MULTIMODAL E-COMMERCE: A USABILITY AND SOCIAL PRESENCE INVESTIGATION

MAJED MOHAMMED ABOROKBAH

THESIS SUBMITTED FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN SOFTWARE ENGINEERING

SUPERVISED BY PROFESSOR DIMITRIOS I. RIGAS

FACULTY OF TECHNOLOGY, DE MONTFORT UNIVERSITY

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THE EFFECT OF MULTIMODAL METAPHORS ON E-COMMERCE INTERFACES: A USABILITY AND SOCIAL PRESENCE INVESTIGATION

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In the name of God, most compassionate, most merciful.

DEDICATION

This thesis is dedicated to the memory of my father who always stood behind me and knew I would succeed, my mother who has been a source of motivation and strength during moments of despair and discouragement, my wife (the twin of my soul) and to my sweet children for their encouragement and patience.

Majed Aborokbah

ABSTRACT

This thesis investigates empirically multimodal socially interactive e-commerce interfaces. The overall hypothesis is that multimodal social interaction will improve the usability of e-commerce interfaces and increase the user's feeling of social presence, decision making and product understanding when compared to an equivalent non-multimodal socially interactive interface. The investigation consisted eight conditions in three experimental phases. The first experimental phase investigated non-socially interactive, static-socially interactive, and interactive-socially interactive interfaces (three conditions) using an e-commerce platform with a dependent sample of users (n=36). The second experimental phase continued with the comparative evaluation of a further two conditions based on the results of the first phase. An audio and an avatar-based socially interactive conditions were evaluated with two independent groups of users (n=18 for each group). The third experimental phase investigated three socially interactive conditions. These were text with graphics, auditory stimuli, and avatars. The results demonstrate that socially interactive metaphors in e-commerce interfaces improved the ability of users to use presented information effectively, make decisions in comparison to non-social or static social interactive interfaces. An avatar-based socially interactive e-commerce interface improved the user's social presence. A set of empirically derived guidelines for the design and use of these metaphors to communicate information in a socially interactive atmosphere is also introduced and discussed.

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Acronyms

SIEE	Socially Interactive e-Commerce Environment.
NSI	Non-Social Interactive Interface.
SSI	Static-Social Interactive Interface.
ISI	Interactive-Social Interactive Interface.
AISI	Audio Interactive-Social Interactive Interface.
AVISI	Avatar Interactive-Social Interactive Interface.
TSI	Text based socially Interactive Interface.
ASI	Audio based socially Interactive Interface.
AVSI	Avatar based socially Interactive Interface.
GUI	Graphical User Interface.

CHAPTER 1 INTRODUCTION

Objectives

- To motivate the need for multimodal socially interactive e-Commerce interfaces.
- To highlight the original contributions and formulate the hypothesis.
- To present the aims and objectives of the theses.
- To present the overall research methodology.
- To present the thesis overall structure outline.

1.1 Overview

Online shopping is often impersonal and anonymous as it lacks human-to-human social interaction, when compared to traditional shopping. These problems are somewhat mitigated by rather complex socially interactive e-commerce environments (SIEE). This research proposes a model of SIEE for consumer transactions. This model is evaluated empirically in three experiments in terms of usability, social presence, purchase intention, and consumer enjoyment.

1.2 Aims

The overall aim is to investigate the effects of incorporating different combinations of social interaction and multimodal metaphors into e-commerce interfaces. More specific sub-aims include the role of text, recorded speech, synthesis speech, earcons, auditory icons, and avatars in e-commerce interfaces in terms of usability, social presence, purchase intention, and consumer enjoyment during a product selection through understanding and decision making of purchase intention. In particular, it will evaluate the usability of the interaction modes in terms of effectiveness, efficiency, and user satisfaction of the interaction modes when task complexity levels and types are considered. Moreover, it aims to evaluate the user‘s acceptance of and social presence with each interaction mode.

1.3 Objectives

Experiments were divided into three phases. The reasons for the staged experimentation was that the output of each stage was used as a basis for the next stage.

The first experimental phase evaluates three conditions:

1. *Non–socially interactive interface (NSI):* is an experimental condition that illustrates a typical e-Commerce interface that does not involve any form or absence of social interaction.
2. *Static social interactive (SSI)*: is an experimental condition that illustrates a partly modified e-Commerce interface that involves a static or simplified form of social interaction.
3. *Socially interactive platform (ISI)*: is an experimental condition presenting the utilisation of social interaction on e-Commerce interface or an enhancement of the static form presented above.

The second experimental phase evaluates two conditions:

1. Audio interaction mode that utilises earcons, auditory icons, and speech *(AISI)* is an improvement of the ISI condition.
2. Avatar e-commerce interface *AVISI* is an improvement of the ISI condition.

The third experimental phase evaluates three conditions:

1. *TSI* condition is a text based socially interactive condition that uses the visual channel of users (text & graphics).
2. *ASI* condition is an audio based socially interactive condition that uses the auditory channel of users (earcons, adiotory icons, and speech).
3. Avatar Socially Interactive *(AVSI)* uses an expressive avatar to communicate information about products, reviews, ratings and recommendations.

The experimental tasks were designed to provide an effective variance amongst the conditions. The socially interactive tasks involved a product selection process in the

presence or absence of social interaction as well as with static interaction. These tasks were rising in difficulty from simple to complex.

The evaluating parameters consisted of effectiveness, efficiency, user satisfaction, social presence and user evaluation.

1.4 Method

The method involved a literature survey and three experimental phases. The literature survey took a critical view of current thinking in e-commerce interfaces and examined the fundamental principles of social interaction in e-commerce environments. The three experimental phases evaluated empirically various approaches that integrated social interaction with e-commerce interfaces. The experimental hypotheses were underpinned to the findings of the literature survey. The sample was opportunistic. The first two experimental phases evaluated five conditions.

The first experiment had three conditions that were evaluated dependently using the within-subject design methodology with one group (n=36) of users. The results of the first experimental phase were used as a basis for the second experimental phase. This second phase evaluated two conditions using two groups (n=18 for each group) of users. The AISI group used an audio enhanced e-commerce interface and the AVISI group used an avatar-based socially interactive e-commerce interface. Thus, the main assumption of this design methodology is that the effect of the control variables on both groups were equalled during the experiment and the perceived variance is due to the treatments. The third experimental phase examined three conditions in a dependent group (n=36) of users using, again, the within-subject design methodology. All results were analysed using statistical tests depends on the data types.

In summary, this Thesis examined eight conditions in three experimental phases. These investigated the effects of social presence on the usability of e-commerce interfaces in terms of efficiency, effectiveness, satisfaction, and user attitudes.

1.5 Research conceptual model

The research that has been carried out in this thesis follows the conceptual model presented which illustrates the relationships between different concepts. It provides a key artefact for understanding and clarity of ideas. Therefore; the model represents stages from which the research process is developing and represents the outcomes and finding from each stage. The model has been built on such a way that for the first time reader or designer or developer can capture the whole idea behind this investigation. The model relates the concepts and domains from which the idea has been subtracted. This model is connected to the thesis outline as it shows the overall structure and Section 1.8 represent the structure of the thesis.

Three phases has been developed the first phase to examine the role of social presence in traditional e-commerce interfaces, that was by adding social presence as a treatment to the three conditions and examining the usability aspects (see Chapter 3 for more details). The second phase; act as an extension of the first phase which moved on to examine the role of avatar and audio in term of usability and social presence. Furthermore, the third phase introduces a hotel booking scenario in which the tasks were deferent from the first and second phases.

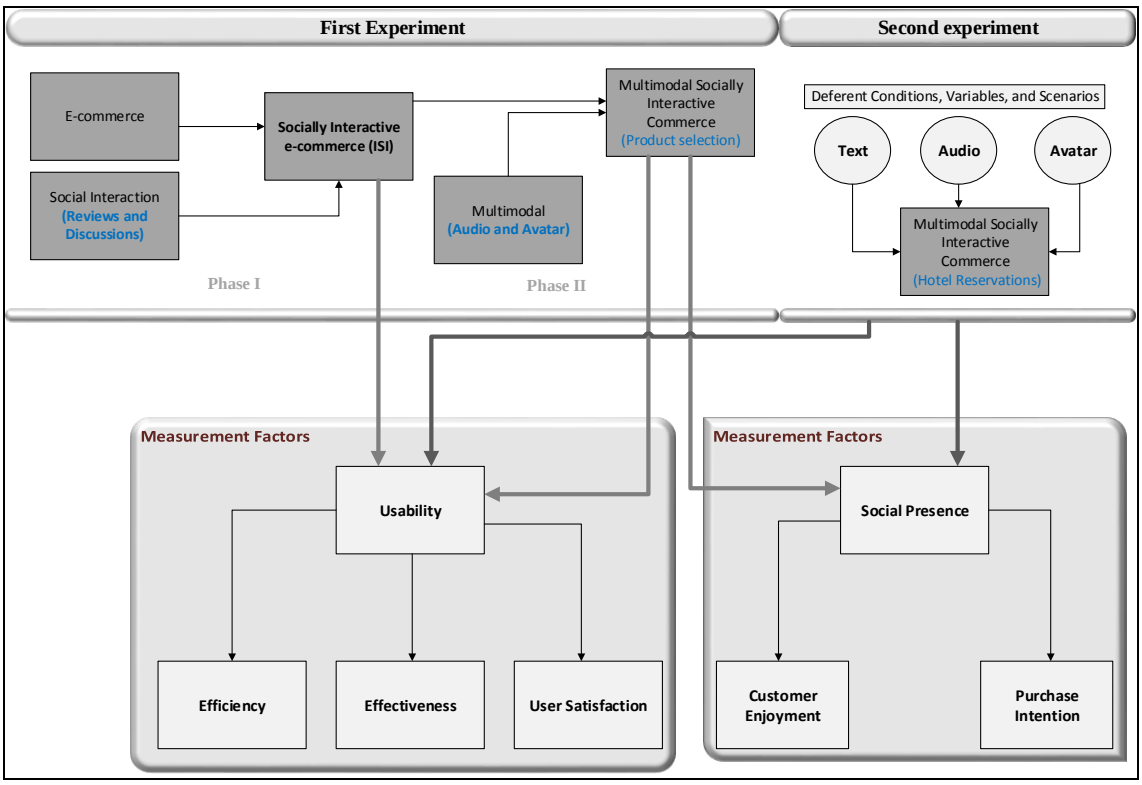


Figure 1.1: Research conceptual Model.

1.6 Hypothesis

The overall hypothesis is that *multimodal social interaction will improve the usability of e-commerce interfaces and increase the user's feeling of social presence, decision making and product understanding when compared to an equivalent non-multimodal socially interactive interface.* Socially interactive metaphors in e-commerce interfaces will improve the ability of users to make decisions in comparison to non-social or static social interactive e-commerce interfaces. The static socially interactive metaphors are however expected to outperform the non-social ones. This overarching hypothesis is divided into the following sub-hypotheses:

- Using social interaction in e-commerce interfaces increases the user's capability to use information effectively compared to non-socially interactive e-commerce interfaces.

- Users of interactive social interaction (ISI) interface mode will be capable of using information more effectively than those who use the no social interaction (NSI) interface mode.
- Users of interactive social interaction (ISI) interface mode will be capable of using information more effectively than those who use the static social interaction (SSI) interface mode.
- Users of static social interaction (SSI) interface mode will be capable of using information more effectively than those who use the no social interaction (NSI) interface mode.

Using social interaction in e-commerce interfaces improves the user's feeling of social presence, compared to the use of non-social interactive e-business interfaces.

- Interactive social interaction (ISI) interface mode users will have more social presence than their counterparts who use the no social interaction (NSI) interface mode.
- Interactive social interaction (ISI) interface mode users will have more social presence than their counterparts who use the static social interaction (SSI) interface mode.
- Static social interaction (SSI) interface mode users will have more social presence than their counterparts who use the no social interaction (NSI) interface mode.

Using multimodal avatar social interaction in e-commerce interfaces improves the user's social presence, compared to using audio-social interactive e-commerce interfaces.

- Using avatar social interaction metaphors in e-commerce interfaces improves the user's usability aspects, capability to make decisions, and feeling of social presence compared to using audio-social interactive.
- Using multimodal avatars in socially interactive e-commerce interfaces improves the user's usability aspects, capability to make decisions, and feeling of social presence, compared to using audio and text with graphics.

1.7 Contribution

This thesis introduces innovative multimodal socially interactive e-commerce user interfaces. The designs combine social presence (e.g. reviews, rating, and recommendations) with multimodal communication metaphors (e.g. speech, earcons, auditory icons and avatar) in a way that increases the volume of information communicated to users. The multimodal designs increased usability in terms of effectiveness, efficiency and user satisfaction, when compared to a typical visual approach to interaction. This thesis also gives a set of empirically derived guidelines for the use of multimodal metaphors in e-Commerce interfaces. This research also contributes to the potential development of user social presence, by linking usability to user attitudes including social presence and shopping enjoyments.

1.8 Thesis outline

This thesis structure is designed as six chapters and three appendices. A short description of the chapters and appendices is given below.

Chapter 1: Introduction provides an overall introduction to the thesis by presenting briefly the research work, aims, objectives, method, thesis structure and its contribution to multimodal socially interactive e-commerce interfaces.

Chapter 2: Multimodal and socially interactive e-commerce interfaces reviews previous work in e-commerce, social interaction, multimodal interaction, and social interactive multimodal in e-commerce interfaces. Usability evaluation approaches and measurement methods of usability and user attitude are also reviewed.

Chapter 3: Conditions design presents the experimental platform that was used as a basis for the first five conditions (experimental phases I and II) and outlines the method used.

Chapter 4: Empirical data of phase I & II: Analysis and discussion analyses and discusses the empirical results of the three conditions in the first experiment and the two conditions in the second experiment.

Chapter 5: Multimodal socially interactive e-commerce interfaces: the role of audio and avatars evaluates empirically the performance of text with graphics (condition: TSI), audio (condition: ASI), and avatars (condition: AVSI) using a one group of 36 users. ASI uses non-speech sounds such as earcons and auditory icons as part of a multimodal message to communicate additional information to users. AVSI uses facially expressive avatars in order to evaluate whether this virtual social presence mitigates the lack of face-to-face contact experienced typically in shop-based shopping.

Chapter 6: Conclusions and Empirically Derived Guidelines presents the main conclusions, limitations and suggests a set of empirically derived guidelines for the design of multimodal and socially interactive e-commerce interfaces. There are also four appendices that present the results of the initial survey **(Appendix A)**, experimental scenario and data of phase I **(Appendix B)**, phase II **(Appendix B)**, and experimental scenario and data of phase III **(Appendix C)**.

Chapter 1: Introduction
Chapter 2: Literature review
Social interaction (social media) | Multimodal metaphors (visual, audio, avatar) | e-Commerce
Chapter 3: Experimental conditions design
Phase I: The role of social interaction on e-commerce applications
Not Socially Interactive Condition | Static Socially Interactive Condition | Interactive Socially Interaction Condition
One group *n = 36* users.
Phase II: The role of multimodal social interaction in e-commerce Interfaces
AISI group *n = 18* users Audio Interactive Socially Interaction Condition (AISI) | **AVISI group** *n = 18* users Audio-Avatar Interactive Socially Interaction Condition (AVISI)
Chapter 4: Empirical data of Phase I & II: Analysis and Discussion
Chapter 5: Third Experiment Multimodal socially interactive e-Commerce interfaces: The role of audio and avatars
Text Socially Interactive Condition (TSI) | Audio Socially Interactive Condition (ASI) | Avatar Socially Interaction Condition (AVSI)
One group *n = 36* users.
Chapter 6: Conclusions and Empirically Derived Guidelines

Table 1.1: Thesis structure outline.

CHAPTER 2 MULTIMODAL AND SOCIALLY INTERACTIVE E-COMMERCE INTERFACES

Objectives

- Provide an overview of usability of interfaces.
- Review social presence and interactions.
- Review e-Commerce interfaces interactions.
- Review multimodal metaphors.
- Critically review the multimodal social interactions.

2.1 Overview

Due to the rapid development and pervasiveness of information technology, many practices in e-commerce environments have changed. e-Commerce sites have grown rapidly to become the main market channel for the majority of businesses all over the world. Figure 2.1 presents the growth of e-commerce retail sales from 1st quarter 2004 to 4th quarter 2013 according to the U.S. Department of Commerce [1]. Web 2.0 technologies and social media provide a unique platform for customers to share their product associated experiences and thoughts. It creates exceptional impacts on firm approaches and customer buying behavior [2]. Online reviews, recommendations, and opinions are an important factor particularly with the emergence of new technology tools [3]. Several studies have examined the impact of the design components for e-commerce interfaces. Their evaluating emphasis was on customer behaviour, individual personal perspectives and shopping experience. These studies demonstrated the importance of building customer trust and providing personalised adapted services [2-5]. For example, Evans et al [6] suggest that shopping behavior is a part of the social process that frequently takes place with family and friends. Therefore, there is a need to discuss shopping experiences and customer behavior from social and interactive relational perspectives. Given this context, the need for an approach based on multimodality and social perceptions is increasingly gaining headway in the context of e-commerce. Moreover, few studies have examined how to enhance shopping experiences with social interaction in e-commerce context. Rigas et al 2013 concluded their study by social presence and multimodal metaphors on overall influence on-line decisions of customers' [7].

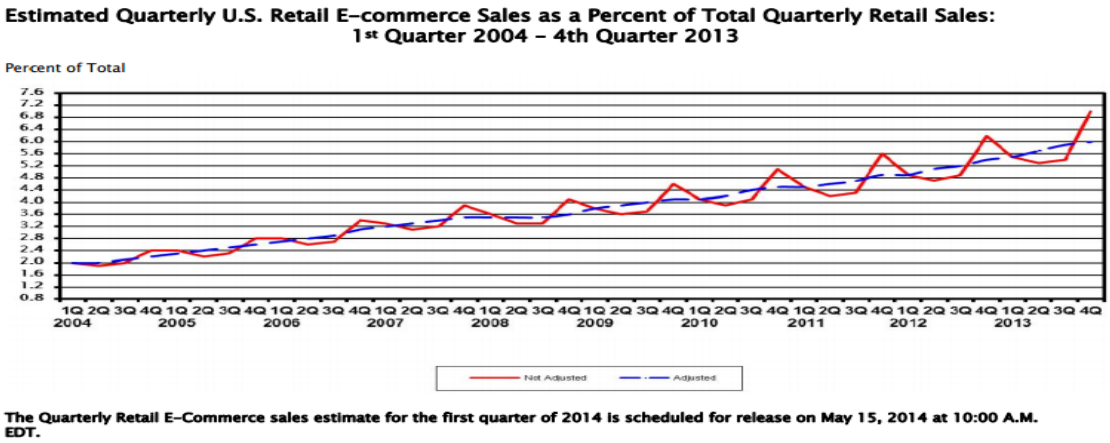


Figure 2.1: Estimated quarterly U.S. retail e-commerce sales.

2.2 Usability of User Interfaces

Usability is an essential element of today's interactive systems. It is defined by the International Standards Organization (ISO 1999) as *"the degree from which a computer-systems can enable users, in a given context of use, for accomplishing specified goals efficiently and effectively while promoting feelings of satisfaction"* [8, 9]. In the user interfaces design process usability evaluation play an important role together with iterative cycles of design, prototype, and evaluation [10]. Evaluation is defined as a process that involves activities such as *capture*, *analysis*, and *critique*. C*apture* is the phase that the usability data is collected (e.g. task completion time, number of errors, and subjective ratings of the user's satisfaction). *Analysis* interprets the collected usability data by applying appropriate data analysis tests and usability scoring techniques to identify the problems with interface usability. *Critique* suggests solutions, guidelines, or improvements in order to mitigate problems [10, 11].

The Human-Computer Interaction (HCI) caters the development of usable interfaces. Some of the development models are also used by the software industry [12, 13]. The focus is in developing and improving the usability, effectiveness, utility and safety of the interactive computer based products [12, 14]. The approach used is often

multi-disciplinary as it involves theory, research methods, user and context, statistics and analysis, and design and implementation [15]. The most common investigation methods are controlled experiments, usability studies, observation, surveys, field studies, interviews, and focus groups [16, 17].

Interaction design was defined by Rogers et al [12]. The focus is on the practices to improve user experience. A methodology that integrates HCI concepts and Software Engineering (SE) is still needed although Usability Engineering (UE) emerged partly in response to this need [12]. Currently, the focus of HCI is on the usability study. The designer's effort is to ensure that prospective users can effectively and efficiently use the interface component of the software. For example, the navigation from one step to another should be clear, preferably without referring to documentation [18]. Moreover; minimising the number of steps and mouse clicks, and the time taken by a user to complete a task. The evaluation of an interface often involves a close observation of users interacting with the software. Reaction and accomplishment times, number of errors, backtracking to previous states and failures to accomplish the specified task are recorded along with the conditions under which they occurred. The collected results are analysed and used to improve the interface and this process is iterated until the software is sufficiently usable [18, 19].

The usability evaluation helps designers to build more effective, efficient, and user satisfying interfaces [4]. An efficient interface enables users to complete tasks with a minimal number and amount of time. Effectiveness enables users to complete tasks with the minimum number of errors. User attitudes contribute to the user satisfaction about the system [12, 15, 20]. An evaluation on the final version of a system is often referred to as a validation test.

2.3 e-Commerce

Electronic commerce (also referred to as e-commerce or internet commerce) is defined as the application of information and communication technologies (ICT) to support business activities [21]. Commerce is the exchange of any form of products and/or services among businesses, groups and individuals. Electronic commerce focuses on the use of ICT in order to enable external actions and relations of the business with external stakeholders [22].

E-commerce is a subset of e-business and covers any form of purchasing, selling, and exchanging of goods, services, and information via the internet. e-Commerce activity includes *business-to-customer* (B2C), *customer-to-business* (C2B), *customer-to-customer* (C2C), and *business-to-business* (B2B) [23].

Category	Explanation
Business-to-business (B2B)	A type of commerce transaction where the product or services occurs between businesses, e.g. those involving a manufacturer and wholesaler, or a wholesaler and a retailer. B2B refers to business that is conducted among companies or commercial organizations, rather than among a company and individual consumers.
Intra-business or business-to-employee (B2E)	Business to employee e-Commerce uses an intra-business network to companies for providing products or services for their employees where the focus of business is the employee.
Business-to-consumer (B2C)	Business to consumer e-Commerce is an activity that occurs both online or offline in which the businesses sell or provide product or services to their consumer or end-users.
Consumer-to-consumer (C2C)	Consumer-to-consumer e-Commerce is the transactions that exist between individuals, often through a third party.

Table 2.1: e-Commerce categories [23].

B2C e-commerce brings together both businesses and consumers to an online marketplace in which they trade goods and services using some type of on-line store

facility (e.g. travel and hotel booking) [23]. C2B e-commerce involves consumers requesting services online for businesses to fulfil or bid for them. C2C e-commerce is takes place often between two consumers (e.g. eBay transactions). B2B is the same as C2C but with two or more companies or businesses (e.g. manufacturers to distributers) [23-25].

2.4 Social Presence

Social presence is the perceived view of users that the interface provides the impression that there has been a human-like contact that is personal, sociable, sensitive and with human warmth [26]. Presence is characterised by *tele-presence* and *physical* or *spatial* presence [27, 28]. This provides to the user the sense of "being there" including automatic responses to spatial cues and the mental models of mediated spaces that create the illusion of place. Social *presence* was originally defined by Biocca as the sense of "being together". It provides means for simple responses to social cues, simulations of other minds, and automatically produced prototypes of the intentionality of others [27, 29]. The term social presence has been used through this thesis to refer to interactions in mediated environments [27, 28, 30]. Measuring and defining social presence via interface design has been a challenge [27, 31-33]. Biocca et al [27], Cyr [26], and Hassanein [34], proposed a measurement instrument that should be able to measure social presence across a very wide range of media. Their measurement consists of five rating questions that obtain an overall viewpoint of users about the interface [26].

Marketers are also beginning to focus on the value of "earned" social media. Such as, Stephen and Galak 2012 [35] find that socially earned media can have a long-term impact on sales and helps to drive more traditional earned media. The effects appear to

be particularly pronounced for online communities, suggesting interesting opportunities for marketers who are thinking of increasing their use of CMSEs as part of their larger marketing plans [35, 36].

2.4.1 The Six Dimensions of Social Commerce

Dimension 1: Social Shopping: Social shopping tools allows people to share the act of online shopping together synchronous shopping.

Dimension 2: Ratings & Reviews: The original social commerce toolset that was originally developed by Amazon's to allow consumer to share their product experiences.

Dimension 3: Recommendations & Referrals: Social commerce reviews are regularly visible to every one recommendation and referrals are personalized endorsements that were designed to recognise the value of referral of customers and advocates.

Dimension 4: Forums & Communities: Forums are the hero of social media as they are popular, effective, and useful platforms of social commerce. They used to assist product discovery by providing a moderated environments around the theme of products.

