNRWA SAP ERP system. The methodology in this thesis consisted of several steps: first, we investigated the best metrics of system usability for UNRWA SAP ERP system, second we used the metrics for evaluating the system by set of testers (employees) using questionnaire approach, third we used other metrics to test the system using some tools, fourth we collected data set (the answers) from testers, and from the tools, fifth also we investigated data mining methods for extracting useful knowledge from our data set, the final step is metrics evaluation.

6.2 Conclusion and Discussions

From our experiments, we found that:

Most employees with high-education, high grade, have experienced, have computer skills and good knowledge of English like the system. In the other hand, employees with less computer skills and not good English language find the system not easy to use. The speed of using the system is average but when using mouse it slow and good using keystrokes. The employees know how to use the systems and how to complete their tasks.

In conclusion, most users found the usability of the system is good; some faced some difficulty using the system.

When we asked for feedback from the employees, we came up with these reasons:

The complex interface of SAP application is always being criticized. The layout is not well sorted at all. Few icons and menus had almost exactly the same function.

The system is displayed in the language of English. However, the SAP is a German company, and the ERP system is original in the German language. Only translating the language may not be enough. Some few words are just directly translated from German to English. These words are not matching the daily jobs and may cause some problems to the user.

The users do not have much complicated interactions with the applications, and the functionality can just meet their requirements.

Users are pretty satisfied with the function, which is called Favorites menu. This is a function that allows the user to save the transaction as a bookmark in the left side panel on the main screen. The users can access the transaction quickly and easily. The standard SAP menu is in a hierarchy model. It means the users sometimes have to drill down into the menu to find out the transaction that is desired.

A customization menu can be very complicated for users. The menu consists of various tabs and options, which are not user-friendly at all.

The help functionality and guidance were lacking especially for novice users. Error messages were not helpful as these did not clearly indicate what the problem was, and where or how it could be resolved.

6.3 Recommendations

Based on our experiments and employees feedbacks, we can recommend the following:

1. System Presentation

Colors are important to use in design. It can make information more accessible Right now; SAP is just a few colors on the interface. It is using black for the Text and blue for the background. There should be more colors in the interface to distinguish the key information.

2. System Learnability

- Provide more knowledge to users. It can be achieved by spending more time on training about SAP. This one will cause some cost of money and time.

- Providing guidance could reduce initial learning time and improving user efficiency and productivity.
- Nowadays many smartphones apps will appear a quick tutorial when users first time launch it. This is a smart way to introduce the functionalities to users. It is compulsory for users to read the tutorial.

3. System Navigation

- Provide some filter functions for the user to hide or fade the disturb information. However, this will increase the burden on the user and cost to maintain.

4. System Customization

- Certain sorting functions should be provided within Favorites menu. It can be sorted by last access date or click times. It makes the most used transaction always on the top of the list. It will help users to build up their recognition of the position.
- Providing users with a reporting wizard that allows for easy customization of reports.

5. System Support

- Another way is to push the educational document as the pop out the news. This is a low cost method to communicate with the users.

Many new technologies have been released by SAP AG, such as:

- SAP Screen Personas:** According to SAP, Screen Personas enable customers to improve the user experience of their specific scenario. It works for all SAP GUI transactions. A user can personalize any transaction without programming skill in minutes. It also provides an option for Application Deliver Team to build a simpler interface for all users. They can manage different user and group profiles to reach the best productivity and reduce the cost and training time on SAP.
- SAP Fiori:** With the SAP Fiori UX, it enables the user to:
 - Improve user productivity by simplifying and automating day-to-day tasks across any device
 - Boost user adoption with an appealing UX design tailored to key tasks and activities
 - Increase compliance and data quality by making it easier to enter information into your system of record

- Reduce training and support costs with simple, role-based screens that speed ramp-up and minimize user errors
 - Easily extend or build customized SAP Fiori apps with SAP developer tools and technology
6. Improving user skills (e.g. computer skills, English language) for more diverse and higher cognition levels would improve the usability of the system.