Dimension 5: Social Media Optimization (SMO): A toolset that has been designed in the context of social commerce to attract people for visiting e-commerce applications. They mainly work on promoting and publicizing e-commerce through social media sites.

Dimension 6: Social Ads & Apps: Social ads & apps are paid for social media platforms to promote e-commerce sites and links [37].

Figure 2.2: Social commerce six dimensions [37].

2.5 Social Media Interactions

The rapid growth of social media has drawn substantial attention in business and academia. Social media provides a communication and interaction processes that typically involve *sharing, exchanging* and *creating* content between people in virtual communities. Kaplan and Haenlein, (2010) defines it as "*a group of Internet-based applications that build on the ideological and technological foundations of Web 2.0*", to permit the process of creating and exchanging the users generated contents [38]. Lately, the application of social media has increased significantly. Examples include Twitter, Facebook, YouTube, Blogger, Flickr, Instagram, Digg, and Tumblr. Furthermore, social media often provides highly interactive stands through which communities and individuals can distribute, co-create, discuss, and edit the user generated content. It has changed fundamentally the communication amongst individuals, communities, and organisations [39-41]. Facebook is one of the leading practices of social media with its celebration of 10 years as the biggest social network, Toward the end of 2013; Facebook has boasted 1.23 billion monthly worldwide active users, by adding 170 million user in just one year. According to Facebook on (31 December 2013), 757 million users used Facebook daily [42].

Social presence in e-commerce environments can help to increase sales and improve consumer trust [43, 44]. Social interaction can be broadly categorised to *user-to-user*

interaction and *user-to-resources* interaction. User-to-user interaction occurs when users communicate with each other (e.g. ask, invite, discuss, confirm, approve, offer, tweet and send). User-to-resources interaction occurs when users interact with the resources of a system by adding, creating, editing, exploring and rating the resources [40]. Traditional marketing approaches primarily involve *one-way* communication channels. Socially interactive marketing provides a two-way communication that benefits from active consumers that contribute to online forums, product and services reviews, blogs and posts [5]. Social media not only allows customers to communicate with companies but also to facilitate customer-to-customer interaction. This makes social media a hybrid factor of the promotion mix [45]. Furthermore, word-of-mouth also becomes highly relevant on the Internet [46]. All these contributing factors enable companies to compete and gain a long-term relationship with existing or new customers [5, 41].

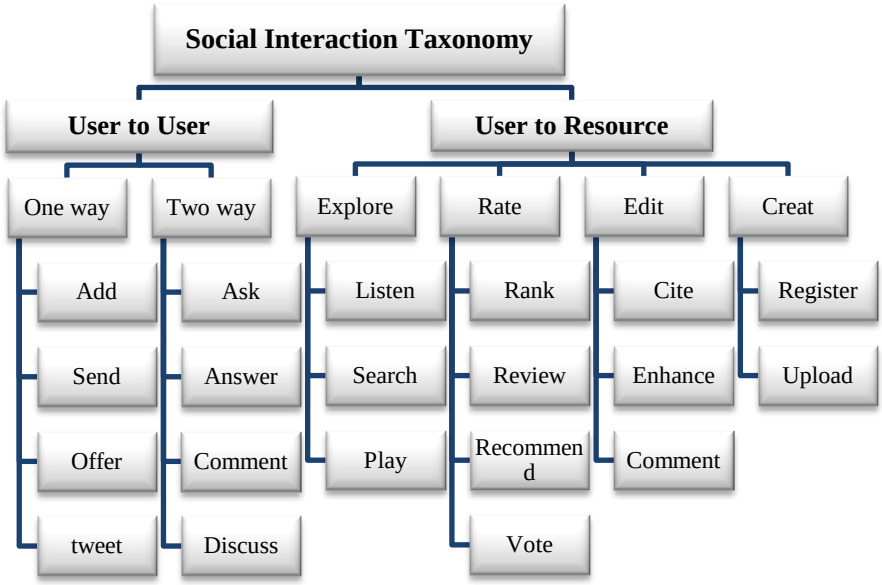


Figure 2.3: The taxonomy of social interaction.

2.6 Social Virtual Worlds (SVWs)

One of social media applications that received attention is the *social virtual worlds* (SVWs). These virtual places imitate the real world. They are defined by Zhou as an internet-based three-dimensional immersive, massive and multi user virtual environment. Members interact through their virtual representatives (i.e., avatars) for a number of purposes, including business and educational activities [47]. Social virtual worlds (e.g. Second Life, Habbo, Club Penguin, and Stardoll) have also appeared as popular cyber social ranges [48]. SVWs act as simulation of the real world in which a large number of users participate, via their avatars, in a range of social activities. For example, taking educational courses, nurturing pets, attending music concerts, and shopping. According to a conference call, Mark Zuckerberg, Facebook, Inc., CEO, said '*After games, Facebook are going to make Oculus a platform for many other experiences, Imagine studying in a classroom of students and teachers all over the world, consulting with a doctor face to face, or going shopping in a virtual store where you can touch and explore the products you're interested in, just by putting on goggles in your own home. This is really a new social platform.'* [48].

KZero (2014) estimated that 1.9 billion people had registered on more than 300 SVWs around the world. Development of SVWs shows a huge business potential and has opened up new doors for marketers [48].

Consumer exposure to these flagship brand stores in SVWs enhances their real-world attitude toward the brands as well as their purchase intention. It is this fact that underscores the potential of SVWs as an effective marketing venue [38]. Previous research has also suggested that virtual worlds offer huge potential for e-commerce

applications because the virtual worlds simulate products and services in a realistic, noticeable manner [47-49].

A survey of 158 participants was carried out by Dianne Cyr et al. 2007 [26] to investigate the role of social presence. The experimental tasks consisted of surfing an e-Services web page for purchasing concert tickets and then completing a questionnaire (via a 7-point Likert scale) which is about their experiences on the website that they just visited. This study was aimed as a one factorial experiment by manipulating five levels of the website social presence with five independent groups of users. Users were randomly assigned to these groups, where each user was shown only one level or condition. The main finding was that; the loyalty within a business to consumer e-Services web page is influenced by perceived social presence, enjoyment in addition to trust. They also recommended that the developers of web site should consider infusing social presence in their designing, as it can have an optimistic impact on the e-Loyalty evoked within their consumers [26].

2.7 Word of Mouth

The word-of-mouth (WOM) theories, within an e-commerce context, are grouped into the *generation of comments* factors and the *impact of comments* on both businesses and customers. The process of generating a review is influenced by gender, psychological aspects, motivation, user satisfaction, group influence, and the sense of community belonging [50].

Word-of-mouth impact on an e-commerce interface can be either *direct* or *indirect*. Negative reviews can be generated easier than positive. Satisfied consumers are more likely to neglect the service or product recommendation compared to their dissatisfied

counterparts that almost immediately they will publicise their concern [51]. Sánchez-García et al. (2011) argued that dis-satisfaction can directly be a reason of negative WOM behavior, and the regretful consumers are more likely to spread their negative WOM possibly with the aim to warn others rather than considering it as revenge [52]. Motivation for WOM [53] enables others to make a good decision. It is divided into five main categories. These are social benefits, consumer empowerment, self-directed, helping other vacationers, and helping companies [50, 54]. The influence of reviews in the customer's decision is significant as electronic word of mouth or reviews is widespread in today's market [55, 56].

2.8 Social Shopping

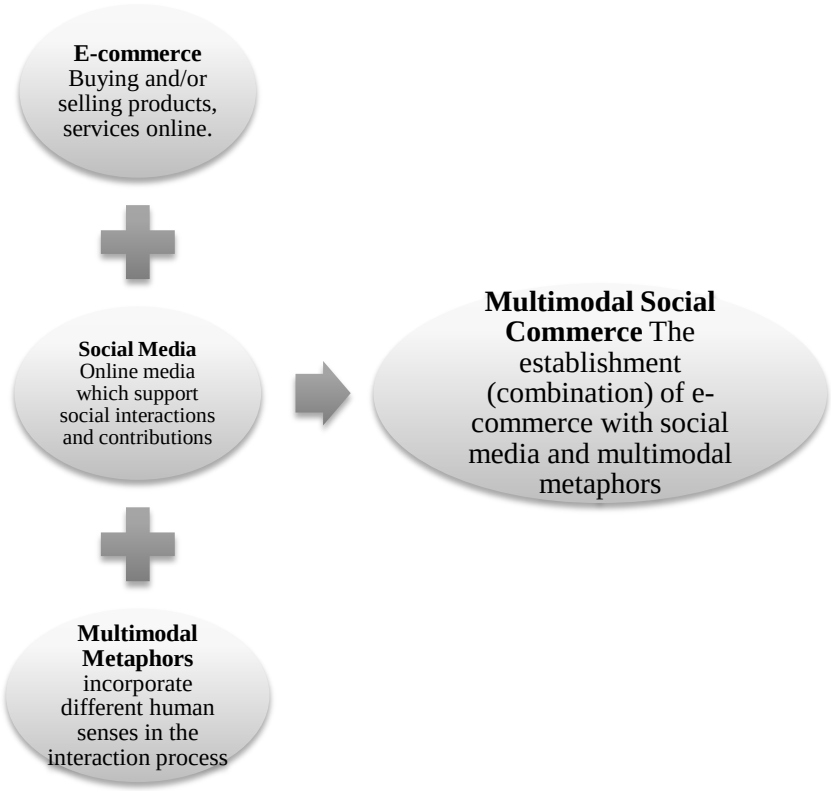


Figure 2.4: Multimodal social commerce.

e-Commerce social shopping is centered on relational human social interactions taken place on the web where the social experiences influence the consumers' decisions [36,

48]. Technology should be used to simulate interactions found in physical or traditional shops [48, 57]. Online shopping practicalities have drawn an interest in businesses academia on the ways used to incorporate interactions between consumers in e-commerce applications [58].

Earlier research studies suggested prototypes from which users virtually can navigate through to perform social shopping with agents of intelligent software [58-60]. Ye et al. [61] proposed a system that called EasyMall for collaborative online shopping. It was created on intelligent agents in a virtual environment that simulated the real interaction which occurred between customers who were attracted to the same products and it supported communication among multiple avatars in a 3D virtual environment. Kim et al [57] proposed two design platforms namely, media richness and embodiment when they investigated the impact on the shopping experience through co-presence from the social and relational perspectives. They found that co-presence would affect the aim to use a collaborative online shopping interface over shopping enjoyment and flow [57].

2.9 Shopping Enjoyment

Few studies have empirically verified the impact of social presence into the enjoyment of user's interfaces and the customer's shopping enjoyment with socially interactive e-commerce interfaces. Shopping with other people or relatives increases both the enjoyment of shopping and the feel-good factor.

Evan et al. [6] reports that shopping with family or friends enables the development of stronger social relationship. Sommer et al. [62] also reported that the social value increased from shopping with another person. It is also more likely to buy more goods

and build stronger relationships, create a social experience, and consequently have a greater degree enjoyment [6, 62, 63].

2.10 Multimodality

Multimodal computer interfaces are interfaces that involve more than one interaction modality to incorporate different human senses in the interaction process [64]. Multimodality improves the interaction between the user and the system. For example, multimodal input can be utilized using devices such as touch screens, handwriting and speech recognition. Also, multimodal output includes metaphors such as speech, text, graphics, audio files, and animation [19, 65].

Recent developments have helped the establishment of the term *Multimodal Human–Computer Interfaces* (MHCI). Unlike traditional Human–Computer Interaction (HCI), MHCI utilieses natural modalities including facial expression, body gesture, verbal and nonverbal vocal cues [12, 66]. A multimodal interface therefore combines multi-channel communication metaphors to interact with the user [67]. The use of several communication metaphors from different channels helps to minimise problems of information overload [68].

Advantages for using multimodality in computer interfaces in general are; they can minimize errors that might the users make, produce a clearer interfaces, increase the communication, and make it easy to locate targets. Also, communications in multimodal interfaces is thus more natural than in single modality systems because humans can easily exploit their interaction strategies which they have learnt in human to human communications [69]. As multimodality can support the design for all principles, and increases the usability of the system as well as the general accessibility of information

technology [70]. However; research has suggested that there are several disadvantages for using MM as from the technical side the setup is more complex and expensive. The process of adding of more modalities in an interactive system requires effort on the coordination and combination and arrangements of modalities. The danger of mental overload; by exposing the customers to stimulation with too many media in an interface which is neither intuitive nor simple and transparent [70].

Visual interaction uses the vision of the user of the system by using text, graphics and colures this will interact with the visual channel of system users [71]. The induction of visual metaphor in user interface improves the usability of the system by easier human computer interaction but the downside of the visually interfaces is the information overload where the sight of the user needs to be focused on the visual representation that take a lot of attention and effort to be carry out by the user [19, 64].

2.10.1 Audio Social Interaction

This type of interaction uses auditory metaphors either on their own or in combination with visual interaction. In the latter case, it will almost certainly reduce the load on the visual channel. Traditionally, sound is used to capture the user's attention on specific events. It has an interrupting nature and for this reason can be used even when the users are engaged visually. Broadly, auditory stimuli is categorised into speech and non-speech [72].

A study by Lee et al. 2003 proposed an experiment which was participant and computer personality: Extrovert vs. Introvert in between-subject factorial design [73]. Their results showed the extrovert computer voice was observed as being more extroverted than the introvert computer voice. They found a noteworthy crossover interaction

between computer voice personality and subject personality for social presence, such that respondents felt stronger social presence when they heard a computer voice manifesting a personality similar to their own.

2.10.1.1 Speech

Speech sounds has been used in auditory models as alarm to be based on a signal for attention of the user to notify them of there is an action being wrong or right. It was first used by Deatherage et al. 1972 [74]. The presentation of some information in sounds helps in reducing the text and graphic in the interface which consequently reduces the information overload [75] as it utilize the hearing and visual senses. It was recommended that the use of voice in computer interfaces is helpful for the reason that the sounds are well-known and standard for conducting information in user's daily life [76].

Speech as an output in computer interface design has been used in wide range of application for information exchange using the human auditory channel. In addition, communicating using auditory metaphors for inputs and outputs shown to be useful for application such as e-learning [77], e-business and social media [78]. Speech sounds can be natural or synthesized speech. Speech is a natural speech when it uses human spoken speech which recorded using some digital technologies, therefore this speech has to be pre-recorded and saved on the system as audio files which need huge space for saving each command [75]. Synthesized speech is the simulation of human speech that generated by speech synthesizers based on two techniques, concatenation or synthesis. Concatenation synthesized speech the messages are produced by concatenating segments which are pre-recorded of human voices after being stored in a database system. The other form of speech is synthesis speech which commonly referred to as

formant speech which can be created at the run time using phoneme generation rules [19].

2.10.1.2 Non-speech

The other form of auditory interaction is non-speech which contains two types that are earcons and auditory icons. Earcons are short sounds of musical nature. Synthetic tones that can be used in structured combinations to create sound messages to represent parts of the interface [79]. Earcons are auditory messages that are presented in a musical nature; it has been used in human–computer interfaces for providing information and feedback to the system users. Utilizing the notions of musical dissonance/consonance and pitch earcons design has shown a variety of combinations according to their degree of aural disagreeableness and pitch [79]. Tuuri et al defined earcons as 'nonverbal audio messages that used in the user-computer-interface to provide information to the user about some computer object, operation, or interaction'. Earcons are created from short series of musical notes to express information [80]. Earcons is a combination of note and pitch, with the use of sound attributes such as pitch, rhythm, timbre, tempo, dynamics, and intensity that create types of earcons [68, 80].

Auditory icons are non-speech sounds from the surrounding everyday life such as glass breaking sound or any sound that recorded form the environment, used to link actions in the computer interface with appropriate sound to reduce the load on the visual channel [68]. The limitation of earcons can be it does not express meaningful association with the data it represents, which require the system user to learn about these associations [81]. Finally, Brewster recommended that '*enriching the computer interface by all of earcons and auditory icons could be the best option which has been confirmed by many experimental studies*' [81-83].

Addressing and communicating product information makes the user bombarded with an excess of information like information overloaded as this situation is handled by introducing new approaches using multimodal interaction and metaphors[84, 85] . Such as, study by Alotaibi et al. introduced a mode called MCKMS which works for a communication purpose of information about the product by merging speech, environmental sound, and metaphors based on the rising pitch [84]. Also; another study by Alharbi et al. investigated the role of audio such as speech and non-speech sounds in e-feedback systems [86]. Thus, multimodal metaphors save users time an ease the access to their desired information in an efficient way when compared to text and graphic communication [86].

2.10.2 Avatar-based Social Interaction

What is most unique to virtual stores, however, is the customized avatar that helps consumers view, navigate, and experience products. The avatar can be defined as '*a general graphic representation that is personified by means of computer technology'* [87]. Avatars are increasingly used on commercial websites and in virtual worlds as company representatives, personal shopping assistants, or recommendation agents [88, 89] . Since an avatar mimics interpersonal interactions with online consumers, it is perceived as a social factor that influences consumer responses [90].

Paul Hemp described avatars as the most conspicuous online manifestation of people's desire to try out alternative identities of themselves [91]. Avatar is a word which originally described the worldly incarnation of the Hindu god Vishnu, was popularized in its cyber sense by Neal Stephenson in his 1992 cult novel Snow Crash. Broadly defined, 'avatar encompasses not only complex beings created for use in a shared virtual reality but any visual representation of a user in an online community' [91, 92].

Audio – visual interaction is a combination of audio and images such as avatars with facial expressions and body gestures [93]. Humans generally communicates using their senses to enhance their objectives [94]; in either face-to-face meetings or face-to-non-face [95].

T. McLaughlin [96] categorized avatars in terms of form to be abstract, realistic and naturalistic. Abstract avatars or symbolic avatars usually represent the real users to remain completely unknown this typically represents cartoon-like interactive characters with limited animations [97, 98]. This type of avatar is not recommended, as it does not deliver a user friendly environment that enhances user experience expected from multi modal communication [99]. The Microsoft help avatar is a good example of abstract avatars. The second type is; realistic avatar or human-like avatar which provides real demonstration of human beings to give more realistic environment [100], that represents still images or video captured images. In addition n the naturalistic avatar is humanoid in a way they look like real humans with a less accuracy [101]. Naturalistic avatar commonly utilised in collaborative virtual environments to embody the users [87].

Avatars can enable businesses to interact and engage with system users in a more dynamic, friendly, and meaningful way [48]. Avatars are gradually more used on e-commerce virtual applications and to act as sales representatives, personal shopping assistants, or recommendation agents [89, 90].

Even with the role of avatars in e-commerce virtual applications, a little empirical work has investigated the importance of avatars in e-commerce applications such as [50, 84, 102, 103]; research has analyzed the impact of spokes-avatars and the modality of interaction on consumer behavior in virtual shopping contexts. However, little is yet known about the role of social presence with avatars on e-commerce applications [7].

Using avatars enables multiple consumers to interact in real time with each other and with sales representatives. Therefore, from both consumers' perspective and usability factors, virtual environments add a distinctive social character to the online shopping experience [26, 34]. The avatar-based social interactions that occur while shopping in virtual worlds might enhance the consumer's sense of realism and social presence; this in turn might influence positively social presence, shopping enjoyment and brand attitude [34, 48].

A study by Jang Ho Moon et al. 2013 created a virtual store of a fictitious clothing brand in Second Life to measure social presence and shopping enjoyment. They examine consumer's interaction in virtual store environments from a shopping context only which examines a single product category with an avatar that of a salesperson and peer consumer influences the brand evaluation and consumer's shopping experience. The results suggest that consumers, when interacting with a salesperson or a peer consumer via avatars, exhibit enhanced social presence, purchase intention, shopping enjoyment, and attitude toward brands [48].

2.11 Critical Review on Multimodal Social Interaction

Multimodal interaction refers to the use of audio and visual metaphors during the user to system interaction processes [12, 103]. The incorporation of social interaction into e-commerce applications encounters several challenges, which can be tackled by involving multimodal metaphors to produce multimodal socially interactive e-commerce applications. Knowledge sharing can be seen as one of the challenges as customers are unwilling to share their experience with others due to the lack of social presence [104-106]. Electronic word-of-mouth, which often represented as online

reviews, recommendations, and opinions, has become important particularly with the emergence of web2.0 and new technology tools [3].

In business-to-consumer e-commerce context, several studies have focused on the impact of the design mechanisms of a website on the customer's behaviour and shopping experience concerning personal, individual standpoints, as demonstrated by the emphasis on structuring customer trust and providing personalized services [44, 107, 108]. Also; shopping experience, argued to be influenced by social, relational, and individual perceptions [6, 48, 62, 109-111]. For instance, customers can share opinions about a product, seek opinions from their families, friends, or other customers; interaction and communications can be enjoyments through interacting with people who has similar interests [112]. Additionally, shoppers when shopping with family or friends tend to spend more time and purchase more products [62].

These approaches can be incorporated into e-commerce interfaces to assist for an optimal alteration of customer expertise and anticipations into valuable recommendations, which can be subsequently used to offer better shopping experiences and lead to influence the social presence and usability of the interface. This framework involves social presence, and hence encouraging customer to share product related knowledge, which indicates to the assumption there is a potential for multimodal interaction metaphors. Therefore, the challenges are:

1. Lack of interfaces that aid social presence in e-Commerce applications.
2. e-Commerce interfaces that used simple forms of social interactions tends to use visual metaphors (text with graphics) which led to information overload to the user.
3. Lack of empirical evidence for socially interactive e-Commerce interfaces.

This research aim to investigates these gaps in term of usability and social presence.

2.11.1 Evaluation Approach

Multimodal social interaction literature has provided an insight into different experimental evaluation methods. For example, usability and attitudes evaluations. In terms of usability evaluation, the concern is not only on empirical evaluation of experimental factors, which produce objective data (e.g. efficiency and effectiveness), but also the measurement of the user's attitudes after using the system. This is achieved by measuring the users satisfaction (subjective data). On the other hand, studies concerning user attitude evaluation only focus on the user views, feelings, and beliefs which also produce subjective data [10, 113]. As a result, user attitudes towards the system can be evaluated under similar or different conditions, and usability levels have to be studied and specified before the actual experiment. To evaluate user satisfaction, it is essential to consider that literary research has proposed system-usability-scale models SUS [114, 115]. Moreover, evaluation of social presence literary research has proposed a subjective rating evaluation approaches developed by [34, 44, 116].

2.11.2 Sample Size

Determining the sample has been widely debated amongst scholars [117]. Jordan [118] suggests that it depends on the purpose and nature of the investigation. It is influenced by a number of factors including the purpose of the study, population size, the risk of choosing a weak sample, and the acceptable sampling error [119-121]. Another approach is to use the same sample size as relevant and recent studies. In user interface experiments design the design methodology applied is one of the important factors to determine the representative sample of the population [122]. According to Lazar et al.,

a within-subject design requires a much smaller sample than an in between-subject design. For example, 16 participants for each condition on the between subject design methodology are required, while for the within subject design methodology a total of n= 16 for all conditions [18, 117]. Hwang et al [20] stated that based on the predictions using the observed data with a variety of experimental conditions, a general rule for optimal sample size would be '10±2' to detect 80% of usability problems [20].

2.12 Concluding Summary

The importance of the multimodality in socially interactive environment was described in this chapter. Multimodality defined as incorporating a number of communication metaphors from different channels of communication (e.g. visual, audio, and audio-visual) into a single and integrated form of communication in order to make the interaction process easier. Auditory metaphors consist of recorded or synthesised speech. Non-speech auditory output consists of earcon and auditory icons. The use of natural speech is more meaningful to users (better understood) compared to the synthesised speech. Earcons are non-speech short musical sounds that are used to communicate information about objects, operations, and other events in the user interfaces.

Social interaction in e-commerce applications through Web 2.0 technologies has provided a platform from which consumers can share and communicate their product experiences and opinions. Moreover, potential aspects and approach of multimodal metaphors and the literature of multimodality in socially interactive e-commerce interfaces were described and discussed. Several issues can be tackled with incorporating social interaction into e-commerce applications interfaces such as; knowledge hoarding, social presence, purchase intention, and information overloading.

CHAPTER 3 CONDITIONS DESIGN

Objectives

- Design of experimental phases I & II.
- Aims, objectives, and hypotheses.
- Review the experiment design.
- Provide the experiment variables.

3.1 Overview

This chapter describes the experimental platform and the conditions of the two experiments that aim to investigate the influence of social interaction on users of e-commerce applications. The first experiment investigated the influence of social interaction and its impact upon usability and the user‘s trust and understanding of e-commerce interfaces. using static social interaction (SSI), interactive social interaction (ISI) and no-social interaction (NSI). The second experiment was based on the results of the first experiment. The second experiment investigated the role of multimodal metaphors on social interactive e-commerce environments. Multimodal metaphors (e.g. earcons, auditory icons, speech output, and audio visual avatars) were examined in addition to the traditional text with graphics approach.

3.2 Aims

The aim of this first experimental study (consisting of two experiments) was to obtain an overall viewpoint on whether social interaction can outperform non-social interaction on e-commerce interfaces. The sub-aims include:

1. Examine the associations of employing the social interaction metaphors and techniques in e-commerce interfaces.
2. Evaluate social interactive e-commerce interfaces in terms of effectiveness, efficiency and the user‘s attitudes including user satisfaction and social presence.
3. Identify significant differences on user performance between the non-social interface, static social interfaces and interactive social interfaces.

4. Evaluate the impact of multimodal metaphors in e-commerce applications and assess the usefulness of audio in conveying products connected to information, knowledge and product selection.
5. Assess the impact of multimodality on users' attitude in terms of satisfaction, consumers' shopping enjoyment and purchase intention.

3.3 Objectives

The objectives needed in order to achieve the aims include:

1. Formulate the experimental hypotheses based on the aims.
2. Develop an experimental e-commerce platform and use this platform as a basis to implement three experimental conditions:
    a. Non-social interaction (NSI).
    b. Static social interaction (SSI).
    c. Interactive social interaction (ISI).
3. Evaluate empirically these conditions with user tasks that reflect a variety of interface circumstances and difficulty in order to gather data on the impact (or lack of) social interaction in e-commerce using a within-subject design approach. The measuring parameters include:
    a. *Efficiency* of task completion (the time taken by users to complete tasks).
    b. *Effectiveness* of task completion (users reaching the end point of a task).
    c. Post experimental *user viewpoint and satisfaction* about the absence or presence of social interaction during transactions (e.g. product selection) in an e-commerce interface.

3.4 Hypotheses

The experimental hypothesis is that the impact of interactive social presence in an e-commerce interface will outperform its counterpart with static or absent social presence in the usability parameters (effectiveness, efficiency and user satisfaction). Based on this hypothesis, eight sub-hypotheses specific to the experimental platform and the three associated conditions have been compiled. These sub-hypotheses are:

H1: (a) SSI will be more effective than NSI in terms of tasks completed successfully.

(b) ISI will be more effective than SSI and NSI in terms of tasks completed successfully.

H2: (a) SSI will be more efficient than NSI in terms of user error.

(b) ISI will be more efficient than SSI and NSI in terms of user error.

H3: (a) Users will be more satisfied with SSI than NSI conditions.

(b) Users will be more satisfied with ISI than SSI and NSI conditions.

For the second phase the overall hypothesis investigated is shown below:

The use of audio visual interaction in socially interactive e-commerce applications will enhance the usability of the interfaces and increase the users' social presence, decision making and product understanding in comparison with the use of audio social interactive interfaces, user can be defined as an individual who interacts with the e-commerce environment to accomplish a defined task.

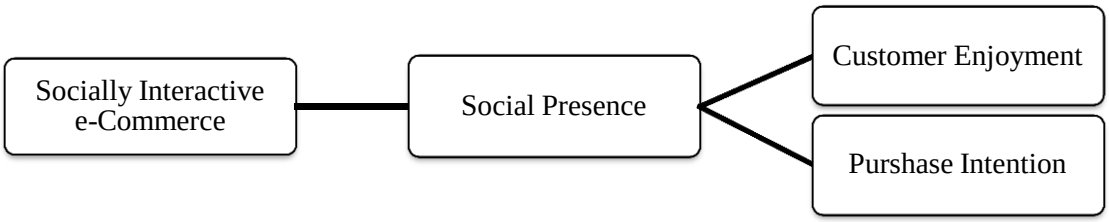


Figure 3.1: A conceptual model of relationships between socially interactive e-commerce, social presence, customer enjoyment, and purchase intention.

This experiment hypothesis is divided as following:

H4: AVISI is more effective than AISI in terms of the percentage of tasks completed successfully in different complexity levels.

H5: (a) AVISI is more efficient than AISI in terms of the task completion time in different complexity levels.

(b) AVISI is more efficient than AISI in terms of the number of mouse clicks required to complete assigned tasks in different complexity levels.

H6: Users will be more satisfied with AVISI in comparing with AISI.

H7: Users will perceive AVISI as being more interactive and helpful than AISI.

H8: Users will perceive AVISI's social presence more than AISI's.

3.5 Experimental Conditions

The first phase of the experiment involved the development of three conditions. These were a *non-social interaction* (NSI), a *static-social interaction* (SSI), and an *interactive-social interaction* conditions (ISI). The second experiment involved an Audio Interactive Social interaction condition (AISI) and an Audio Visual interactive Social Interaction condition (AVISI). However; this part explains the experiment conditions

designs and shows screenshots of the system pages starting with the system home page or group selection page in Figure 3.2 which shows the deferent groups total of six groups.

In summary, this study considered evaluating different conditions according to two aspects; one is the present or absence of social interaction (e.g. reviews) which presents three conditions (NSI, SSI, and ISI); and the other phase is the focus on the role of multimodal interactions. Therefore, the second phase of the experiment involved developing an experimental ISI system with two interface conditions, these were an Audio Interactive Social Interaction (AISI) and an Audio Visual Interactive Social Interaction (AVISI). Table 3.1 shows the mapping between tasks content and multimodal metaphors. Figure 3.3 demonstrate the pre-experiment questions which looks to the users profile and internet experiences.

Experimental Conditions	AISI Audio Interactive Social interaction							AVISI Audio visual Interactive Social interaction			
Interaction metaphors / Content	**Text**	**Graphics**	**Interactive colours**	**Recorded speech**	**Synthesised speech**	**Auditory icons**	**Earcons**	**Text**	**Graphics**	**Interactive colours**	**Audio Visual (Avatar)**
Product Description	✓	✓						✓	✓	✓	
Task content	✓	✓			✓			✓	✓	✓	✓
Customer Reviews	✓		✓		✓	✓	✓	✓	✓	✓	✓
Reviews Rating		✓				✓	✓			✓	
Price	✓		✓	✓				✓	✓		
Features	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓

Table 3.1: The allocation of metaphors to the information communicated.

Figure 3.2: Experiment group selection screenshot.

Figure 3.3: Pre-experiment questions screenshot.

3.5.1 e-Commerce in the Absence of Social Interaction (NSI)

Figure 3.4 shows an example screenshot of the non-social interactive condition (NSI). In the experimental set-up, the user read the requirements prior to completing the task (e.g. product selection). This condition is a typical non-social e-commerce product selection scenario. Users search and browse the available products. The decision of users to proceed with a product selection is based on written descriptions (sometimes complemented by video or pictures). The assumption is that users would successfully match their needs based on the presented information. It involves navigation through

lists and the accurate understanding of the specifications of products prior to selection in the absence of social help (e.g. reviews or user-generated discussions).

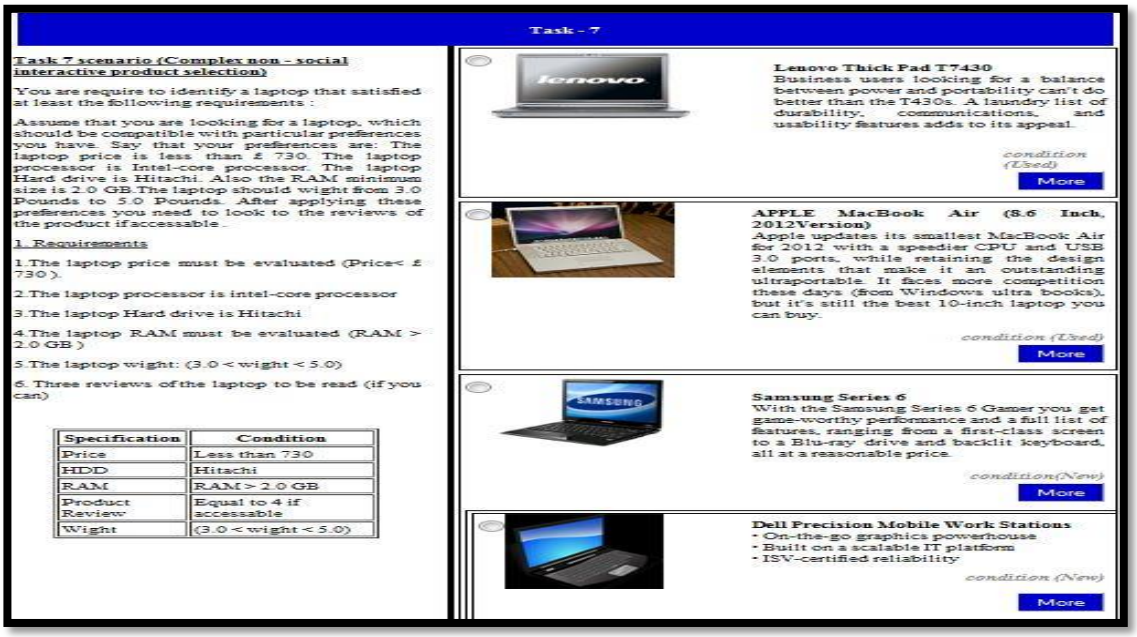


Figure 3.4: An example display of the NSI condition.

3.5.2 e-Commerce with Static Social Interaction (SSI)

Figure 3.5 demonstrates the static social interaction condition to enable the selection of a range of products presented to the system users. The SSI condition in this experiment benefit from having a static form of social interaction that helps the users to make more accurate decisions this comes from a reviews page. The reviews page gives a list of product related reviews. Reading those reviews which were designed to help users and direct them toward the right selection. However; this condition simulated the review pages that can be found in current traditional e-Commerce sites.

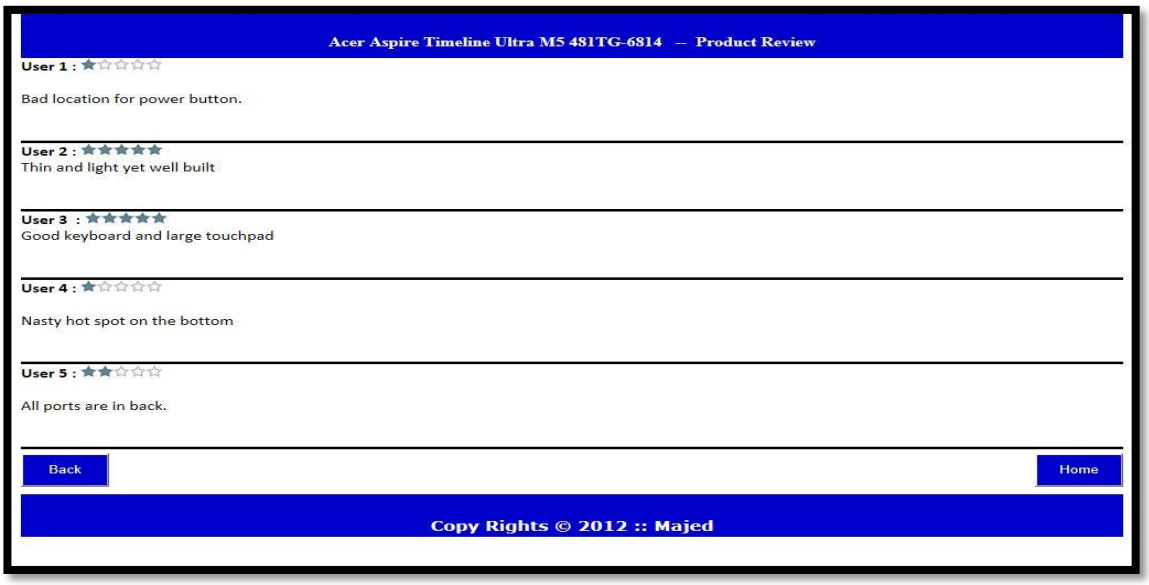


Figure 3.5: SSI screenshot.

3.5.3 e-Commerce with Interactive Social Interaction (ISI)

Figure 3.6 demonstrates the interactive social interaction condition. It designed to enable the selection of a range of products presented to the system users. Each review has an interaction within the review; the form of interaction which was adopted is that any review has replays and rating so the users would know how valuable the review is by looking at the discussions under each review. The main characteristics of the ISI condition are:

- It benefit from a review page.
- Each review has a discussion within the review.
- Has a review rating score.

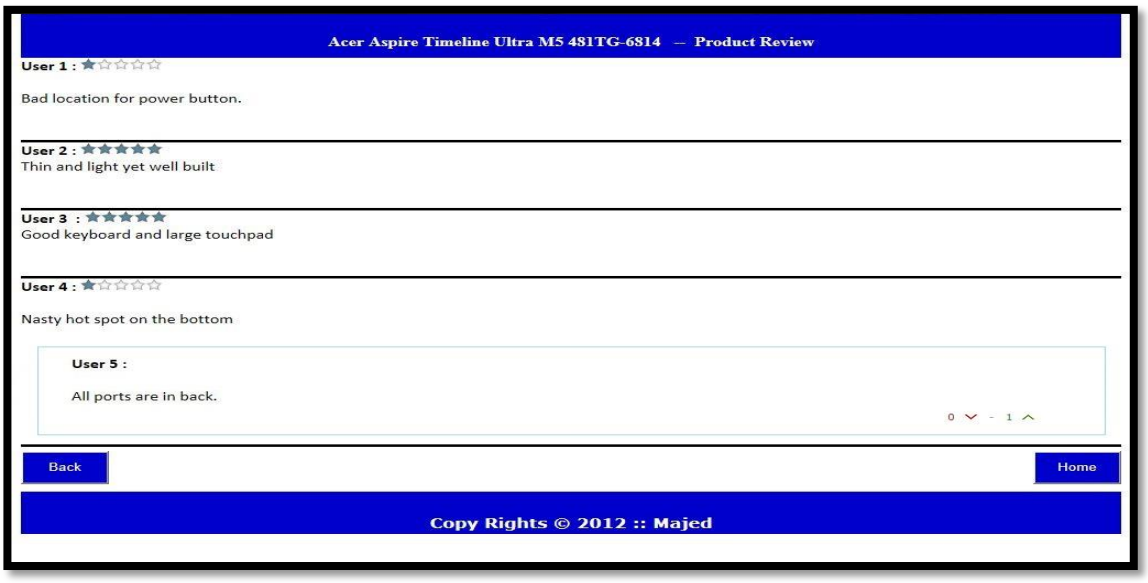


Figure 3.6: ISI screenshot.

3.5.4 Audio Interactive Social Interaction (AISI)

Figure 3.7 shows a visual example of the Audio Interactive Social Interaction condition (AISI) interface in which the required information was delivered in an auditory approach and could be communicated by the auditory channel in addition to the text and graphics in the interaction process.

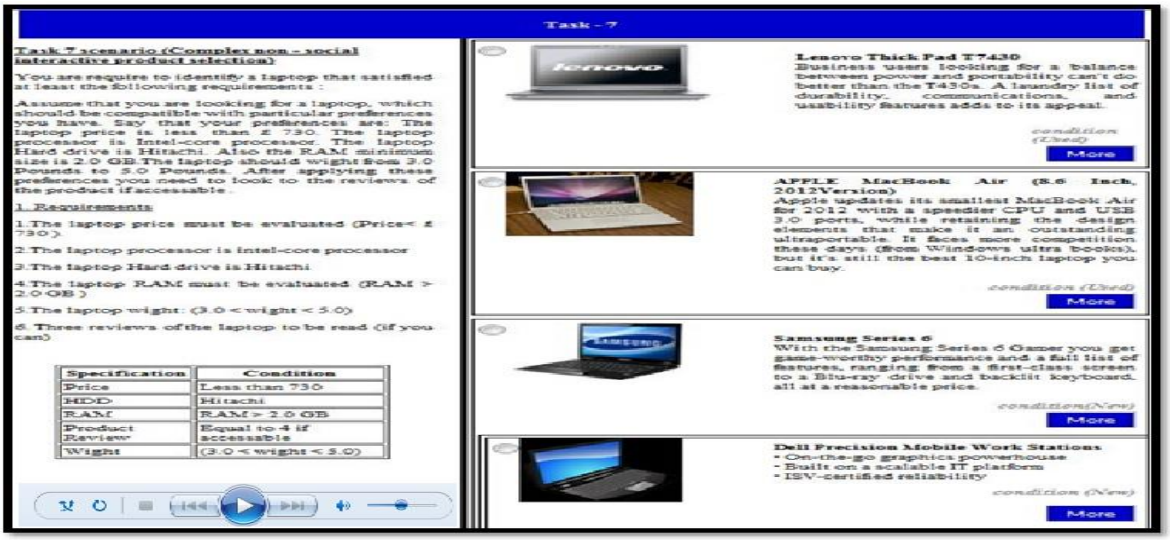


Figure 3.7: An example screenshot of auditory interface AISI.

3.5.5 Audio Visual Interactive Social Interaction (AVISI)

Figure 3.8 shows an example screenshot of the Audio Visual interactive Social Interaction condition (AVISI) interface in which the required information was delivered in an audio visual (Avatar) approach and could be communicated by both the visual channel and the auditory channel in addition to text with graphics in the interaction process.

Figure 3.8: An example screenshot of audio visual interface AVISI.

3.6 Implementation

The implementation of the platform involved the use of several technologies and tools.

The auditory design involved earcons, auditory icons and speech. Specialised software used included text-to-speech [123] and digital sound recording [124].

Guidelines provided by other research for the creation earcons, icons, and auditory icons were followed [125]. In addition, the environmental sounds used were the sounds of clapping, camera shot, typing, laughing, cheering, gasping, and whistle. Synthesised speech was also employed to read customer reviews and other textual information, for

example product description and tasks instructions. The software was used to present the synthesised speech is eSpeack which support multi-language [126].

The use of facially expressive avatars to illustrate product related information and tasks related instructions; that includes three expressions for example, happy, neutral and sad. The software used to implement avatars is CrazyTalk 6.0 which is the most popular multifunction facial animation tool that uses sound and text to vividly animate facial images to create human-like avatars [127].

3.7 Experimental Design

The within-subject design methodology was used in the first experiment to evaluate the NSI, SSI, and ISI conditions. The within-subject methodology reduces the risk of external factors influencing the performance of users from one condition to another. In this way, each user was exposed to all three conditions and experimental tasks. The user sample consisted of 36 users and was evaluated on an individual basis. The group was divided into six groups of six users. The experiment consisted of four parts. These were a pre-experimental questionnaire, the experiment, post-task questions and post- experimental questions.

3.8 Experimental Procedure and Rotation of Tasks

The rotations were calculated by the factorial value function of the conditions using the function $n! = \prod_{k=1}^{n} k$ [128]. As there are three conditions (n = 3), this function will be $3! = 3 \times 2 \times 1 = 6$. This results in six possible rotation groups with six users in each group with a total user sample of 36 users.

Each user performed nine tasks of different complexity and type. Table 3.2 shows the order and rotation that each user performed the experimental tasks. The sample was

divided to six groups. This experiment has two independent variables; the task type (SSI, NSI and ISI) and the task level (simple, moderate and complex). Therefore, the number of conditions is: number of conditions = 3×3 = 9.

The users carried out the tasks in varied order. The three types of tasks were performed by users in six orders. Each of these orders was carried out by a group of users. The first group of six users evaluated first the NSI condition followed by the SSI and ISI conditions. Another group of users started with the SSI condition, followed by NSI and ISI conditions. These combinations of sequences were manipulated between all variables and users. The full order rotation can be seen in Table 3.3.

Table 3.4 shows the allocation of tasks to conditions according to task complexity. The tasks are designed according to the variables of increasing complexity and mutual interaction modes. The total number of tasks involved in the experiment is nine tasks for all users to undertake. For the second phase of the experiment illustrates both the experimental and the rotation schemes together with the users groups.

Users	*Pre – experimental Questionnaire*	*Demonstration of the experiment*	**Simple**	*Post Task Questions*	**Moderate**	*Post Task Questions*	**Complex**	*Post Task Questions*	*Post – experimental Questionnaire*
1 ,7,13,19,25,31			NSI		SSI		ISI		
2,8,14,20,26,32			NSI		ISI		SSI		
3,9,15,21,27,33			SSI		NSI		ISI		
4,10,16,22,28,34			SSI		ISI		NSI		
5,11,17,23,29,35			ISI		NSI		SSI		
6,12,18,24,30,36			ISI		SSI		NSI		

Table 3.2: Experimental procedure according to the experimental conditions.

Users	Allocation of tasks to conditions and order of user performance								
	Simple			Moderate			Complex		
Group 1	NSI (T1)	SSI (T2)	ISI (T3)	NSI (T4)	SSI (T5)	ISI (T6)	NSI (T7)	SSI (T8)	ISI (T9)
Group 2	NSI (T1)	ISI (T3)	SSI (T2)	NSI (T4)	ISI (T6)	SSI (T5)	NSI (T7)	ISI (T9)	SSI (T8)
Group 3	SSI (T2)	NSI (T1)	ISI (T3)	SSI (T5)	NSI (T4)	ISI (T6)	SSI (T8)	NSI (T7)	ISI (T9)
Group 4	SSI (T2)	ISI (T3)	NSI (T1)	SSI (T5)	ISI (T6)	NSI (T4)	SSI (T8)	ISI (T9)	NSI (T7)
Group 5	ISI (T3)	NSI (T1)	SSI (T2)	ISI (T6)	NSI (T4)	SSI (T5)	ISI (T9)	NSI (T7)	SSI (T8)
Group 6	ISI (T3)	SSI (T2)	NSI (T1)	ISI (T6)	SSI (T5)	NSI (T4)	ISI (T9)	SSI (T8)	NSI (T7)

Table 3.3: Experimental procedure of the tasks, conditions and groups of users.

Level	Tasks		Task Type
	Code	**Description of the allocated condition**	**Task type code**
Simple	T1	No social interaction	NSI
	T2	Static social interaction	SSI
	T3	Interactive social interaction	ISI
Moderate	T4	No social interaction	NSI
	T5	Static social interaction	SSI
	T6	Interactive social interaction	ISI
Complex	T7	No social interaction	NSI
	T8	Static social interaction	SSI
	T9	Interactive social interaction	ISI

Table 3.4: The allocation of tasks to conditions.

Users	***Pre – experiment Questionnaire***	***Demonstration of the experiment***	**Task**	***Post Task Questions***	**Task**	***Post Task Questions***	**Task**	***Post Task Questions***	***Post – experiment Questionnaire***
1 ,7,13			Simple		Moderate		Complex		
2,8,14			Simple		Complex		Moderate		
3,9,15			Moderate		Simple		Complex		
4,10,16			Moderate		Complex		Simple		
5,11,17			Complex		Simple		Moderate		
6,12,18			Complex		Moderate		Simple		

Table 3.5: The procedural scheme of the second experimental phase.

Figure 3-9 demonstrates the experimental procedure using the experimental platform. Each user completed nine tasks by selecting the relevant group prior to proceeding with the pre-experimental questions, complete the experimental tasks and post-task questions.

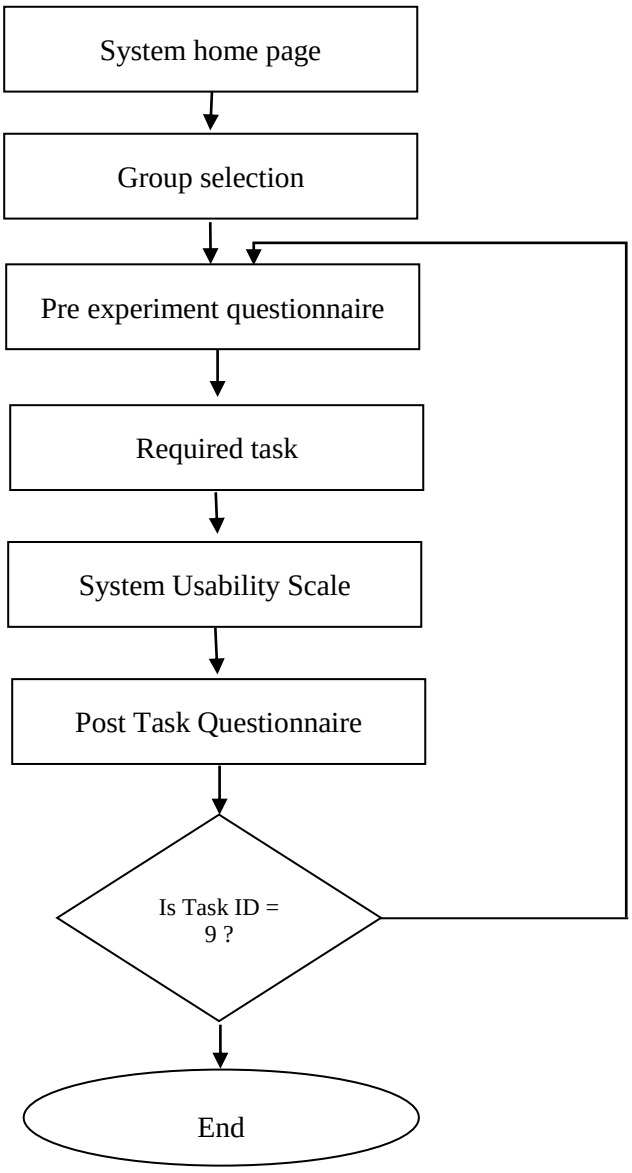


Figure 3.9: Flowchart of the experiment.