6.4 Future Works

Possible directions for future works include:

- To evaluate all UNRWA SAP ERP area fields (West Bank, Syria, Jordan, and Lebanon).
- To use other data mining methods to evaluate UNRWA SAP ERP system such as
- (decision tree).
- The evaluators of tasks scenario in our thesis are admin officers; in future work we extent our evaluation of system usability to include different positions (clerk, deputy, storekeeper).
- To develop future work to subjective evaluation of the system by using opinion mining and text mining techniques.

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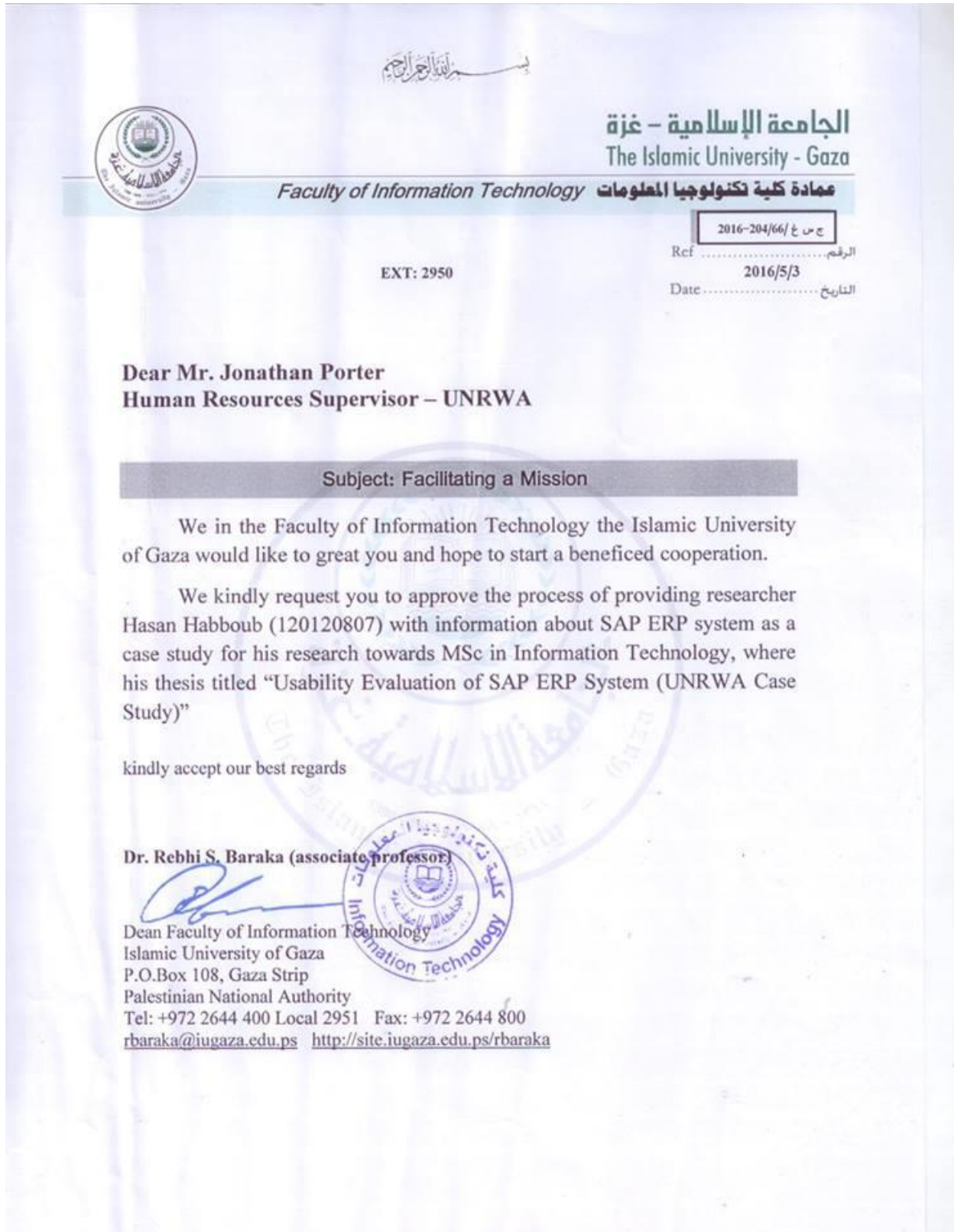
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Appendix 1: Facilitating a Mission from the Islamic University



Appendix 2: Usability Evaluation Questionnaire

Usability Evaluation of SAP ERP System Survey Questionnaire (UNRWA-Gaza Field Office (GFO) Case Study)

Thank you for your time and participation in my questionnaire, for the study of Usability evaluation of UNRWA SAP ERP System.