3.9 Experiment Task Diagram

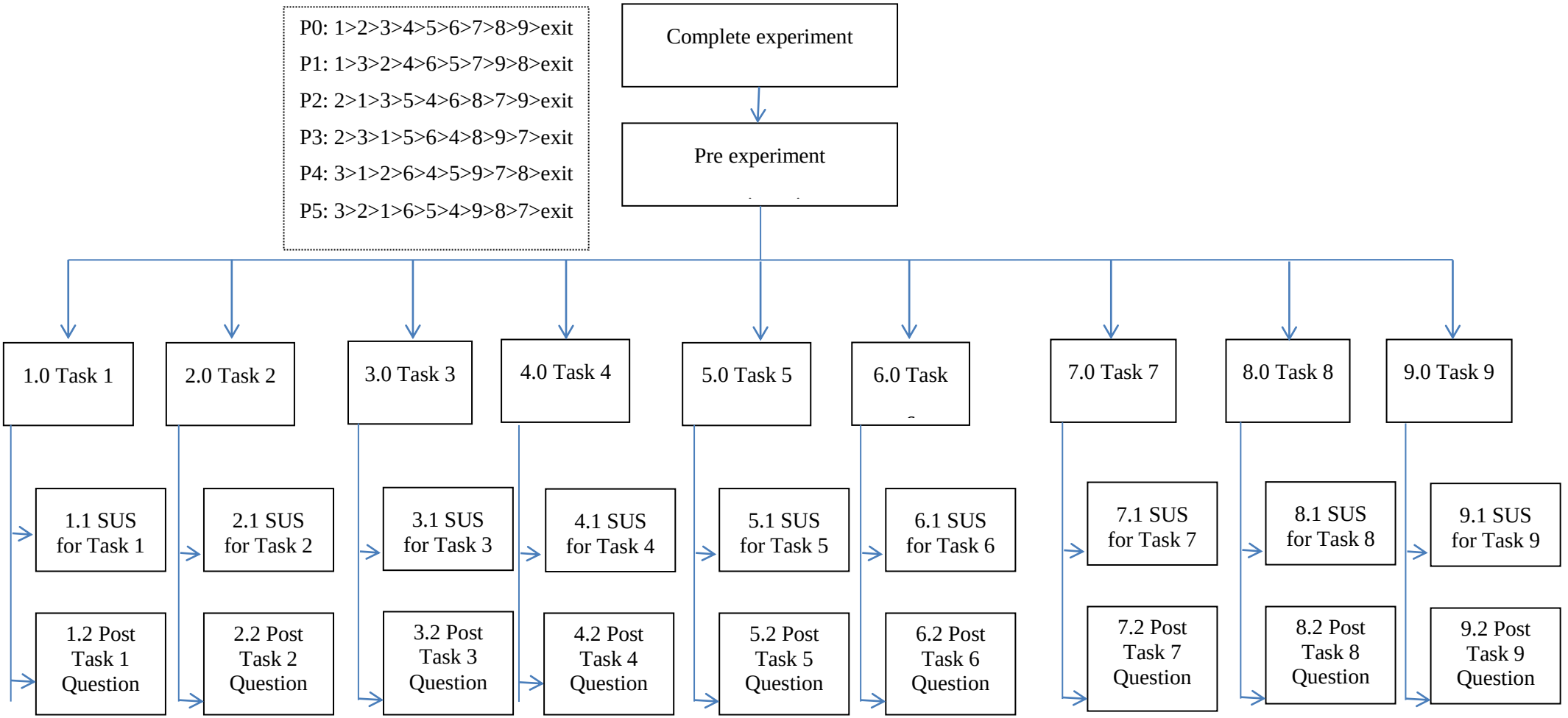


Figure 3.10: Task diagram experiment I.

The user sample of the second experiment consisted of 36 users who performed six experimental tasks with pre-experimental and the post-experimental questionnaires. The user sample was split into two groups of 18 users each. One group evaluated AISI and and the other group evaluated the AVISI conditions. A rotation scheme was used to reduce the learning effect. Each group was divided into six sub-groups of three users. The sub-groups were assigned with a specific rotation scheme of tasks.

3.10 Experimental Variables

This experimental involved independent, dependent variables, and controlled variables [129]. The following sections describe these variables.

3.10.1 Independent

Independent variables are the variables that affect the dependent variables. When manipulated are the cause of the results obtained from this study [117, 122].

IV1: Interaction mode: The first experiment had the non-social interactive (NSI), static social interactive (SSI), and interactive social interactive modes (ISI). The second experiment had the audio interactive social interactive (AISI) and the avatar interactive social interactive modes (AVISI).

IV2: Task complexity level: The tasks were design to increase in complexity ranging from simple, moderate, and complex tasks (see Table 3.6).

The complexity of the tasks was the main differentiating factor. Complexity increased with the intensity of the knowledge communicated to the users and mental workload. For instance, simple tasks had a low volume of information to be communicated and required smaller mental workload compared to moderate and complex tasks.

Variable code	Variable name	Conditions for phase I	Conditions for phase II
IV1	Interaction mode	NSI	AISI
		SSI	AVISI
		ISI	
IV2	Task complexity level	Simple	Simple
		Moderate	Moderate
		Complex	Complex

Table 3.6: Independent variables of the two experimental phases.

3.10.2 Dependent

Dependent variables are the measured variables. Therefore, the simplest method to examine the usability approach is to compare it with another one by number of measurement factors. The dependent variable shows the outcome measured during the experimental treatment.

DV1: Task completion time: the time each user took to complete a particular task.

DV2: Count of mouse clicks: number of mouse clicks while the task is performed.

DV3: Successfully task completion: measure the completion of tasks with successful selection these tasks included product selection; task completion determined the accuracy of the selection. The task was considered successfully completed only if the selection was deemed accurate.

DV4: User satisfaction: This variable was measured by completing a satisfaction questionnaire which provides information about several aspects of user satisfaction, such as the need for support, training, and complexity. The questionnaire was implemented via a five-point Likert scale. On the achievement of collecting user

responses, the system usability scale SUS approach was applied in order to produce the user satisfaction score.

DV5: Perception of social presence: On completion of the tack, users were asked to score their agreement or disagreement with statements on the provided questionnaire. There related to perception of social presence that measures the following aspects of social presence: '*sense of human contact, sense of personalness, sense of sociability, sense of human warmth and sense of human sensitivity*'[44]. A score was produced through a five-point Likert scale. Table 3.7 summarises the dependent variables in this study.

Variable code	Variable name	What is it measured?
DV1	Task completion time	Efficiency
DV2	Frequency of mouse clicks	Efficiency
DV3	Successfull task completion	Effectiveness
DV4	User satisfaction	Satisfaction
DV5	Perception of social presence	Social Presence

Table 3.7: Dependent variables of the two experimental phases.

3.10.3 Controlled variables

The controlled variables [117, 130] of the experiment were:

CV1: *Tasks required*: all users complete the same tasks using different rotations.

CV2: *Nature of tasks and presentation*: the contents of the tasks was the same for all groups and they were represented uniformly to the users.

CV3: *Tasks requirements*: tasks requirements were similar to all users.

CV4: *Familiarity*: all users were new to the experimental conditions and received the same training prior to the experiment.

3.11 Data Collection

Observations, questionnaires and system monitoring were used to collect the empirical data. This included the time taken by each user to complete a task, the number of mouse clicks by each user per task, accurate menu selection and tasks completed successfully. Post-experimental data was also collected from users using a questionnaire for both conditions. This included user attitudes towards the social presence of the interactive system, user satisfaction, and user evaluation.

The data collection techniques consisted of the direct observation of the experimenter and questionnaires. The collected data was analysed using descriptive and inferential statistics. The descriptive statistics provided summaries and comparisons on the experimental observations. The central tendency (or location) includes the mean, median and mode. The mean is the weighted sum of the value of each observation in a dataset divided by the number of observations or in other words it is the arithmetic average of the scores. It has the advantage of taking all the scores into consideration [131]. It is argued that the mean has a limitation by not representing the whole set of data, because it is influenced by outliers and skewed distributions and it cannot be calculated for categorical data. Therefore, the median can be a representative of the central tendency of the data set; the median is the middle value in distribution when the values are arranged in ascending or descending order. However, the mean and the mode do not provide a reasonable indication of the central tendency of categorical data as the values cannot be summed nor ordered. Hence, the mode is regarded as a reasonable

indicator because it is the most commonly occurring value in a distribution. In addition, the representation of the data in graphs enables the process of comparing variables based on the arithmetic means. In the categorical data, illustrative tables have been used to present the mode, frequency of the mode and the mean. A brief description of the data set was produced based on descriptive statistical techniques, graphical charts and illustrative tables [132]. Inferential statistics apply the logic of hypothesis testing to examine the statistical significance differences between variables, and traditionally the 5% level of significance (p-value = 0.05) has been used. The selection of statistical tests is an important element in research design, relying on several factors, such as experiment design methodology, characteristics of variables, data type, number of samples, and the distribution of the data set.

3.12 Summary

This chapter described the five conditions of the first two experimental phases. The first three conditions (NSI, SSI, and ISI) were evaluated by one dependent group using a 'within subject' design. The other two conditions (AISI and AVISI) were evaluated by a further two groups of users. Although all five conditions are described in one Chapter, the latter two conditions were designed in the light of the results from the first three conditions. The Chapter also describes the experimental variables and associated methodology for the settings of the two experimental stages.

CHAPTER 4 EMPIRICAL DATA OF PHASE I & II: ANALYSIS AND DISCUSSION

Objectives

- Empirical data and analysis of phases I and II.
- Discussion, statistical analysis and conclusions.

4.1 Experiment Phase I: Results and Analysis

The obtained results of this experiment were analysed in terms of tasks completed by users successfully (*effectiveness)*, user satisfaction and task completion time (*efficiency)*. The repeated measures analysis of variance (*ANOVA* – as an extension of the paired samples t-test) which was used to determine the statistically significant differences amongst the population means of three or more related groups [133]. The groups are related as they contain the same cases (e.g., participants) in each group and each group represents a repeated measurement on the same dependent variable. This test is also referred to as a *within-subject ANOVA* or *ANOVA* with repeated measures [134-136].

4.1.1 Sample Profile

Figure 4.1 shows the sample profile in terms of age, education, and experience of internet shopping. The majority of the users were between 25 and 44 years old. 67% of the users were postgraduate students. The users of this experiment were distributed in three groups according to the internet usage by having over 50% of the users used internet more frequently that's more than five times a week with over ten hours a week, also 42% six to ten hours a week which considered as 15 users; 28% of the users uses internet three to five times a week and 8% uses internet from one to five hours a week, likely 19% uses internet once or twice a week, therefore in the randomly selected sample of the population there were no users who does not use internet at all. The frequencies of purchasing a product over the internet shows that around 47% of the users purchase a product occasionally, another 17% purchase one or two times a week, also 8% purchase from three to five times a week, and amazingly 3% that's one user purchase more than five times a week.

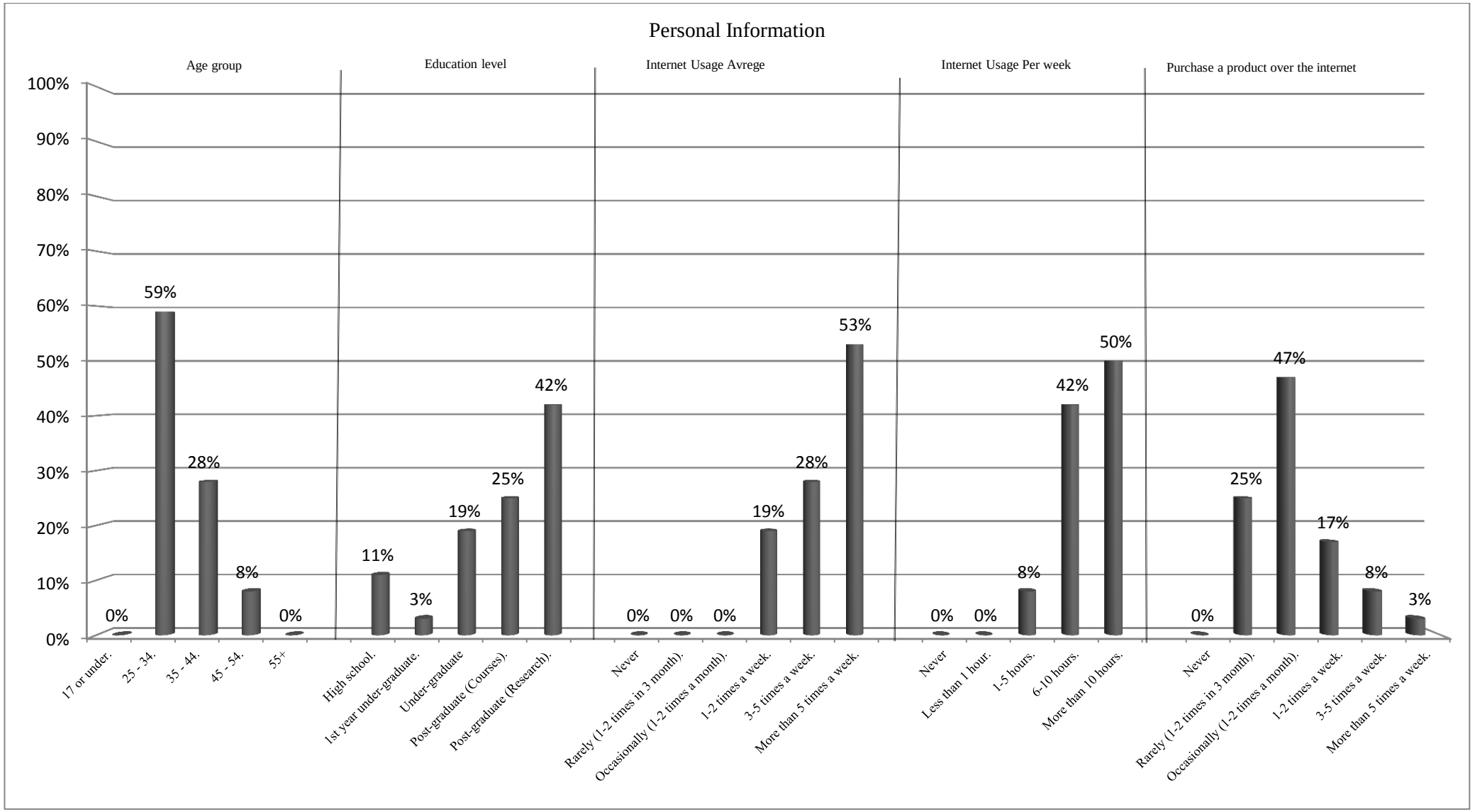


Figure 4.1: user profile (Phase I).

4.1.2 Efficiency

Efficiency was measured by the time taken by users to complete the tasks and the frequency of mouse clicks for each condition (NSI, SSI, and ISI) and task complexity (simple, moderate, and complex). Figure 4.2 shows the mean values of the time taken by the users to complete all tasks (A), grouped by the task complexity level (B) and interaction mode (C). Figure 4.3 shows the mean values of the number of mouse clicks by the users to complete all the assigned tasks (A), grouped by the task complexity level (B) and interaction mode (C). The raw data for task time can be found in Appendix A.

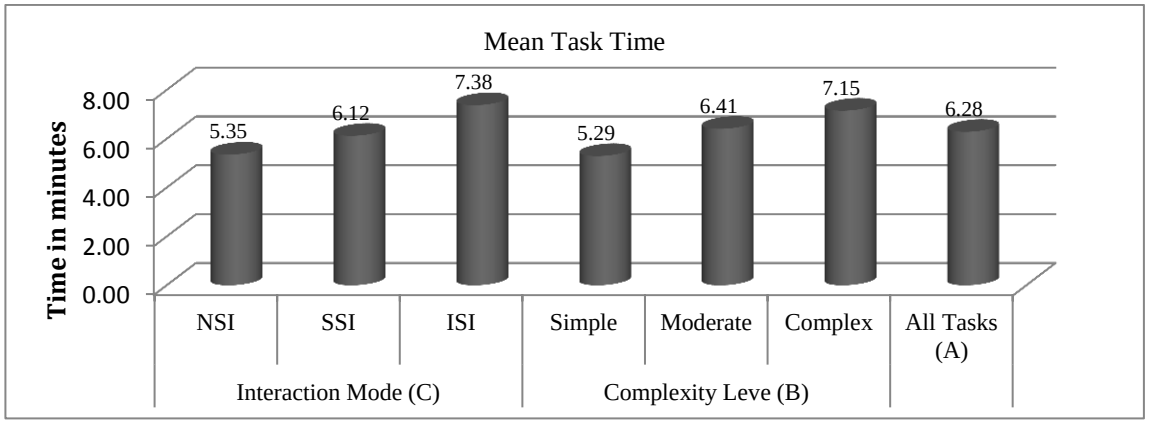


Figure 4.2: Mean values of time taken by users to complete tasks (Phase I).

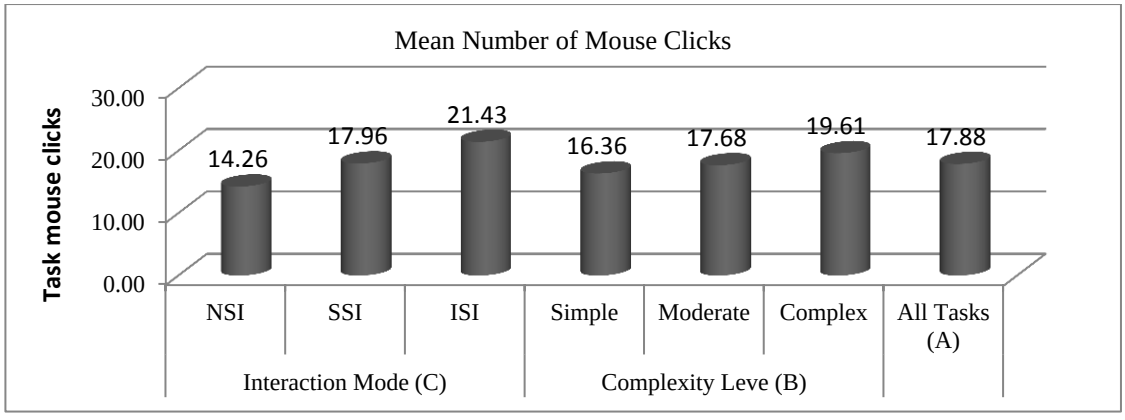


Figure 4.3: Mean values of the number of mouse clicks used by users to complete tasks.

4.1.3 Tasks completion time according to interaction modes

In total of nine tasks each user undertakes there were three interaction modes, each interaction mode consist of three tasks of different complexity levels. Figure 4.2 (a) shows that according to interaction modes which are ‘’NSI’’, ‘’SSI’’ and ISI.

The mean time taken by users to complete all tasks was 56.53 minutes, 16.06 minutes for NSI tasks, 18.36 minutes for SSI and 22.11 minutes for ISI. However due to the nature of tasks, it was expected that ‘’ISI’’ tasks will take longer as users were required to visit more pages and perform more activities than ‘’SSI’’ and ‘’NSI’’ tasks. Figure 4.4 shows the task accomplishment time per interaction mode for all users in minutes.

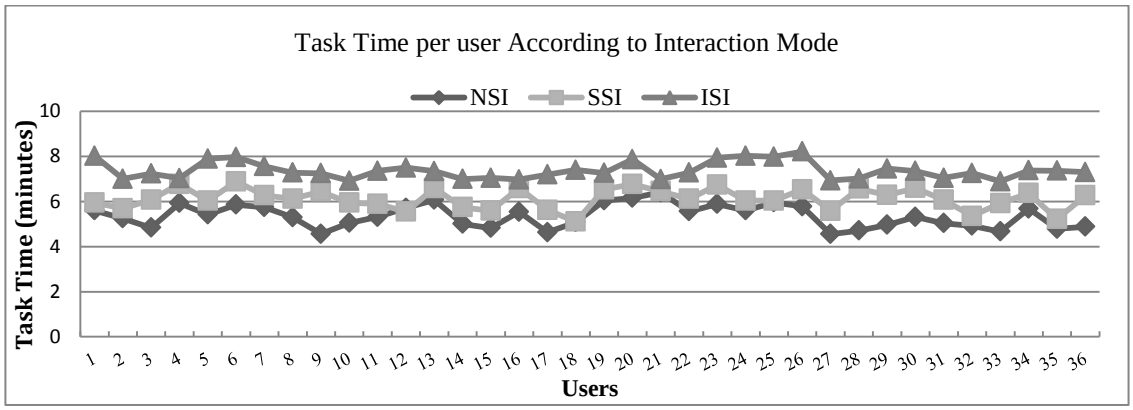


Figure 4.4: Time taken by users to complete each task according to interaction modes (Phase I).

4.1.4 Task Efficiency According to Task Complexity

The experimental tasks were classified into *simple, moderate* and *complex*. Figure 4.2 (b) shows the efficiency results for each task category. These are 15.88 minutes for simple tasks, 19.22 for moderate and 21.45 for complex.

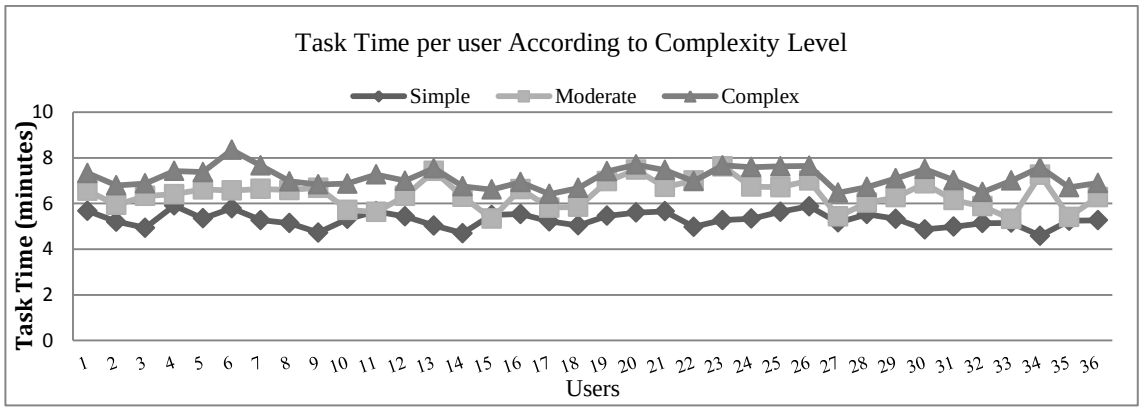


Figure 4.5: Time to complete each task according to interaction modes (Phase I).

There were no outliers in the data, as assessed by inspection of a boxplot for values greater than 1.5 box-lengths from the edge of the box. Task accomplishment time was normally distributed at each task, as assessed by Shapiro-Wilk's test with p >.05 (see also Appendix A). The within-subjects factors, the levels of the independent variables (interaction modes: NSI, SSI, and ISI) and complexity levels (simple, moderate, and complex). The task accomplishment time increased from 5.294±0.054 minutes in the NSI to 6.407±0.102 minutes to SSI and 7.134±0.73 minutes to SSI.

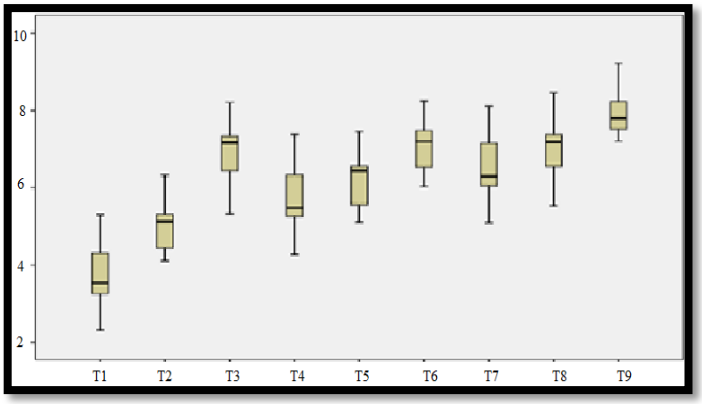


Figure 4.6: Profile pots for task accomplishment time (Phase I).

Again, there were no outliers in the data as assessed by the inspection of the boxplot for values greater than 1.5 box-lengths from the edge of the box. Task accomplishment time was normally distributed for each task as assessed by Shapiro-Wilk's test, p >.05.

The within-subjects factors, the levels of the independent variables, which are interaction modes (NSI, SSI, and ISI) and complexity levels (simple, moderate, and complex). Task accomplishment time increases from 5.294 ± 0.054 minutes NSI-Interaction mode to 6.407 ± 0.102 minutes at SSI-Interaction mode and 7.134 ± 0.73 minutes at SSI-Interaction mode.

Estimates				
Measure: Time				
Interaction Mode	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
NSI	5.294	.054	5.183	5.404
SSI	6.407	.102	6.201	6.614
ISI	7.134	.073	6.986	7.282

Table 4.1: Time estimates per experimental condition (Phase I).

The profile plot demonstrates that task accomplishment time increased at each successive time point. For example, the time points from "1" to "2" is marginally greater than from "2" to "3". The *estimated marginal means* are the values of the related groups (technically, they are each group's estimated population mean).