Your answers play an important role to gain my master degree in Information Technology at The Islamic University of Gaza Supervised by Dr. Alaa Mustafa Elhalees.

The purpose of my study is to evaluate the usability of the current SAP ERP system in UNRWA GFO(Gaza Field office) in several strategies, since SAP ERP users (UNRWA employees), encounter challenges using complex UNRWA SAP ERP interfaces according to research knowledge.

This study and its results will be used solely for the purpose of scientific research and will be treated confidentially
many thanks for your cooperation.

Best Regards,
Hasan Faraj Habboub
Mobile no.: 059-7920792

* Required

First Part

Personal Data

1. Gender * *Mark only one oval.*

- Male
 Female

2. Residence Area * *Mark only one oval.*

- South Governorates
 Middle Camps
 Gaza Governorate
 North Governorates

3. Age * *Mark only one oval.*

- 20 -Less than 25
 25 - Less than 30
 30 - Less than 35
 35 - Less than 40
 40 - Less than 45
 45 - Less than 50
 50 - Less than 55
 55 and above

4. Education * *Mark only one oval.*

- Secondary Certificate
- Diploma Degree
- Bachelor Degree
- Master Degree
- PhD Degree

5. Grade in UNRWA * *Mark only one oval.*

- 3-7
- 8-12
- 13-15
- 16 and Above

6. Department / Office * *Mark only one oval.*

- Director of UNRWA Operations (DUO)
- Program Integration\ Operator Support Office (OSO)
- Program Integration \ Legal
- Program Integration \ Monitoring & Evaluation
- Program Integration \ Construction Access Team
- Program Integration \ Public Information Office
- Program Integration \ Job Creation Program (JCP) UNIT
- Program Delivery \ Health
- Program Delivery \ Education
- Program Delivery \ Infrastructure & Camp Improvement Program (ICIP)
- Program Delivery \ Relief & Social Services
- Program Delivery \ Community Mentality Health
- Program Delivery \ Microfinance &
- Microenterprise Program Delivery \ Project Office
- Support \ Logistics Office
- Support \ Procurement Office
- Support \ Human Resources Office
- Support \ Finance Office
- Support \ Information Systems Office (ISO)
- Support \ Administration Office
- Support \ Head Quarter Gaza Field Office
- Support \ Security and Safety Department (SSD)

7. Work Area * *Mark only one oval.*

- South Governorates
- Middle Camps
- Gaza Governorates
- North Governorates

8. Years of Experience with UNRWA (Per Years) * *Mark only one oval.*

- 1 - Less than 5
- 5 - Less than 10
- 10 - Less than 15
- 15 and Above

9. SAP ERP Experience (Per Months) * *Mark only one oval.*

- 1- Less than 3
- 3 - Less than 6
- 6 - Less than 9
- 9 - Less than 13
- 13 and above

10. Computer Skills * *Mark only one oval.*

- Beginner
- Medium
- Advanced

11. Knowledge of the English Language * *Mark only one oval.*

- Poor (Less than 50%)
- Medium (50% - Less than 70%)
- Good (70% - Less than 80%)
- Very Good (80% and above)

12. Have you ever took training on SAP ERP? * *Mark only one oval.*

- Yes.
- No.

13. Does SAP ERP replaced the old software on your P.C., or you are still using that software besides SAP ERP? * *Mark only one oval.*

- Yes.
- No.

Second Part

SAP ERP Usability Criteria

14. 1- System Navigation * *Mark only one oval per row.*

	Strongly Disagree	Disagree	Neither Agree on Nor Disagree	Agree	Strongly Agree
I think that it is easy for me to navigate and access information.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I always find what I am looking for.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt it is easy to get to the function from the screen I started on.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I always use hot-key / t-code to operate.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I always use the search function rather than typing.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think search function matches my expectations.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think it is easy to find the next step while performing a multi-step task	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

15. 2- System Presentation * *Mark only one oval per row.*

	Strongly Disagree	Disagree	Neither Agree on Nor Disagree	Agree	Strongly Agree
I think that it is easy for me to understand and comprehend the presentation of output.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I found the information is easy to read (Both fonts and size).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think the system speaks human language.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think the Visual Design and placement of items in the interface is comfortable.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I always felt error messages are clear and understandable.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

16. 3- System Support * *Mark only one oval per row.*

	Strongly Disagree	Disagree	Neither Agree on Nor Disagree	Agree	Strongly Agree
I think that the application support me with works.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I always use the help document rather than asking my colleague when I find something is hard to accomplish.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think the application improved my productivity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt it takes long response time in any transaction.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think it takes short completion time to complete common or target tasks.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt the application always help me in handling any error encountered while doing transaction.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

17. 4- System Learnability * *Mark only one oval per row.*

	Strongly Disagree	Disagree	Neither Agree on Nor Disagree	Agree	Strongly Agree
I think that it is easy for me to initiate the applications with nature requirement.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt it is easy to memorize steps for performing a task .	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think my interaction with the system is clear and understandable.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt it takes a long time to be skillful for a new application.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

18. 5- System Customization * *Mark only one oval per row.*

	Strongly Disagree	Disagree	Neither Agree on Nor Disagree	Agree	Strongly Agree
I think that it is easy for me to customize the interface.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I always customize my system layout.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I found the system is flexible to interact with.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt the feedback and information by customization the application became more clear.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Appendix 3: Usability Evaluation Tasks Scenario

Usability Evaluation of SAP ERP System (UNRWA-Gaza Field Office (GFO) Case Study)

Thank you for your time and participation in my tasks scenario, for the study of Usability evaluation of UNRWA SAP ERP System.

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This study and its results will be used solely for the purpose of scientific research and will be treated confidentially
many thanks for your cooperation.

Best Regards,
Hasan Faraj Habboub
Mobile no.: 059-7920792

Personal Data

Gender <input type="radio"/> Male <input type="radio"/> Female	Age <input type="radio"/> 20 -Less than 25 <input type="radio"/> 25 - Less than 30 <input type="radio"/> 30 - Less than 35 <input type="radio"/> 35 - Less than 40 <input type="radio"/> 40 - Less than 45 <input type="radio"/> 45 - Less than 50 <input type="radio"/> 50 - Less than 55 <input type="radio"/> 55 and above
Education <input type="radio"/> Secondary Certificate <input type="radio"/> Diploma Degree <input type="radio"/> Bachelor Degree <input type="radio"/> Master Degree <input type="radio"/> PhD Degree	Grade in UNRWA <input type="radio"/> 3-7 <input type="radio"/> 8-12 <input type="radio"/> 13-15 <input type="radio"/> 16 and Above

Department / Office	Years of Experience with UNRWA (Per Years) <input type="radio"/> 1 - Less than 5 <input type="radio"/> 5 - Less than 10 <input type="radio"/> 10 - Less than 15 <input type="radio"/> 15 and Above
SAP ERP Experience (Per Months) <input type="radio"/> 1 - Less than 3 <input type="radio"/> 3 - Less than 6 <input type="radio"/> 6 - Less than 9 <input type="radio"/> 9 - Less than 13 <input type="radio"/> 13 and above	Computer Skills <input type="radio"/> Beginner <input type="radio"/> Medium <input type="radio"/> Advanced
Knowledge of the English Language <input type="radio"/> Poor (Less than 50%) <input type="radio"/> Medium (50% - Less than 70%) <input type="radio"/> Good (70% - Less than 80%) <input type="radio"/> Very Good (80% and above)	Have you ever took training on SAP ERP? <input type="radio"/> Yes <input type="radio"/> No

Tasks Scenario

Task no.	Task Description
Task 1	Login into UNRWA SAP ERP system
Task 2	Check available budget
Task 3	Create purchase request in the system
Task 4	Change purchase request in the system
Task 5	Display purchase requests
Task 6	Display purchase requests as a list
Task 7	Logout off the system