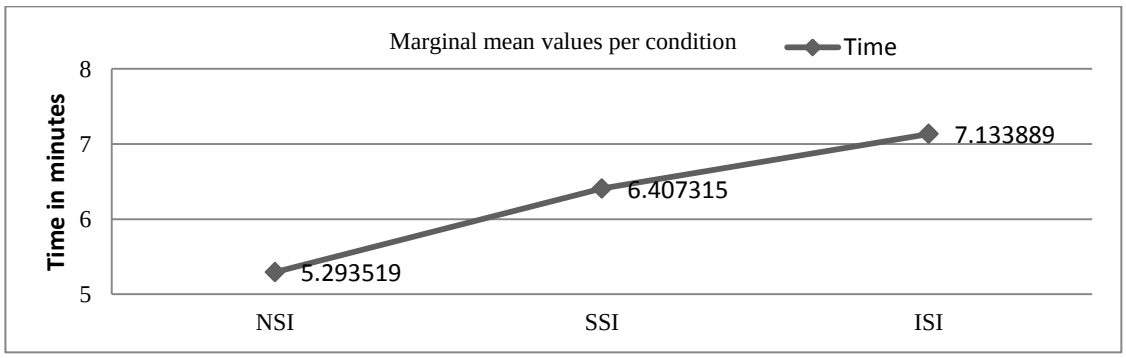


Figure 4.7: Mean values of (a) time taken by users to complete tasks per condition and (b) task types per condition.

The time taken by users to complete tasks increased from 5.341 ± 0.086 minutes for simple tasks to 6.121 ± 0.077 for moderate and 7.372 ± 0.062 for complex.

The Bonferroni post-hoc test is an alternative way to compare group differences. This test provides both confidence intervals for the differences between group means

and the statistical significance of the differences. According to this test, a statistically significant increase of 0.78 minutes for simple tasks (95% CI, 0.59 to 0.98, p < .0005), 2.03 minutes for moderate tasks (95% CI, 1.8 to 2.23, p <.0005) and 1.25 minutes for complex tasks (95% CI, 1.03 to 1.47, p < .0005).

The assumption of *sphericity* was tested using Mauchly's test. Sphericity is the condition where the variances of the differences amongst all combinations of related groups (levels) are equal. *Violation of sphericity* is when the variances of the differences between all combinations of related groups are not equal. Sphericity can be likened to homogeneity of variances in a between-subject ANOVA and tested for with Mauchly's Test of Sphericity. Mauchly's Test of Sphericity tests the null hypothesis that the variances of the differences are equal. Thus, if Mauchly's Test of Sphericity is statistically significant (p < .05), we can reject the null hypothesis and accept the alternative hypothesis that the variances of the differences are not equal (i.e., sphericity has been violated).

Mauchly's test indicated that the assumption of sphericity had been violated for the conditions (x^2(2) = 19.985, p = 0.000), interaction mode * complexity of tasks (x^2(2) = 25.115, p = 0.03). However, sphericity had not been violated for complexity level (x^2(2) = 0.674, p = 0.714). In this case, the Greenhouse-Geisser correction is applicable for the condition given the value of epsilon ((ε) = 0.692).

The time taken users to complete tasks in each of the conditions was different. This time difference was found to be statistically significant (F(1.385, 70) = 213.506, p < .0005, partial η2 = 0.859). Table 4.2 explains these statistical findings. A statistical

significance was also reached for each task type (simple, moderate and complex) per condition ($F(2, 70) = 321.820$, $p < .0005$, partial $\eta 2 = 0.902$).

Statistic	Explanation
F	*F*-distribution (*F*-test)
1.385 in (1.385, 70)	Degrees of freedom for the conditions
70 in (1.385, 70)	Degrees of freedom for error (conditions)
213.506	*F*-value
$p < .0005$	Probability of obtaining the *F*-value if the null hypothesis is correct
partial $\eta^2 = 0.859$	A measure of effect size.

Table 4.2: *F*-distribution (*F*-test) to determine statistical significance for the time taken by users to complete tasks for each condition.

4.1.5 Post-hoc analysis for interaction modes

There was an increase in Task accomplishment time from 5.294 ± 0.054 minutes NSI-interaction mode to 6.407 ± 0.102 minutes at SSI-Interaction mode, a statistically significant increase of 1.114 (95% CI, 0.823 to 1.405) minutes, $p < .0005$. Also, there was an increase in task accomplishment time from 5.294 ± 0.054 minutes NSI-interaction mode to 7.134 ± 0.73 minutes at ISI-interaction mode, a statistically significant increase of 1.84 (95% CI, 1.66 to 2.03) minutes, $p < .0005$. Also, there was an increase in task accomplishment time from 6.407 ± 0.102 minutes at SSI-interaction mode to 7.134 ± 0.73 minutes at ISI-interaction mode, a statistically significant increase of 0.727 (95% CI, 0.534 to 0.91) minutes, $p < .0005$.

4.1.6 Mouse clicks within-subjects factors

The descriptive statistics Table 4.3 provides the necessary information to describe the dependent variable based on the combination of levels of the two within-subjects factors.

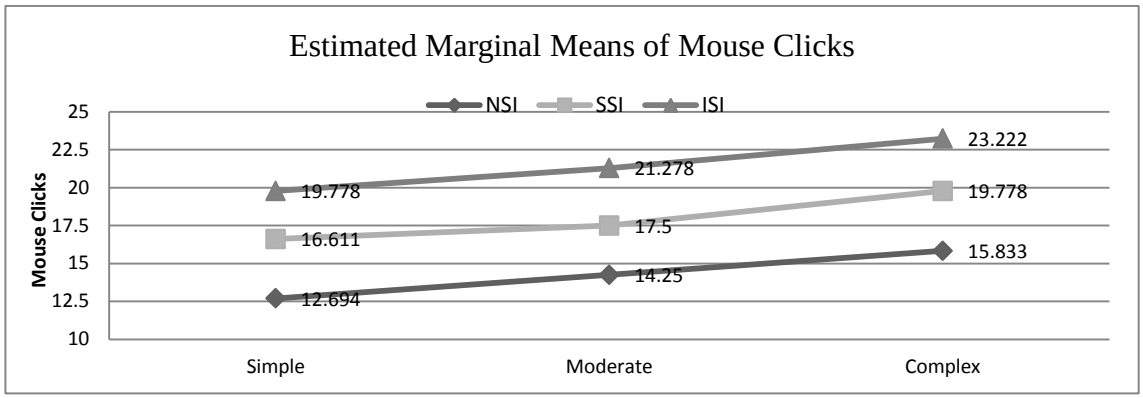


Figure 4.8: Mouse clicks within-subjects factor (Phase I).

Condition	Task Complexity	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
NSI	Simple	12.694	.326	12.033	13.356
	Moderate	14.250	.339	13.562	14.938
	Complex	15.833	.280	15.264	16.402
SSI	Simple	16.611	.372	15.855	17.367
	Moderate	17.500	.430	16.627	18.373
	Complex	19.778	.352	19.063	20.493
ISI	Simple	19.778	.324	19.120	20.435
	Moderate	21.278	.413	20.439	22.117
	Complex	23.222	.470	22.268	24.176

Table 4.3: Descriptive Statistics of mouse clicks used by users to complete simple, moderate and complex tasks per condition.

Pairwise Comparisons						
Measure: Mouse Clicks						
Variable (I)	Variable (J)	Mean Difference	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
SSI	NSI	3.704*	.284	.000	2.991	4.417
ISI	NSI	7.167*	.270	.000	6.488	7.846
	SSI	3.463*	.251	.000	2.831	4.095
Simple	Moderate	-1.315*	.281	.000	-2.021	-.609
	Complex	-3.250*	.322	.000	-4.061	-2.439
Moderate	Complex	-1.935*	.305	.000	-2.702	-1.169

Table 4.4: Mouse clicks pairwise comparisons of interaction modes and complexity levels (Phase I).

The assumption of sphericity test results show that sphericity has not been violated ($p = 0.650$ and $p = 0.721$); therefore, we accept the null hypothesis that the variances of the differences are equal. The main consideration in running a within-within-subjects

ANOVA - determining whether there is an interaction effect - is presented in the Tests of Within-Subjects Effects. Also; there was a statistically significant interaction between Interaction modes (NSI, SSI, and ISI) in task mouse clicks, $F(2, 70) = 355.984$, $p < .0005$, partial $\eta 2 = 0.624$. Also, There was a statistically significant interaction between complexity levels (simple, moderate, and complex) in task mouse clicks, $F(2, 70) = 58.168$, $p < .0005$, partial $\eta 2 = 0.910$. In term of interaction modes; task mouse clicks increases from 14.259 ± 0.22 clicks NSI-Interaction mode to 17.693 ± 0.295 clicks at SSI-Interaction mode and 21.426 ± 0.284 clicks at ISI-interaction mode. Additionally; the pairwise comparisons of the three interaction modes namely NSI, SSI, and ISI are shown in Table 4.4. A confidence interval is a measure of the reliability of an estimate. It is a type of interval estimate of a population parameter [137].

There was an increase in number of mouse clicks during tasks from 14.259 ± 0.22 clicks NSI-interaction mode to 17.693 ± 0.295 clicks at SSI-interaction mode. A statistically significant increase of 3.704 (95% CI, 2.991 to 4.417) clicks, $p < .0005$. Also; there was an increase in number of mouse clicks during tasks from 14.259 ± 0.22 clicks NSI-Interaction mode to 21.426 ± 0.284 clicks at ISI-Interaction mode. A statistically significant increase of 7.167 (95% CI, 6.488 to 7.846) clicks, $p < .0005$. Similarly; there was an increase in number of mouse clicks during tasks from 17.693 ± 0.295 clicks at SSI-Interaction mode to 21.426 ± 0.284 clicks at ISI-Interaction mode. A statistically significant increase of 3.463 (95% CI, 2.831 to 4.095) clicks, $p < .0005$. On the other hand; in term of complexity levels, the task mouse clicks increases from 16.361 ± 0.218 clicks simple-level to 17.676 ± 0.309 clicks at moderate- level and 19.611 ± 0.305 clicks at complex- level. Whereas; the pairwise comparisons of the three complexity levels namely simple, moderate, and complex are shown in Table 4.4.

There was an increase in number of mouse clicks during tasks from 16.361 ± 0.218 clicks Simple-level to 17.676 ± 0.309 clicks at Moderate-level. A statistically significant increase of 1.315 (95% CI, 0.609 to 2.021) clicks, $p < .0005$.

There was an increase in number of mouse clicks during tasks from 16.361 ± 0.218 clicks Simple-level to 19.611 ± 0.305 clicks at Complex-level. A statistically significant increase of 3.25 (95% CI, 2.439 to 4.061) clicks, $p < .0005$.

There was an increase in number of mouse clicks during tasks from 17.676 ± 0.309 clicks at Moderate-level to 19.611 ± 0.305 clicks at Complex-level. A statistically significant increase of 1.935 (95% CI, 1.196 to 2.702) clicks, $p < .0005$.

4.1.7 Effectiveness

The number of tasks completed successfully by the user during the experiment was used to measure the effectiveness. Effectiveness is analysed in terms of the conditions (NSI, SSI, and ISI) and the difficulty of the tasks (simple, moderate, and complex). Figure 4.9 shows the mean values of tasks completed successfully per condition (a) and task complexity (b). The ISI condition achieved the highest percentage of tasks completed successfully (79.63%). The variance (8.33%) between the ISI and SSI was significantly lower than the variance (32.41%) between ISI and NSI. This variance amongst the three conditions was significant ($x^2 = 9.262$, df=2, $p<0.05$).

Figure 4.9 (b) shows the mean value of percentage of tasks competed successfully according to the three levels of task complexity which are: simple, moderate, and complex tasks when using the conditions: NSI, SSI, and ISI experimental conditions. At a glance, it can be seen that the complex tasks showed the greatest variance amongst the three interfaces, whereas the simple tasks shows similar completion rates amongst the

three interaction modes (27 for NSI, 30 for SSI, and 32 for ISI), It shows the highest completion rate (82%) because of its simplicity that allows the user to almost fulfil task requirements that were simple and few. In moderate tasks 66% of the tasks were completed successfully, it was noteworthy that all ISI users have completed 31 moderate tasks that's 86% of the tasks and 69.4% for SSI , where the completion rate for NSI has decreased to 41.6%. This reflection on the results supported the results that were found in interaction modes, where the variance between the three groups presented relatively the same representation. The complex tasks show that the variance in tasks completion rates from NSI to ISI increase of 38% of completion rates similarly it increased by 36% in SSI interaction mode.

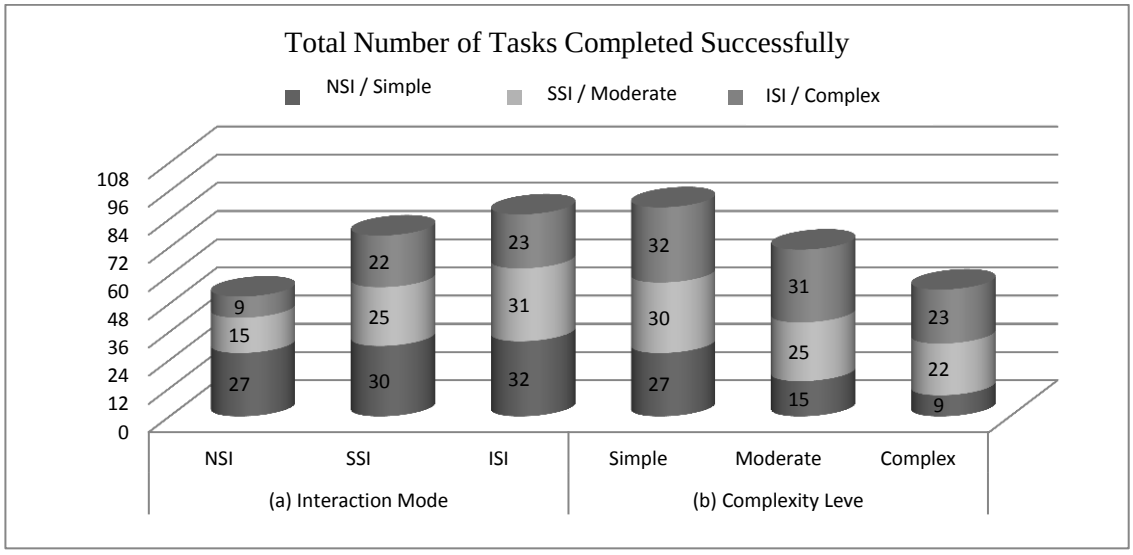


Figure 4.9: Mean values of total of tasks completed successfully (Phase I).

Test Statistics			
	Task	Interaction	complexity
Chi-Square	14.688[a]	5.281[b]	8.172[c]
df	5	1	2
Asymp. Sig.	.012	.022	.017

Table 4.5: Chi-Square test results for effectiveness (Phase I).

4.1.8 Subjective Satisfaction

The user's subjective satisfaction about each interface condition and viewpoints metaphor was asked. User's responses to the system usability scale (SUS) were used in this experimental study to measure the attitudes toward using the three different conditions. The SUS consists of ten statements each was measured according to 5-point Likert scale, the scale (1 as strongly disagree where 5 as strongly agree). These ten statements was analyzed using SUS scoring technique to calculate the satisfaction score for each statement; this scoring scheme was adopted from [8 and 9].

There was a strong user agreement in favour of the ISI condition. The user score increased by almost 20% from the NSI (30%) to the SSI (54%) and the ISI conditions 74%. Figure 4.11 presents the users responses for each statement. Figure 4.10 show all users perception of satisfaction with the different three conditions.

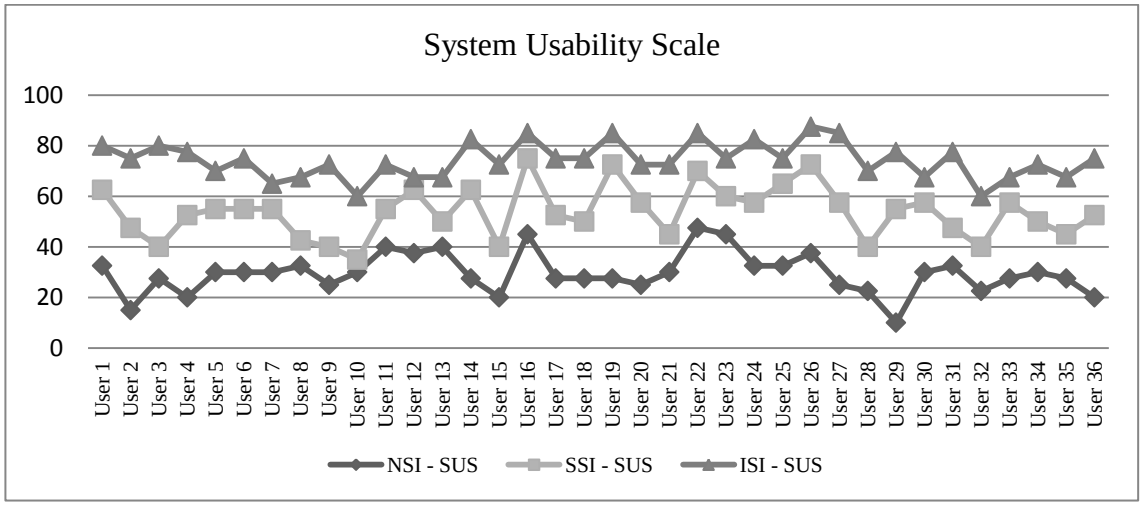


Figure 4.10: The System Usability Scale per user.

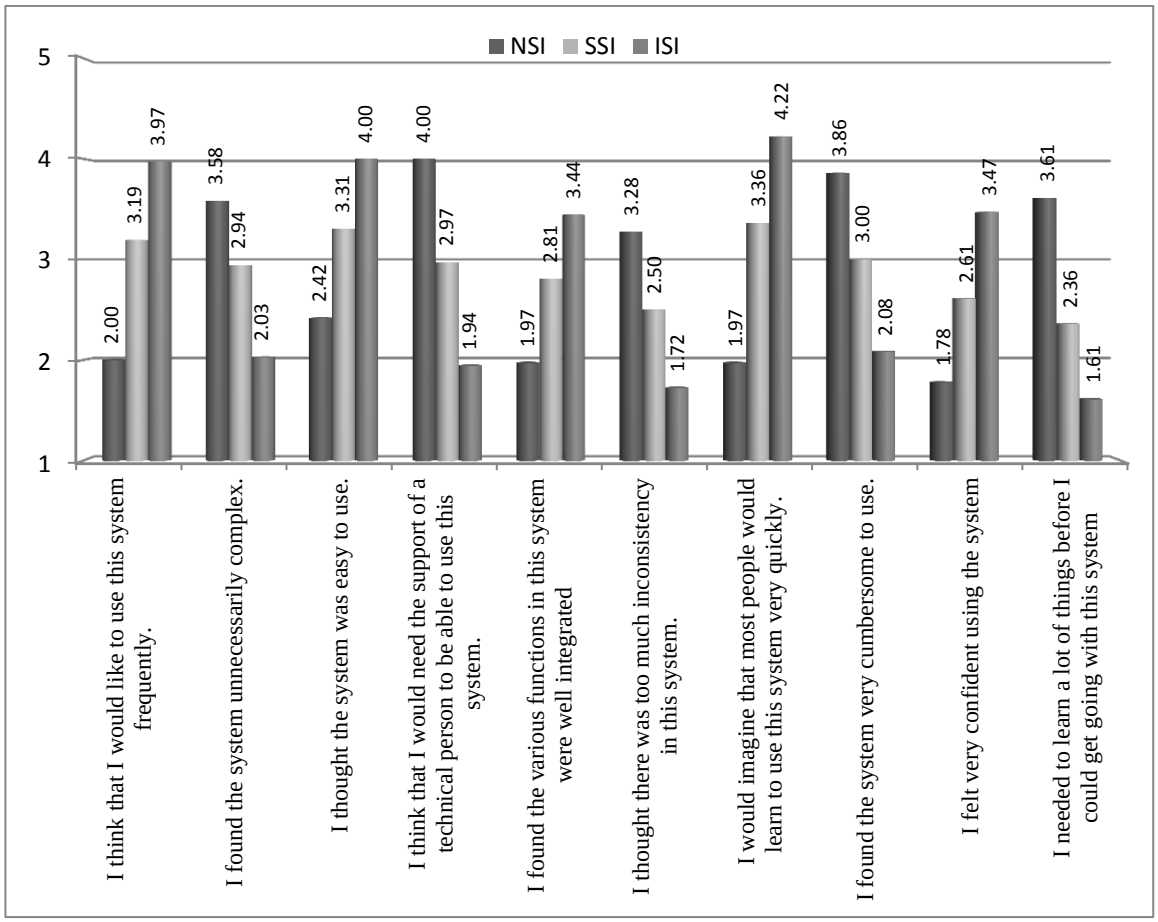


Figure 4.11: The System Usability Scale.

4.2 Result and Analysis for Experiment phase II

In this phase, the comparison between the two groups of users (*between-subject design*) was analysed with regard to several continuous, discrete and categorical variables. For the statistical analysis, in categorical data, Mann-Whitney equivalent of the independent t-test is used to assess the difference between the mean ranks of two independent conditions. Chi-square test examines the efficient distribution of categorical data were used to test the statistical significance for the non-parametric variables. In interval data, the independent t-test examines the difference between the means; it was selected to examine the significance between the two independent groups with regard to normally distributed parametric variables. The results obtained from both groups were analysed in terms of efficiency (task accomplishment time and number of mouse clicks consumed), effectiveness (number of tasks completed successfully), and user satisfaction (based on a rating scale).

4.2.1 Efficiency

The efficiency parameter of this evaluation was analysed according to the conditions and the difficulty of the task.

Figure 4.12 shows the mean time taken by users to complete simple, moderate, complex and all tasks. The AVISI condition had the lowest task completion time as tasks were completed 1.48 minutes (11%) faster.

Figure 4.13 shows the boxplot of the data. There are no outliers. Median time was significantly higher in AISI (5.085) than in AVISI (4.26), U = 1,095, z = -2.231, p = 0.026 [138].

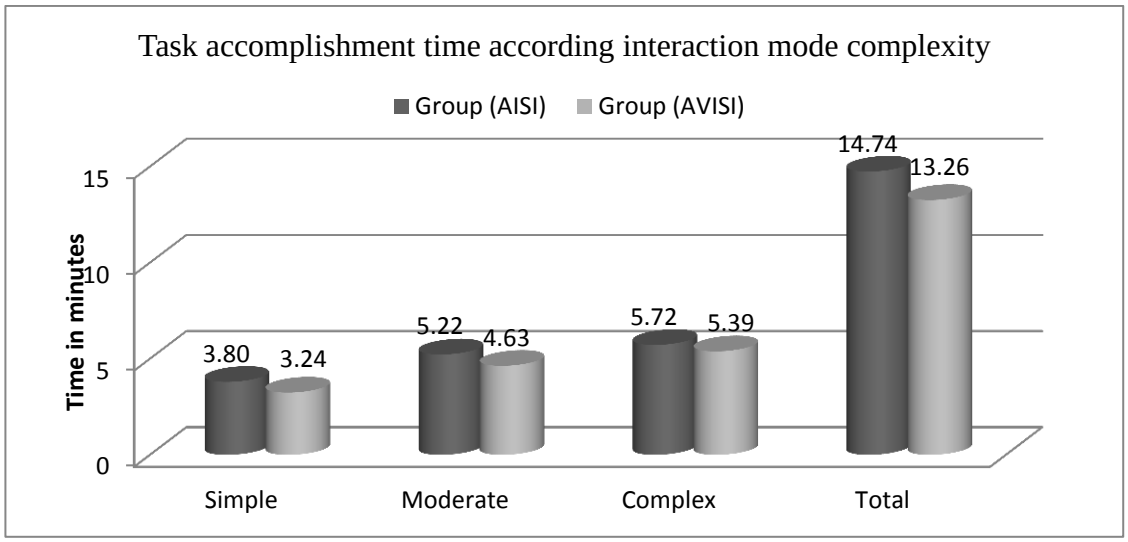


Figure 4.12: Mean value of task accomplishment time.

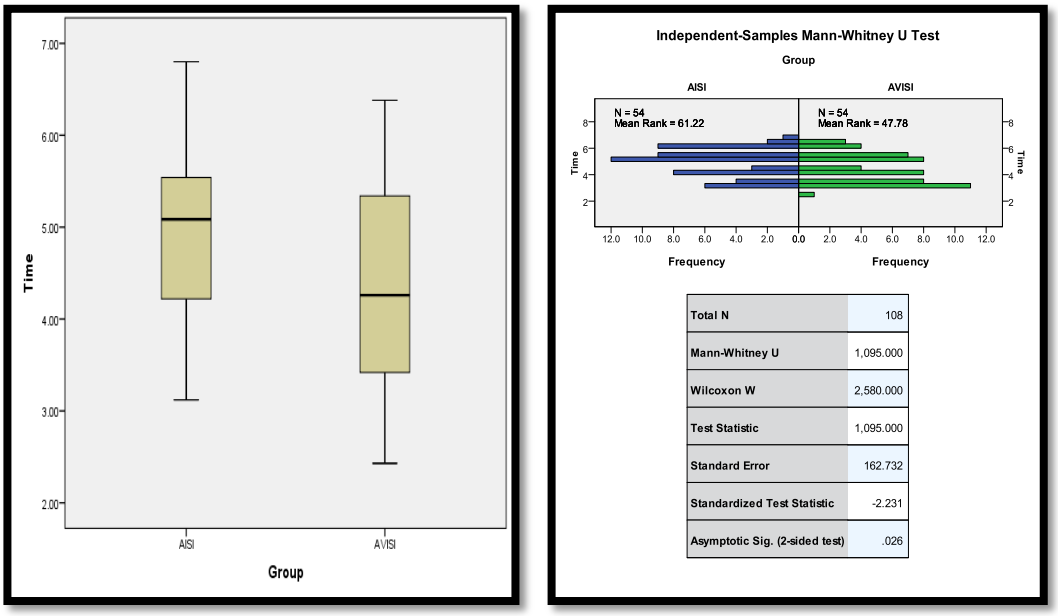


Figure 4.13: Task accomplishment time boxplot and Mann-Whitney U test results.

4.2.2 Effectiveness

Figure 4.14 shows the percentages of tasks completed successfully in the AISI and AVISI conditions. Chi-square (x^2) test - 2×2 independence - measured any possible associations between the conditions. A significant deference was identified ($x^2 = 4.458\ df = 1, p < 0.05$).

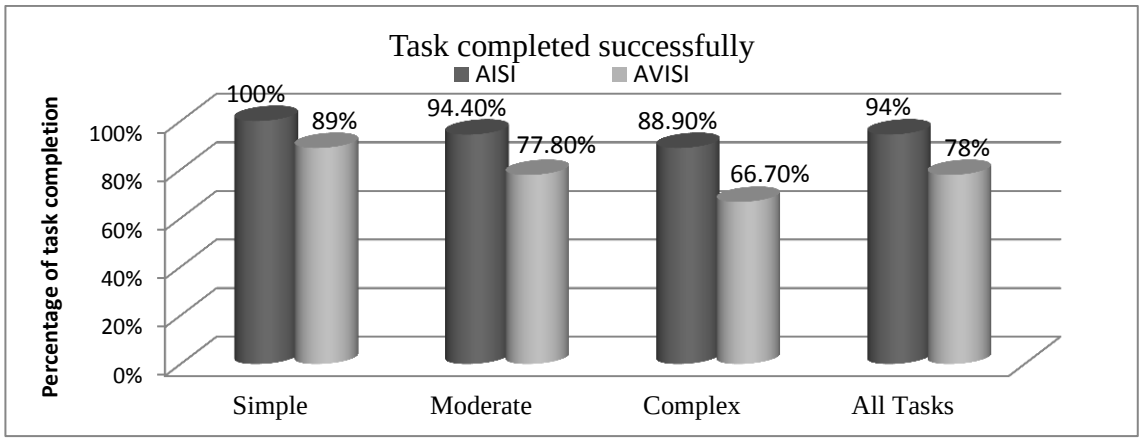


Figure 4.14: Percentage of tasks completed successfully.

Figure 4.14 shows both number and percentage of successfully completed tasks in all the complexity levels according to the AVISI and AISI experimental conditions. On the whole, it can be seen that the percentage of tasks completed successfully decreases as the task complexity levels increases. The percentages of tasks completed successfully in the simple level were 100%. This is then decreased to 94.4% and 88.9% in the moderate and complex levels, respectively. Chi-Squire test shows a significant deference in tasks completion rates ($x^2 = 7.171\ df = 2, p < 0.05$).

Complexity level	**Interaction mode**	**Task completion status**		**Sig.**
		Completed	Uncompleted	
Simple ($x^2 = 1.234\ df = 1, p > 0.05$)	Group AVISI	18 (100%)	0(0%)	No
	Group AISI	16 (88.89%)	2 (11.11%)	
Moderate ($x^2 = 5.242\ df = 1, p < 0.05$)	Group AVISI	17 (94.4%)	1 (5.6%)	Yes
	Group AISI	14 (77.8%)	3 (16.67%)	
Complex ($x^2 = 6.481\ df = 2, p < 0.05$)	Group AVISI	16 (88.89%)	2 (11.11%)	Yes
	Group AISI	12 (66.67%)	6 (33.33%)	
Overall ($x^2 = 6.481\ df = 2, p < 0.05$)	AISI and AVISI	94 (87.04%)	14(12.963%)	Yes

Table 4.6: Percentages of tasks completed successfully.

In the simple level the percentage of tasks completion was 100% for the AVISI group and 88.89% for the AISI group. The difference was 11.11% between the groups but the

Chi-Squire test does not shows a significant deference in tasks completion rates in simple level. This is because of the complexity nature of the tasks involves ($x^2 = 1.234\ df = 1, p > 0.05$). By comparison, the variance between the two groups rose in moderate and complex tasks significantly. In moderate tasks, task completion rate for the AVISI group was (94.4%) which was considerably higher than that for the AISI group (77.8%); Chi-Squire tests also show a significant deference in tasks completion rates ($x^2 = 5.242\ df = 1, p < 0.05$). When the complexity level increased to complex, the percentage in tasks completion rates was 88.89% for AVISI group and that was considerably greater than the AISI group (66.67%). Chi-square results also indicated there was a noteworthy difference between the AVISI group and AISI group regarding the completion rate for complex tasks ($x^2 = 6.481\ df = 2, p < 0.05$). Thus it can be concluded that the variance between the AVISI group and AISI group were in a close relationship with the complexity level regarding the percentage of tasks successfully completed as the completion rate decreases when the complexity level increases.

4.2.3 User Subjective Satisfaction

User's responses to the system usability scale (SUS) were used in this experimental study to measure the attitudes towards the three different conditions. The SUS consists of ten statements each of which is measured according to a five-point scale (1 representing strong disagreement and 5 strong agreements). The statements were analysed using a SUS scoring technique to calculate the satisfaction score for each statement. This scoring scheme was adopted from [4]. Figure 4.15 shows the system usability scale scores and the average score for all the various tasks.

Table 4.8 shows frequencies of user level of agreement with the ten satisfaction statements for both AVISI and AISI groups.

Statements	Code
'I think that I would like to use this system frequently'.	USF
'I found the system unnecessarily complex'	SUC
'I thought the system was easy to use'	SEU
'I think that I would need the support of a technical person to be able to use this system'	TSU
'I found the various functions in this system were well integrated'	FSI
'I thought there was too much inconsistency in this system'	INC
'I would imagine that most people would learn to use this system very quickly'	LVQ
'I found the system very cumbersome to use'	CUM
'I felt very confident using the system'	CON
'I needed to learn a lot of things before I could get going with this system'	GGS

Table 4.7: User Satisfaction statements coding [4].

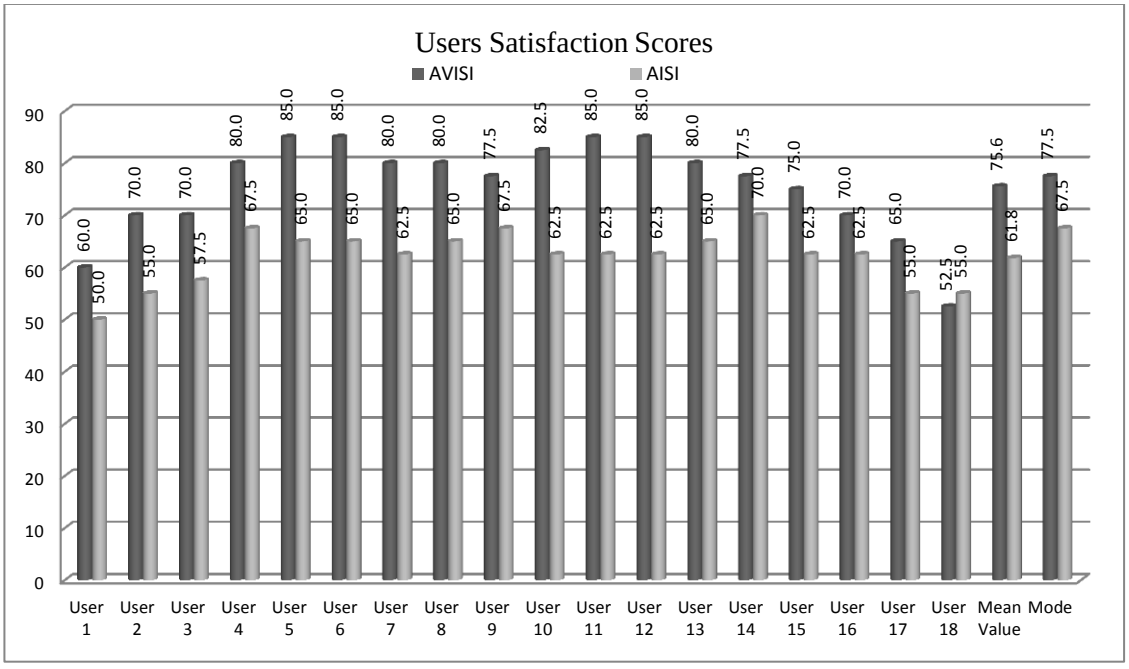


Figure 4.15: Users satisfaction scores for (AVISI and AISI).

These ten statements were analysed using SUS scoring techniques to calculate the satisfaction score for each statement. This scoring scheme was adopted from [4, 114].

Figure 4.15 shows the system usability scores, At first glance, there was a general strong agreement that the AVISI group condition has outperformed the AISI group. The mean value of system usability score was 75.5 for the AVISI condition while the mode was 77.5. The mean value of system usability score was 61.8 for the AISI condition while the mode was 67.5. Users' responses that rated the statement with fives or fours were regarded as agreement and with twos or ones as disagreement.

Users were asked a total of ten statements that were designed based on positive and negative items. Therefore items were chosen so that the common response to half was strong agreement, and to the other half, strong disagreement. This aimed to decrease response biases, generally seen when respondents do not think through the given statement. Thus, the alternation of between positive and negative statements necessitates respondents reading through each statement. They then must think through whether they agree or disagree with the statement, reducing bias. As can be seen, the selected statements cover a variety of aspects of system usability, including support, training, and complexity. So the statements have a high level of face validity for measuring the system's usability. The users' responses to the statements indicate the AVISI condition was the easiest to use.

Positive items of the system usability scale for the AVISI condition shows an agreement with the items (82.22%) of the users agreed to the statements USF, SEU, FSI, LVQ, and CON while only 10% shows disagreement. Chi-square results also suggested that there was a significant difference in the AVISI group between the agreement and disagreement with regard to the system usability scale scores ($x^2 = 84.168\, df = 1, p < 0.05$). On the other hand, negative items of the system usability scale for the AVISI condition shows a general disagreement with the items (66.67%) of those users

that disagreed with the statements SUC, TSU, INC, CUM, and GGS while only 13.33% expressed agreement. Chi-square results also indicated there was a significant difference in the AVISI group between the agreement and disagreement with regard to the system usability scale scores ($x^2 = 86.677\ df = 1, p < 0.05$).

Positive items of the system usability scale toward the AISI condition shows an agreement with the items 55.6% of the users agreed to the statements USF, SEU, FSI, LVQ, and CON while another 21.1% shows disagreement. Chi-square results also showed there was a significant difference in the AISI group between the agreement and disagreement of system usability scale scores ($x^2 = 81.966\ df = 1, p < 0.05$). On the other hand, negative items of the system usability scale for the AVISI condition show a general disagreement with the items. 47.7% of the users disagreed to the statements SUC, TSU, INC, CUM, and GGS while only 22.2% shows agreement. Chi-square results also demonstrated as significant difference in the AISI group between the agreement and disagreement with regard to the system usability scale scores ($x^2 = 87.881\ df = 1, p < 0.05$). Table 4.8 shows the frequencies of users rating of the satisfaction statements (1 as strongly disagree and 5 as strongly Agree).

Statements	**AVISI Group**					**AISI Group**				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
USF	1	2	1	5	9	1	2	4	5	6
SUC	7	7	2	1	1	5	4	5	2	2
SEU	0	1	2	4	11	3	0	4	5	6
TSU	5	7	4	1	1	4	3	5	2	4
FSI	0	0	1	3	14	1	3	4	5	5
INC	8	7	2	0	1	4	4	6	4	0
LVQ	3	1	1	4	9	2	2	6	4	4
CUM	4	2	6	3	3	6	3	7	2	0
CON	0	1	2	7	8	3	2	3	5	5
GGS	6	7	4	0	1	4	6	4	2	2

Table 4.8: User's satisfaction statements frequencies.

4.2.4 User Perception of Social Presence

The perception of users on social presence was measured using five statements (see Table 4.9 for the statements) using a five-point Likert-type scale [27]. Users were asked to express their agreement or disagreement with these statements. The perception of a human presence within an interface is subjective and complex. The subjectivity aspect is due to the individual user preferences and opinion as with all user satisfaction post-experimental views of users. It is also complex as the experience and forming of an opinion of a human presence is based on the individual subjective views and personality traits of the users. The following sections examine and analyse the user views on social presence for the specific sample of users that participated in the experiments.

The results of the Chi-square test demonstrated that the AVISI condition scored higher in these user satisfaction statements.

Statements	**SP1: There is a sense of human contact in the website.**		**SP2: There is a sense of individualism in the website.**		**SP3: There is a sense of sociability in the website.**		**SP4: There is a sense of human warmth in the website.**		**SP5: There is a sense of human sensitivity in the website.**	
Conditions	**AVISI**	**AISI**	**AVISI**	**AISI**	**AVISI**	**AISI**	**AVISI**	**AISI**	**AVISI**	**AISI**
1	**4**	**2**	**3**	**1**	**1**	**3**	**2**	**1**	**2**	**4**
2	**3**	**4**	**0**	**5**	**2**	**4**	**3**	**4**	**1**	**5**
3	**1**	**5**	**2**	**3**	**1**	**4**	**2**	**5**	**1**	**5**
4	**4**	**3**	**6**	**4**	**6**	**0**	**5**	**4**	**5**	**2**
5	**6**	**4**	**7**	**5**	**8**	**7**	**6**	**4**	**9**	**2**

Table 4.9: Frequencies of perceived social presence and codes [44].

A significant difference ($x^2 = 57.093\ df = 1, p < 0.05$) was identified amongst the post-experimental perception of AVISI and AISI users with regard to "*a feeling or sense of human presence when they were interacting with the interface*". This statement was agreed by 55.56% of the AVISI users and 38.89% of the AISI users.

Secondly, users were also asked whether there is a sense of *indivisualism* in the AVISI condition. 72.22% of the AVISI sample expressed a general agreement but only 50% of the AISI sample agreed with the same statement. Chi-square results shows that there was a marked difference between the AVISI condition and the AISI condition in regard to the agreement and disagreement to the individualism in the interface ($x^2 = 32.717\ df = 1, p < 0.05$). Users of both conditions were also asked about the *sociability* in the conditions. AVISI scores were 77.78% and AISI scores were 38.89%. Chi-square results suggest that there is a difference ($x^2 = 42.282\ df = 1,\ p < 0.05$). Users of both conditions were asked about the *human warmth* in the conditions. AVISI scored 61.11% while AISI scored 44.44%. Chi-square results also demonstrates a clear difference ($x^2 = 45.993\ df = 1, p < 0.05$). Finally, users of both conditions were asked about the human sensitivity in the website. AVISI scored 77.78% while AISI scored only 22.22%. Chi-square results suggested that there was a significant difference ($x^2 = 65.435\ df = 1, p < 0.05$).

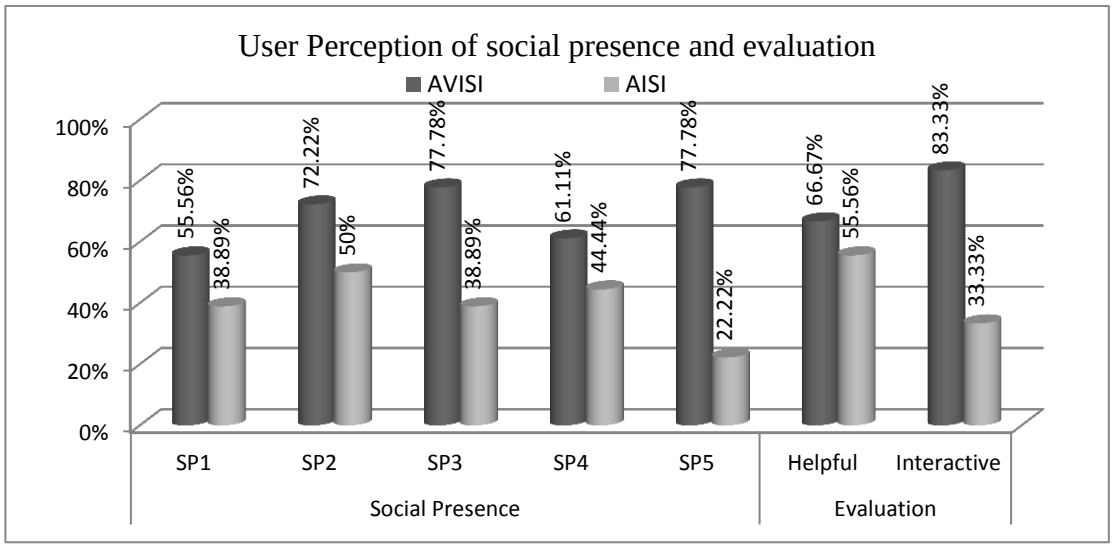


Figure 4.16: Users perception of social presence & evaluation for AVISI and AISI.

4.2.5 User Evaluation

Users were requested to express their agreement or disagreement with regard to the use of audio and audio-visual avatar of the condition (see Figure 5.16). Users of both conditions were asked about their agreement in considering the review helpful in the interface. AISI scored 55.56% and AVISI 66.67%. Chi-square results shows a significant difference ($x^2 = 30.858\ df = 1, p < 0.05$). 33.33% (83.33%) of the users from the AISI group (AVISI) group found the condition interactive. Chi-square results suggests that there is a significant difference ($x^2 = 30.858\ df = 1, p < 0.05$).

4.3 Discussion

The Interactive Social Interaction Condition (ISI) improved the mean value of task completion time and improved user attention. Also, this condition enabled users to make more accurate selections of products. Some variations were observed with the way that different forms of social presence communicated information.

The presence of social interaction (SSI and ISI) facilitated accurate decision-making in the absence of user-initiated detailed investigation about a product. The absence of social interaction appeared to be not as useful as the static form of social interaction because there was a form of interaction integrated.

Users were also positive towards the interactive social interaction modes and particularly with the ISI condition. In this condition, user satisfaction and social presence were improved as users reported to be more satisfied and socialised. Social presence have contributed positively towards the improvement of the user‘s attitudes and satisfaction.

Although, users were more satisfied with the ISI-condition, the ISI-condition was the most effective. Users taken longer to complete tasks and needed more mouse clicks. These two considerations led to the second and third experimental phases. The second experiment introduces two conditions one with audio social interaction and one with avatar social interaction. The second experiment investigates in more depth the level of social presence and how it is affected with the use of multimodal technologies. The third experiment introduces new scenarios to test deferent types of multimodality interfaces; it sheds more light into the evaluation of social presence.

Subsequently; the second experimental phase study investigated the usability and social presence of audio visual (AVISI) condition, as opposed to the audio (AISI) condition. The experimental results have been used to compare the two interfaces in terms of usability from the perspective of efficiency, effectiveness and user satisfaction and social presence with both conditions. This experimental study was conducted based on the role of multimodal interaction metaphors such as audio and audio-visual Avatar

with different complexity levels (simple, moderate, and complex) of the e-commerce applications. The results were discussed accordingly to get insight of the contributions that been made by using multimodal metaphors in e-commerce applications from the prospective of usability (efficiency, effectiveness, and satisfaction) and social presence. Even though that the audio metaphor condition offered simpler interaction than the audio visual metaphor condition, the results showed that the use of audio visual avatar was significantly more efficient, effective, and satisfactory than using the audio metaphor in communication of the e-commerce interfaces.

4.3.1 Efficiency

Figure 4.12 showed that the task completion time in the audio visual (Avatar) condition is more significant than in the audio condition. These findings provide an additional support to ***Hypothesis 5(a):*** AVISI is more efficient than AISI in terms of the task completion time. Also,

Figure 4.12 showed that the audio visual condition (AVISI) was considerably less time consuming for all complexity levels. Overall, 1.48 minutes was the difference between the AVISI and the AISI groups. A Mann-Whitney U test was run to determine if there were any differences in time between the AISI and AVISI conditions. Distributions of the time for AISI and AVISI were similar, as assessed by visual inspection. Median time was statistically higher in AISI (5.085) than in AVISI (4.26), U = 1,095, z = -2.231, p = 0.026. From this finding, it is noticed that there was a significant difference between the conditions; thus hypothesis 5 was accepted.

4.3.2 Effectiveness

Hypothesis 4 was accepted, thus indicating that AVISI will be more effective than AISI in terms of the percentage of tasks completed successfully. As Figure 4.14 showed, 94.4% of the experimental tasks were successfully completed in the AVISI condition while only 77.8% were completed successfully in the AISI condition. These results indicate the efficiency of multimodal metaphors, such as audio and audio visual avatars. Comparisons between the AISI condition and the AVISI condition by means of Chi-Squire tests show a significant deference in tasks completion rates ($x^2 = 4.458\, df = 1, p < 0.05$). Comparison between the completion time for the tests performed at the simple level for both conditions shows categorically the advantages of the AVISI method. Chi-squire test has confirmed the **hypothesis 4** ($x^2 = 1.234\, df = 1, p > 0.05$). In moderate levels the difference in completion rates has risen to be 94.4% for AVISI against 77.8% for AISI ($x^2 = 5.242\, df = 1, p < 0.05$). In complex levels the difference in completion rates has increased to 88.9% for AVISI against 66.7% for AISI. Chi-squire test also shows a significant deference ($x^2 = 6.481\, df = 2, p < 0.05$).

4.3.3 User satisfaction and evaluation

The experimental **hypothesis 6** was corroborated as users were more satisfied with AVISI methods as the SUS score was significantly higher by 13.7%. Also Figure 4.15 offered additional support to what has been hypothesised in H6 as it looks to each user score and their corresponding condition.

Also, 50% more users rated the audio visual AVISI condition as more interactive than the audio AISI condition. Chi-squire test has confirmed that there was a significant

difference ($x^2 = 30.858\ df = 1, p < 0.05$). Furthermore, 11.11% more users evaluated AVISI condition as more helpful. Chi-square results also suggested that there was a high significant difference ($x^2 = 30.858\ df = 1, p < 0.05$) that confirmed what has been hypothesised in **hypothesis 7.**

4.3.4 Perceived social presence

The results demonstrated in Figure 4.16 showed that the users perceptions of social presence were rated higher across the five statements for the AVISI condition. In general, the AVISI scored 68.8% while the AISI scored only 38.8% hence supporting **hypothesis 8.** The use of avatar technology in social interaction has outperformed the use of audio cues. Chi-squire test has confirmed that there is significant statistic deference in all aspects of social presence, such as the sense of human contact, the sense of individualism, the sense of sociability, the sense of human warmth and the sense of human sensitivity.

4.4 Conclusion

The first experimental phase evaluated the hypothesis that social interaction can improve e-commerce interfaces usability and increase social presence and knowledge as opposed to interfaces with no social interaction or static social interaction.

This involved implementing three experimental conditions (NSI, SSI, and ISI), which were evaluated by one dependent group of users (n=36). Results showed that the use of interactive social interaction was more usable than both the absence of social interaction and even the static social interaction. It also showed that the social presence and knowledge was increased in the ISI condition, compared to SSI and NSI. Although this experiment has proven to be successful, it is important for the overall experimental

programme to progress and introduce multimodal metaphors of social presence which has been introduced as the second phase of this experiment.

The second experiment examined the role of audio and avatar to improve the usability aspects of interactive social interaction condition ISI. The use of avatar has shown to contribute positively to the e-commerce interface in terms of efficiency, effectiveness, and user satisfaction. Also, it contributes positively to the perception of social presence. The idea was to present a simulation for communicating the product information by introducing human-like sale characters (Avatars) in the AVISI interface. The avatar communicated the product features in the AVISI condition while the product features were presented orally by recorded and synthesized speech in the AISI condition. The second experimental phase confirmed the social aspects of avatars and verified use of avatars in communication enriches the user interaction experience. Avatars also proved to alleviate the lack of social presence usually associated with online markets. The avatar-enhanced multimodal e-commerce condition AVISI appears to be more user friendly compared to audio enhanced AISI interaction mode under different usability and complexity conditions. It is important for the research in order to rate the users acceptance for each interface and to prove the usability of all multimodality metaphors to develop a new experimental scenarios that test the hypothesis.

CHAPTER 5 MULTIMODAL SOCIALLY INTERACTIVE E-COMMERCE INTERFACES: THE ROLE OF AUDIO AND AVATARS

Objectives

- Describe the conditions for the experiment.
- Provide the aims, objectives, and hypotheses.
- Review the experiment design.
- Provide the experiment variables.
- To provide full empirical analysis of data.
- To discuss the obtained results in term of measurements factors.

5.1 Introduction

This Chapter investigates the role of different multimodal metaphors (full body avatar with body gestures to audio and text) in e-commerce applications with social presence. This investigation could help to explain the potential role of multimodal technology in improving the sociality of e-commerce interfaces.

5.2 Aims and Objectives

The primary aim is to examine the impact of employing different types of multimodal metaphors in e-commerce interfaces and to evaluate three new conditions. These are Text Socially Interactive (TSI), Audio Socially Interactive (ASI), and Avatar Socially Interactive (AVSI). Specifically, it evaluates the usefulness of text, audio and avatar in conveying social presence, products connected to information, knowledge and product selection. The experiment evaluates the effectiveness of such metaphors in various types of task and at various levels of complexity. In particular, the aim is to investigate the existence of significant differences between task completion and user performance when dealing with the three experimental conditions. The study compares the three interaction modes. Another aim is to measure users' attitudes (satisfaction, social presence) towards the three e-commerce conditions. These conditions were evaluated by a group of 36 users. The evaluating parameters were effectiveness, efficiency and user satisfaction. Effectiveness was measured in terms of the frequency of tasks completed successfully. Efficiency was measured by the time taken each user to complete a task and frequency of mouse clicks. User satisfaction and social presence was measured by gathering post-experimental users' views using a questionnaire.

5.3 Hypothesis

The overall hypothesis investigated is:

> *The use of avatar in socially interactive e-commerce applications will enhance the usability of interfaces and increase users' social presence, decision-making and product understanding in comparison with the use of audio or text in socially interactive interfaces. A user can be defined as an individual who interacts with the e-commerce environment to accomplish a defined task.*

H1: AVSI will be more effective than TSI and ASI in terms of the percentage of tasks completed successfully.

H 2: AVSI will be more efficient than TSI and ASI in terms of task completion time.

H 3: AVSI will be more efficient than TSI and ASI in terms of the number of mouse clicks required completing the assigned tasks.

H 4: Users will be more satisfied with AVSI than TSI or ASI.

H 5: Users will perceive AVSI as being more interactive and helpful than TSI or ASI.

H 6: Users will perceive AVSI's social presence more than TSI or ASI.

H7: Users will perceive AVSI's social presence to be more enjoyable than TSI or ASI.

H8: AVSI users' decisions will be perceived as more confident than TSI or ASI.

5.4 Experimental Design

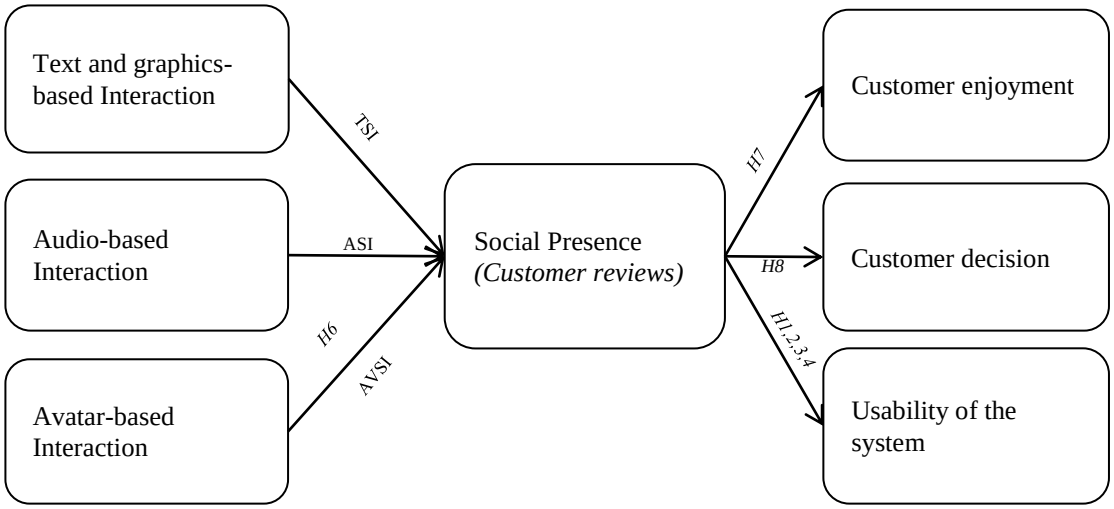


Figure 5.1: The conceptual model of the experimental design.

The *within-subject* one group of users methodology was followed in order to ensure that each user tested all system types on different complexity levels. The user sample (n=36) was divided into six groups of six users in order to perform the experimental tasks using the three conditions. The experiment had four parts. These were the pre-experimental questions, the experimental task completion, post-task questioning and post-experimental user evaluation.

5.4.1 Experimental procedure and tasks

The experiment required users to perform nine tasks of different complexity levels and types. Table 5.1 shows the design of the tasks, the six user groups, the rotations and order of tasks. This experiment had two independent variables: *task type* and *task level*. The task types were ASI, TSI and AVSI. The difficulty of tasks was categorised into three levels. These were *simple, moderate* and *complex*. The rotation of the variables in this experimental study depended upon the task type. Users were presented with three

task types in different order. For example, group 1 was presented with the text metaphor, then the audio and finally the avatar. An alternated order was used for group 2 and so on. Table 5.2 shows the rotations for the six sub-groups. Table 5.3 shows the tasks levels, complexity and describes the notions of tasks involved in this experiment.

Users	***Profile of the sample***	**Simple**	***Post Task Questions***	**Moderate**	***Post Task Questions***	**Complex**	***Post Task Questions***	***Post – experimental Questionnaire***
1 ,7,13,19,25,31		TSI		ASI		AVSI		
2,8,14,20,26,32		TSI		AVSI		ASI		
3,9,15,21,27,33		ASI		TSI		AVSI		
4,10,16,22,28,34		ASI		AVSI		TSI		
5,11,17,23,29,35		AVSI		TSI		ASI		
6,12,18,24,30,36		AVSI		ASI		TSI		

Table 5.1: Experimental procedure according to interaction conditions.

Group No.	**Task level**								
	Simple			**Moderate**			**Complex**		
	(Task Number)			(Task Number)			(Task Number)		
Group 1	TSI (T1)	ASI (T2)	AVSI (T3)	TSI (T4)	ASI (T5)	AVSI (T6)	TSI (T7)	ASI (T8)	AVSI (T9)
Group 2	TSI (T1)	AVSI (T3)	ASI (T2)	TSI (T4)	AVSI (T6)	ASI (T5)	TSI (T7)	AVSI (T9)	ASI (T8)
Group 3	ASI (T2)	TSI (T1)	AVSI (T3)	ASI (T5)	TSI (T4)	AVSI (T6)	ASI (T8)	TSI (T7)	AVSI (T9)
Group 4	ASI (T2)	AVSI (T3)	TSI (T1)	ASI (T5)	AVSI (T6)	TSI (T4)	ASI (T8)	AVSI (T9)	TSI (T7)
Group 5	AVSI (T3)	TSI (T1)	ASI (T2)	AVSI (T6)	TSI (T4)	ASI (T5)	AVSI (T9)	TSI (T7)	ASI (T8)
Group 6	AVSI (T3)	ASI (T2)	TSI (T1)	AVSI (T6)	ASI (T5)	TSI (T4)	AVSI (T9)	ASI (T8)	TSI (T7)

Table 5.2: Experimental rotation of tasks and conditions.

Level	**Tasks**		**Task Type**
	Code	**Description of socially interactive metaphor**	**Condition**
Simple	T1	Text	TSI
	T2	Audio	ASI
	T3	Avatar	AVSI
Moderate	T4	Text	TSI
	T5	Audio	ASI
	T6	Avatar	AVSI
Complex	T7	Text	TSI
	T8	Audio	ASI
	T9	Avatar	AVSI

Table 5.3: The distribution of experimental tasks.

5.4.2 Experimental Conditions

The experiment had three conditions (AVSI, ASI, and TSI). Table 5.4 shows the requirements of the experimental tasks. The multimodal conditions were speaking avatar with facial expressions for the AVSI condition, synthesised speech for the ASI condition, and text and graphics only for the TSI condition.

To explain Table 5.4 which show the requirements of the experimental task; for example task 1 the following paragraph shows a sample of the simple task scenarios.

'Assume that you are looking for a hotel room; you do not have any particular preferences in term of price, nor location. But you are concern about the hotel room reviews and recommendations. Therefore; the hotel room information it must be recommended from at least five users with the rating of more than six out of ten.

T1: To accomplish this task, the following requirements need to be fulfilled:

- **The hotel room must be recommended from at least five users.**
  (Tip: see the hotel room main page).
- **The hotel room average rating must be evaluated. (Rating is greater than six point out of ten)**

Task level	Type	Detailed Inspection of Reviews (DIR)			Brief Inspection (BIP)	
	Task ID	Number of reviews	Discussion	Likes	Recommended	Rating
Simple	Task 1				> 5	> 6
	Task 2	> = 8	At least one			
	Task 3	= 3				Top 5
Moderate	Task 4	>4			<=3	> 7
	Task 5		= 2 in both	>= 5	>= 6	
	Task 6	> = 6		>= 5		Top 10
Complex	Task 7	> = 4		< 8	> 6	>= 4
	Task 8		= 3 in two of the reviews	>= 5	>= 5	> 6
	Task 9	> = 6		> 8	> 7	>= 5

Table 5.4: The requirements of the experimental tasks.

Task level	Type	Multimodal Metaphors		
	Task ID	Text	Audio	Avatar
Simple	Task 1	✓		
	Task 2		✓	
	Task 3			✓
Moderate	Task 4	✓		
	Task 5		✓	
	Task 6			✓
Complex	Task 7	✓		
	Task 8		✓	
	Task 9			✓

Table 5.5: The allocation of multimodal metaphors in the experimental tasks.

5.4.2.1 Avatar Socially Interactive Condition (AVSI)

Figure 5.2 shows an example of this condition that uses facially expressive avatar to communicate information about the products and reviews. When a review about a product was neutral, the expressive avatar facial expressions were also neutral during the presentation. Similarly for negative, sad feeling, happy or positive reviews, the avatar adopted corresponding facial expressions to present the review.

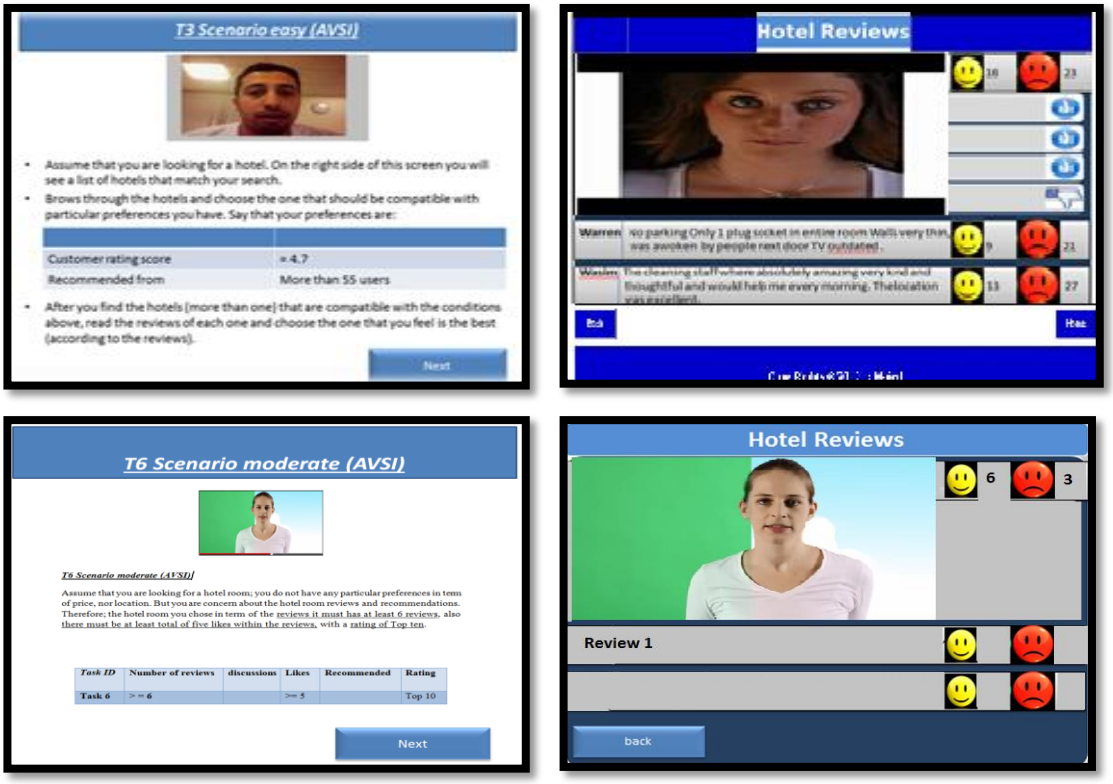


Figure 5.2: An example of the avatar-based socially interactive condition.

5.4.2.2 Audio Socially Interactive Condition (ASI)

Figure 5.3 shows the audio-based condition that uses recorded and synthesised speech, auditory icons, and earcons. Earcons were differentiated using rhythms and timbre to communicate the rating of users. Facial expressions communicated the status of the reviews and the overall user feeling behind the review (positive, negative and neutral).

These audio-enhanced designs were applied to a *hotel booking systems* scenario for the purpose of the experiment. The rating scores, the recommendation status, and overall user review feeling was communicated using non-speech sound or sounds from our daily environment such as glass breaking sound (*when not recommended*), and clapping sound (*when recommended*), and laughing sound (*for a positive-happy reviews*).

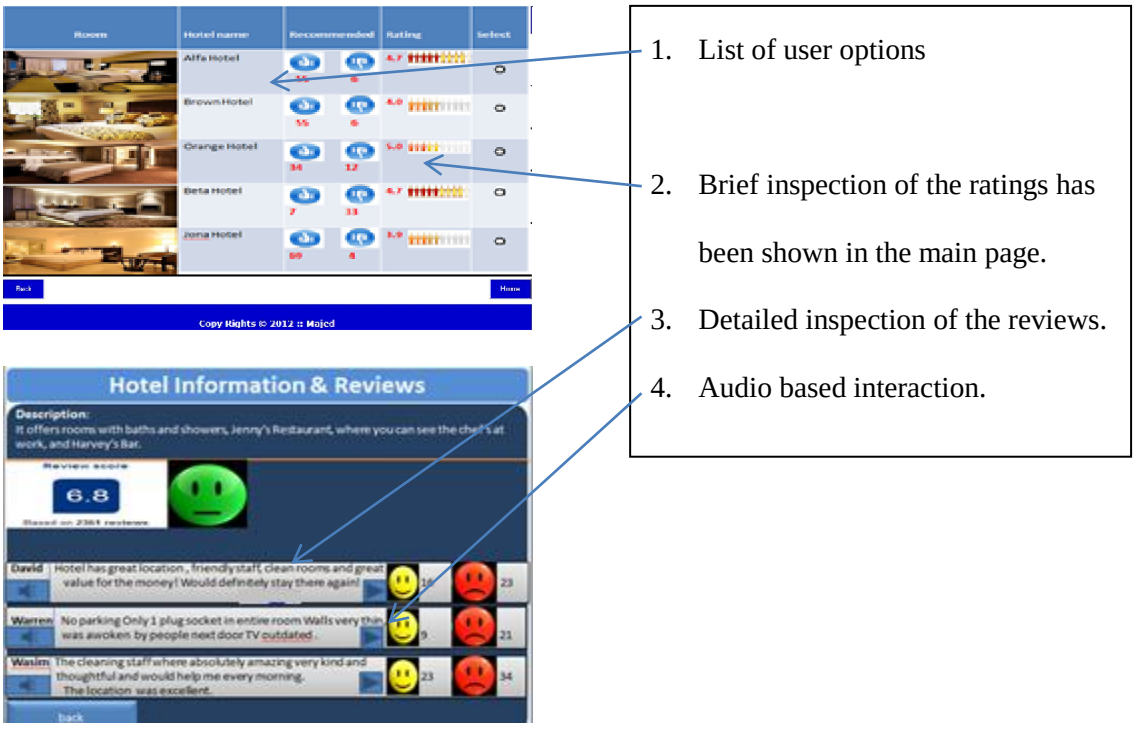


Figure 5.3: An example of the audio-based socially interactive condition.

5.4.2.3 Text-based Socially Interactive Condition (TSI)

Figure 5.4 shows an example of text with graphics, and facial expressions (happy, neutral, and sad) to communicate information about the tasks (requirements, room details, and reviews). A neutral review was presented simultaneously with a neutral expressive image. Users were therefore able to obtain an immediate understanding of the reviews at a glance. Similar synchronisation between the content of the review and the image occurred for happy, sad, negative or positive reviews. Figure 5.4 shows an interface instance of the user's attitudes towards each presentation mode.

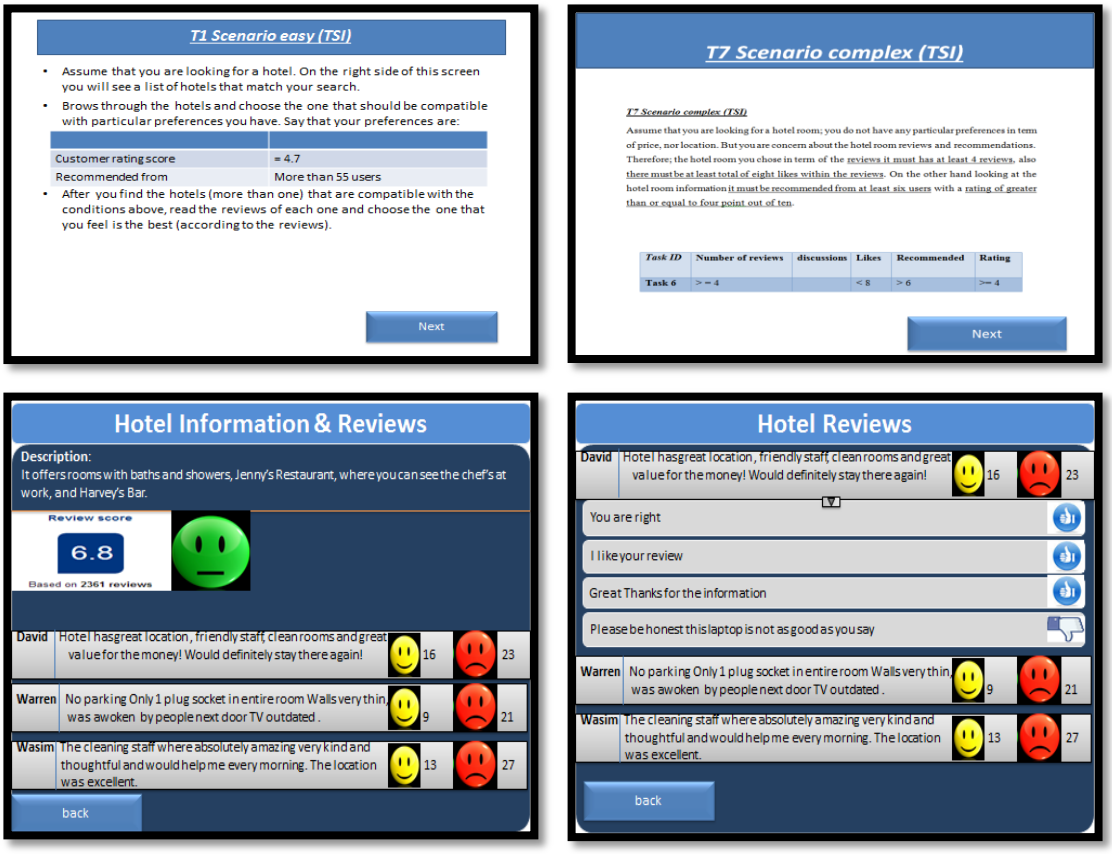


Figure 5.4: Text socially interactive metaphor screenshot.

5.5 Independent, Dependent and Control Variables

The independent variables were:

1. *Communication metaphors*. These were visual, auditory, and avatar.

2. *Task type*. Two task types were used. (DIR and DIB)
3. *Task complexity (difficulty)*. Tasks were of increasing difficulty ranging from simple, moderate, and complex.

The dependent variables were:

DV1: *Task completion time:* the time each user took to complete a particular task.

DV2: *Frequency of mouse clicks:* The number of mouse clicks needed by the user to complete a task.

DV3: *Successful task completion:* This was measured by the frequency of successfully completed tasks by the user. A task was completed successfully when the user had made the correct product selection.

DV4: *User satisfaction:* This was measured via a post-experimental user questionnaire that examined the need for support, training, and complexity. The questionnaire was based on the five-point Likert scale and the System Usability Scale (SUS) was applied to produce the user satisfaction score.

DV5: *Perception of social presence:* The values were sense of human contact, "personalness" (lack of presence), sociability, warmth and sensitivity. On completion of each experimental task, users' views on their perception of social presence were collected. Users selected a point from the five-point Likert scale.

The controlled variables of this experiment study were similar to the ones discussed in Section 3.10.3.

5.6 Sampling, Data Collection and Analysis

An opportunistic sample of 36 users was recruited to evaluate the conditions. The within-subject user trials helped to reduce error variance that may be linked with individual differences of users. The three experimental conditions were rotated in order to minimise any the learning effect.

In this chapter, the within-subject design methodology has been followed where the number of conditions is three conditions. For normally distributed interval data according to our design methodology and number of conditions it is recommended that the repeated measures ANOVA be used and if the data is not normally distributed the non- parametric Friedman test is recommended. For ordinal data (such as Likert scale) or nominal data we also use the non-parametric Friedman test. The results obtained from both groups were analysed in terms of efficiency (task accomplishment time and number of mouse clicks consumed), effectiveness (number of tasks completed successfully), and user satisfaction (based on a rating scale). For more information about the data collection (see section 3.11).

5.7 User Profile

Thirty-six users consisting of both genders were selected to undertake the experiment, 75% males and 25% females. The sample consisted of different age groups. In order to cover all categories of online shoppers the sample tried to represent the various groups in terms of gender, age, education level, and frequency of online purchases. Figure 5.5 shows the distribution of the sample among the categories of users that were selected.

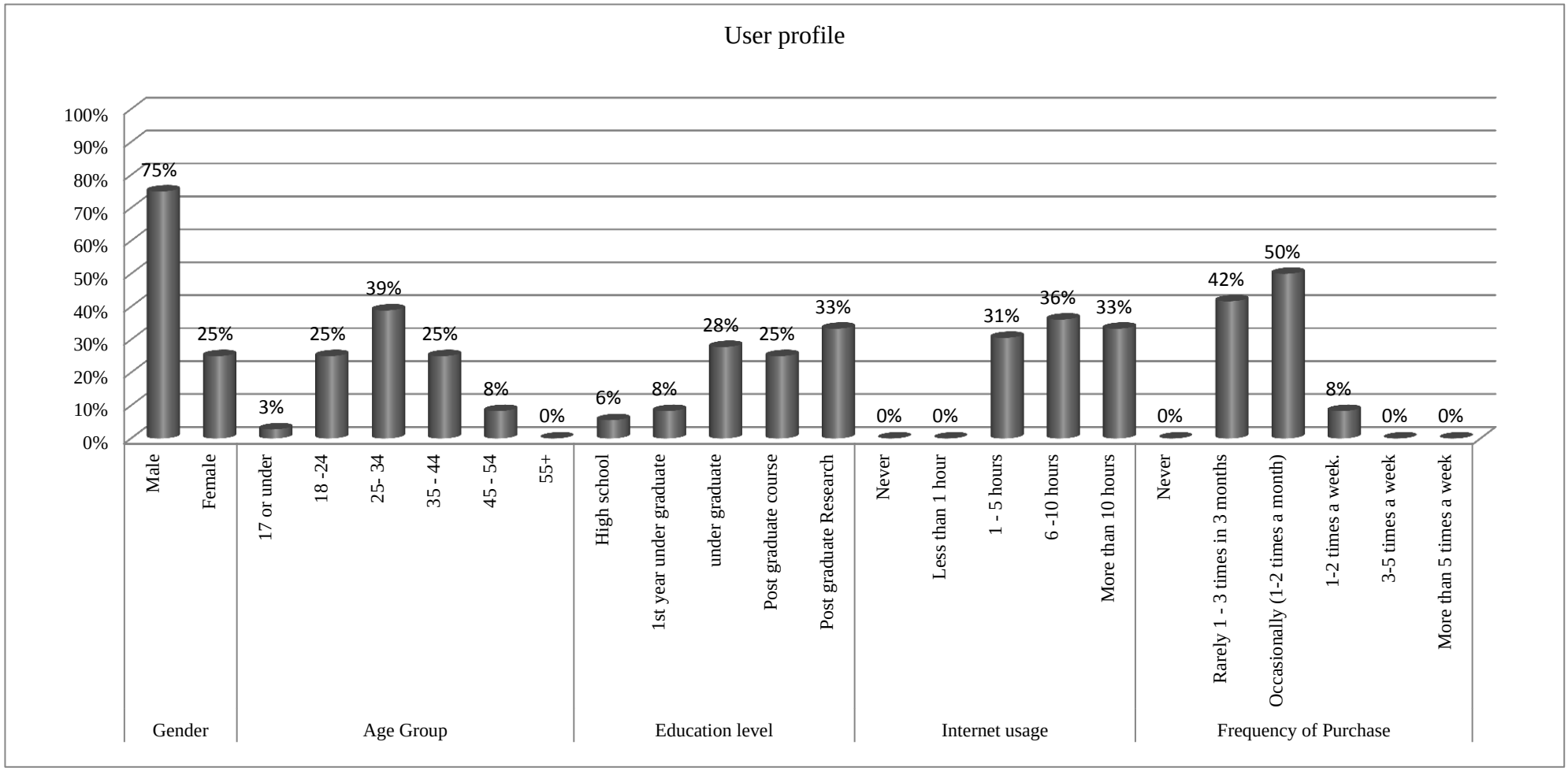


Figure 5.5: User profile of the sample.

5.8 Efficiency

The interacting efficiency of each user was measured in terms of time taken by users and the frequency of mouse clicks in order to complete each task. The collected data were categorised according to the type (TSI, ASI, or AVSI) and level (simple, moderate and complex) of difficulty of each experimental task.

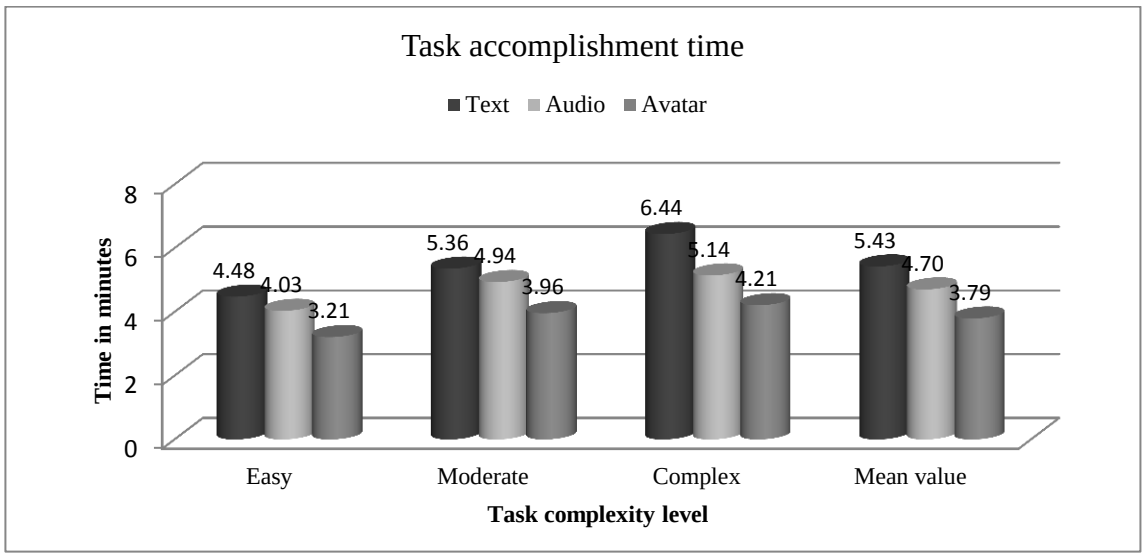


Figure 5.6: Mean values of time taken for each task.

Tests of Normality for Task Accomplishment Time EX3

Task No. (condition)	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
T1 (text)	.123	36	.187	.970	36	.423
T2 (audio)	.124	36	.174	.966	36	.319
T3 (avatar)	.090	36	.200*	.983	36	.842
T4 (text)	.189	36	.002	.939	36	.048
T5 (audio)	.121	36	.200*	.952	36	.117
T6 (avatar)	.073	36	.200*	.973	36	.501
T7 (text)	.091	36	.200*	.986	36	.920
T8 (audio)	.117	36	.200*	.948	36	.092
T9 (avatar)	.081	36	.200*	.977	36	.654

Table 5.6: Normality test of the time taken by users to complete tasks.

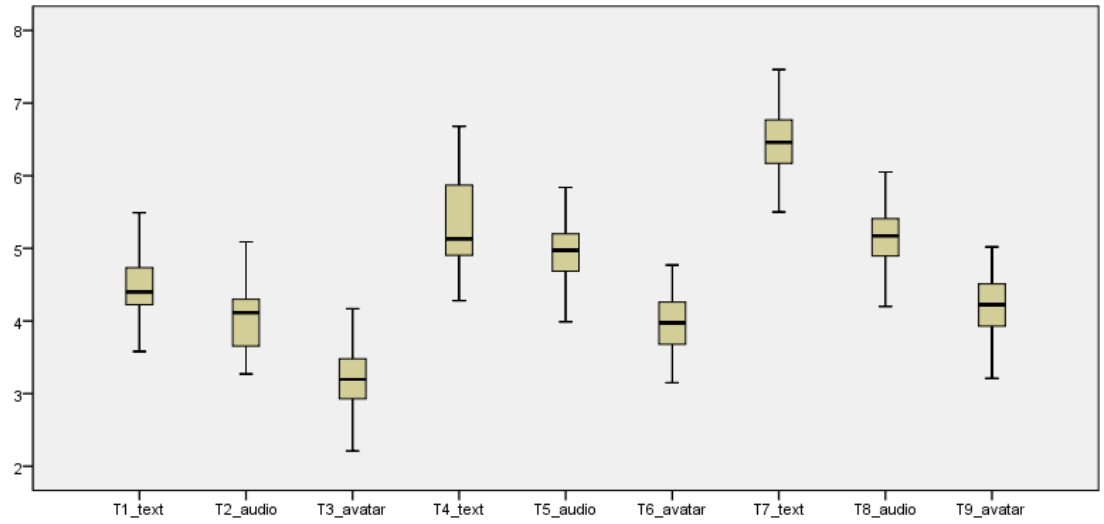


Figure 5.7: Box plot for task accomplishment time.

The time needed by a user to complete a task was validated using the normality test of Shapiro-Wilk ($p>0.05$). This test demonstrated that the data had no outliers as the boxplot in Figure 5.7 demonstrates for values greater than 1.5 box-lengths from the edge of the box.

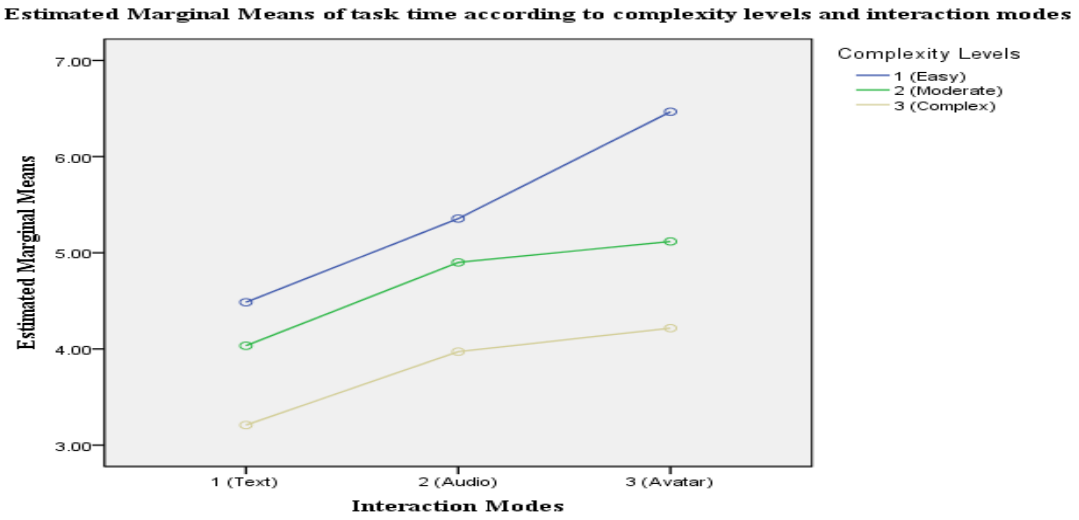


Figure 5.8: Estimated Marginal Means of time taken for tasks according to complexity levels and interaction modes.

Tests of Within-Subjects							
Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Interaction Modes	Sphericity Assumed	101.230	2	50.615	393.017	.000	.918
	Greenhouse-Geisser	101.230	1.821	55.597	393.017	.000	.918
	Huynh-Feldt	101.230	1.915	52.853	393.017	.000	.918
	Lower-bound	101.230	1.000	101.230	393.017	.000	.918
Error(Interaction Modes)	Sphericity Assumed	9.015	70	.129			
	Greenhouse-Geisser	9.015	63.728	.141			
	Huynh-Feldt	9.015	67.036	.134			
	Lower-bound	9.015	35.000	.258			
Complexity Levels	Sphericity Assumed	145.031	2	72.515	229.517	.000	.868
	Greenhouse-Geisser	145.031	1.529	94.832	229.517	.000	.868
	Huynh-Feldt	145.031	1.585	91.492	229.517	.000	.868
	Lower-bound	145.031	1.000	145.031	229.517	.000	.868
Error(Complexity Levels)	Sphericity Assumed	22.116	70	.316			
	Greenhouse-Geisser	22.116	53.527	.413			
	Huynh-Feldt	22.116	55.481	.399			
	Lower-bound	22.116	35.000	.632			
Interaction Modes * Complexity Levels	Sphericity Assumed	13.326	**4**	3.332	**24.618**	**.000**	**.413**
	Greenhouse-Geisser	13.326	2.687	4.959	24.618	**.000**	.413
	Huynh-Feldt	13.326	2.932	4.545	24.618	**.000**	.413
	Lower-bound	13.326	1.000	13.326	24.618	**.000**	.413
Error(Interaction Modes*Complexity Levels)	Sphericity Assumed	18.946	**140**	.135			
	Greenhouse-Geisser	18.946	94.055	.201			
	Huynh-Feldt	18.946	102.622	.185			
	Lower-bound	18.946	35.000	.541			

Table 5.7: Tests of within-subjects effects over time.

A statistically significant difference amongst the three conditions and the time taken by users to complete simple, moderate and complex tasks was identified ($F(4, 140) = 24.618$, $p < .0005$, partial $\eta 2 = 0.413$). Table 5.8 shows that the conditions were significantly different on task accomplishment timing for the simple tasks ($F(2,70) = 109.849$, $p < .0005$, partial $\eta 2 = 0.758$), moderate tasks ($F(2,70) = 63.741$, $p < .0005$, partial $\eta 2 = 0.646$) and complex tasks ($F(2,70) = 274.216$, $p < .0005$, partial $\eta 2 = 0.887$).

(S = Sample, M = Moderate, C = Complex, F = F-distribution (F-test)). See Table 4.2 for meaning of results.

Source		Type III Sum of Squares			df			Mean Square			F			Sig.			Partial Eta Squared		
		S	M	C	S	M	C	S	M	C	S	M	C	S	M	C	S	M	C
Interaction Modes	Sphericity Assumed	30.195	35.789	92.373	2	2	2	15.097	17.895	46.187	109.849	63.741	274.216	.000	.000	.000	.758	.646	.887
	Greenhouse-Geisser	30.195	35.789	92.373	1.811	1.958	1.141	16.671	18.275	80.975	109.849	63.741	274.216	.000	.000	.000	.758	.646	.887
	Huynh-Feldt	30.195	35.789	92.373	1.904	2.000	1.154	15.855	17.895	80.059	109.849	63.741	274.216	.000	.000	.000	.758	.646	.887
	Lower-bound	30.195	35.789	92.373	1.000	1.000	1.000	30.195	35.789	92.373	109.849	63.741	274.216	.000	.000	.000	.758	.646	.887
Error (Interaction Modes)	Sphericity Assumed	9.621	19.652	11.790	70	70	70	.137	.281	.168									
	Greenhouse-Geisser	9.621	19.652	11.790	63.393	68.542	39.926	.152	.287	.295									
	Huynh-Feldt	9.621	19.652	11.790	66.654	70.000	40.383	.144	.281	.292									
	Lower-bound	9.621	19.652	11.790	35.000	35.000	35.000	.275	.561	.337									

Table 5.8: Tests of within-subjects effects for the all tasks.

Mouse clicks

The mouse clicks needed by users to complete tasks were significantly different during the experimental tasks ($x^2 = 259.166\ \mathrm{df} = 8, p < 0.05$). Table 5.10 and Figure 5.11 show that the data were not normally distributed. The Friedman test is a nonparametric test that compares three or more matched or paired groups. It first ranks the values in each matched set (each row) from low to high, with each row ranked separately. It then sums the ranks in each group (column). If the sums are very different, the P value will be small. Prism reports the value of the Friedman statistic, which is calculated from the sums of ranks and the sample sizes.

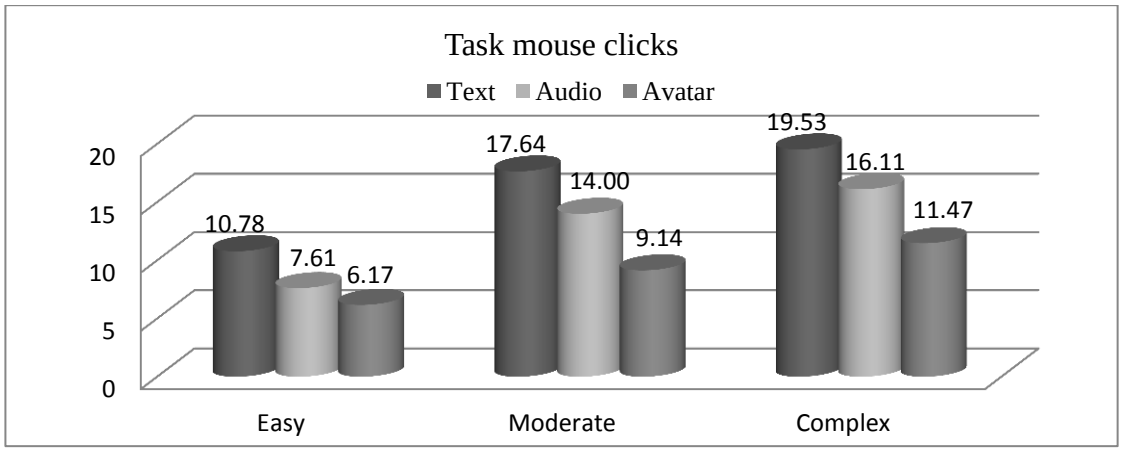


Figure 5.9: Mean values of tasks mouse clicks.

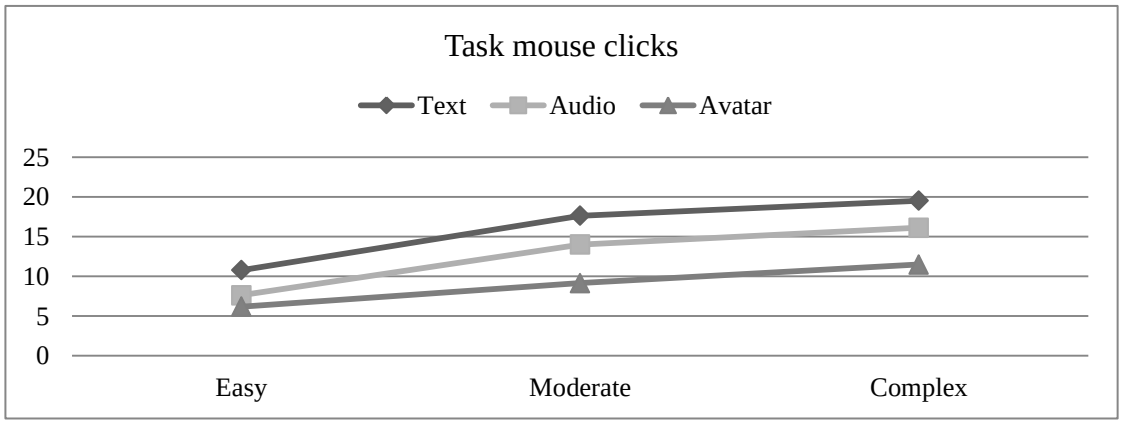


Figure 5.10: Mean values of tasks' mouse clicks.

Level	Multimodal Metaphors		*p-value*	Significance
Simple	Text	Audio	0.036	**Yes**
	Text	Avatar	.000	**Yes**
	Audio	Avatar	1.000	No
Moderate	Text	Audio	0.107	No
	Text	Avatar	.000	**Yes**
	Audio	Avatar	.000	**Yes**
Complex	Text	Audio	0.725	No
	Text	Avatar	.000	**Yes**
	Audio	Avatar	0.003	**Yes**

Table 5.9: Pairwise comparison of tasks' mouse clicks.

Tasks (Condition)	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
T1 (text)	.132	36	.113	.952	36	.121
T2 (audio)	.167	36	.013	.938	36	.044
T3 (avatar)	.182	36	.004	.905	36	.005
T4 (text)	.145	36	.053	.960	36	.218
T5 (audio)	.167	36	.013	.954	36	.136
T6 (avatar)	.170	36	.010	.934	36	.033
T7 (text)	.165	36	.015	.960	36	.214
T8 (audio)	.158	36	.024	.942	36	.059
T9 (avatar)	.145	36	.052	.960	36	.212

Table 5.10: Normality tests of mouse clicks used to complete experimental tasks.

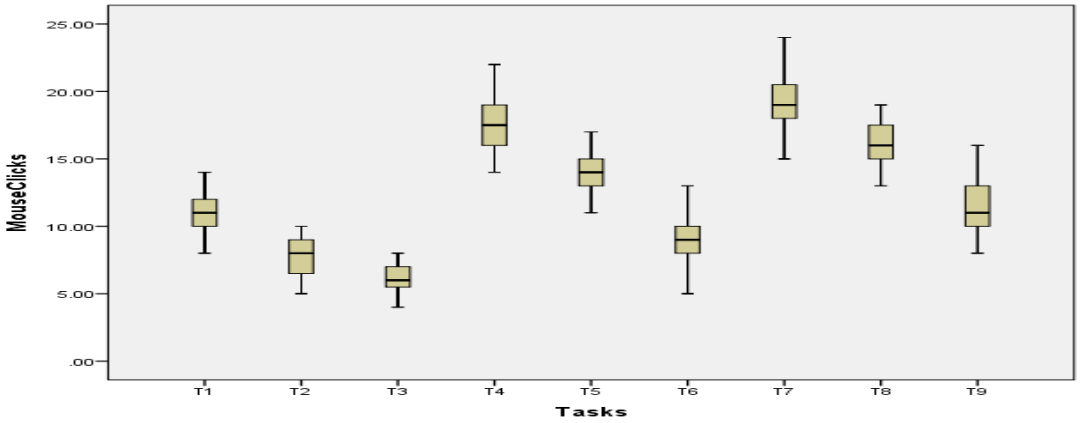


Figure 5.11: Box plot for tasks' mouse clicks.

Tasks	Mean Ranks	Chi-Squire Results	
T1	4.24	N	36
T2	2.11	Chi-Squire	259.166
T3	1.32	df	8
T4	7.92	Asymp. Sig.	.0001
T5	6.00		
T6	3.13		
T7	8.61		
T8	7.11		
T0	4.57		

Table 5.11: Friedman test results.

The following presents the pairwise comparisons of all tasks.

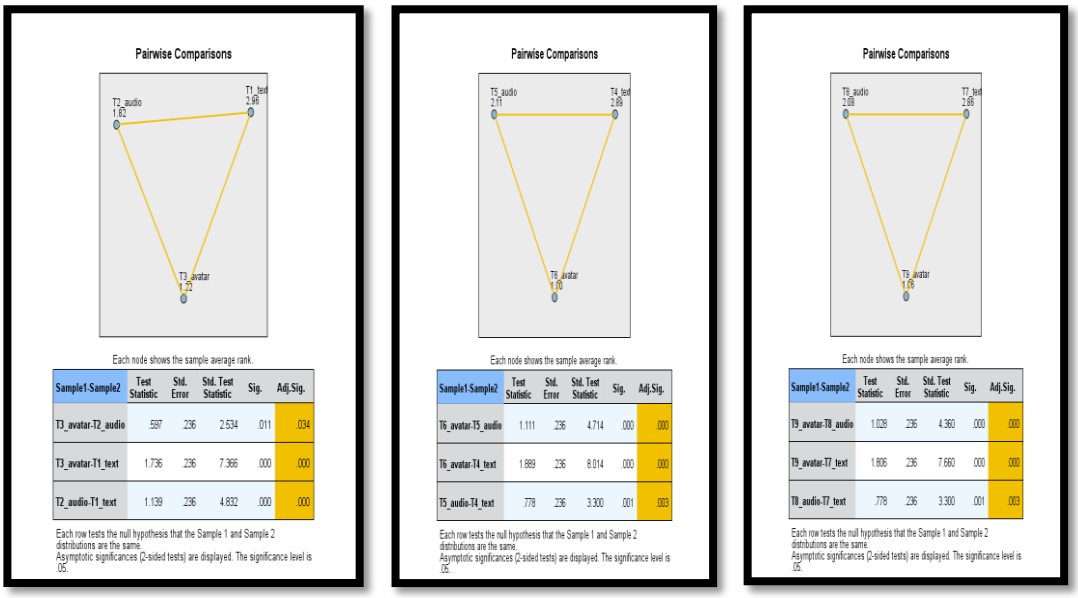


Table 5.12: Pairwise comparison of tasks' mouse clicks.

5.8.1 Effectiveness

The effectiveness of each condition was measured by the frequency of tasks completed successfully by the users. Figure 5.12 shows the percentages of successfully completed tasks (all), simple, moderate and complex per condition. In total, 77.16% of all tasks (250 out of 324) were successfully completed. The avatar-based condition achieved 96.30% of the tasks compared to 54.63% for the text and 80.56% for the audio conditions. When the completion rates of the tasks are analysed according to their level of difficulty (simple, moderate and complex), users' completion rate decreased as the difficulty of the task increased. Task completion rates of all tasks were statistically significantly different during the experimental tasks ($x^2(8) = 93.072$ cv $= 1.86, p <$ 0.05). Figure 5.13 shows pairwise comparisons (SPSS, 2012) using the Bonferroni correction for multiple comparisons. The completion of complex tasks complex was statistically significant between the text and audio conditions ($p<0.05$), avatar and audio ($p<0.05$), and text and avatar ($p<.0005$). Also, task completion rates on moderate levels

were statistically significantly different between text and audio conditions ($p<0.05$) and between the text and avatar conditions ($p < .0005$). The avatar and audio conditions had no statistically significant difference in terms of task completion. However, a significant difference for simple tasks was demonstrated between the text and avatar conditions ($p < 0.05$).

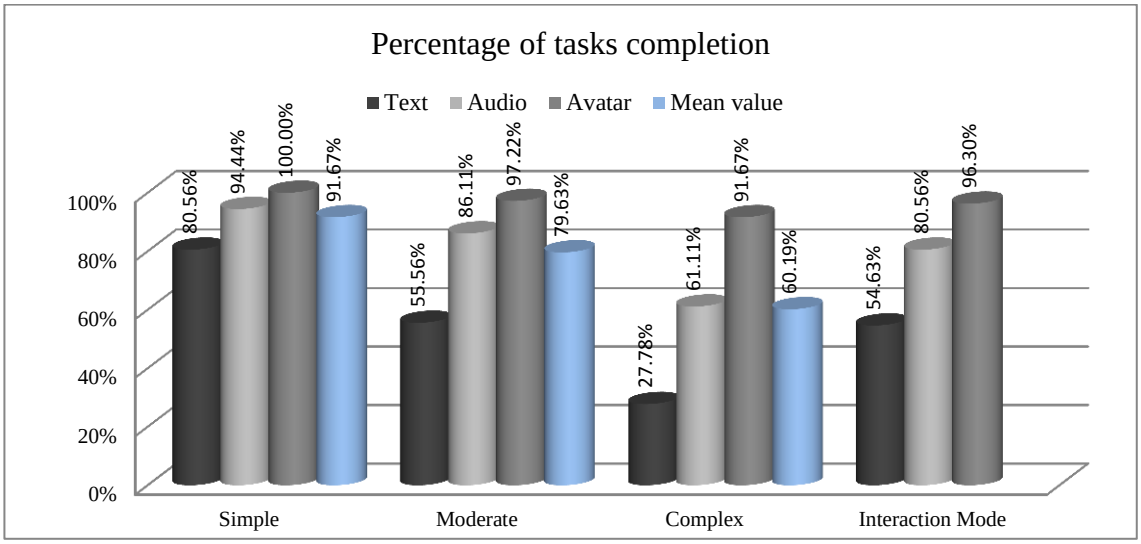
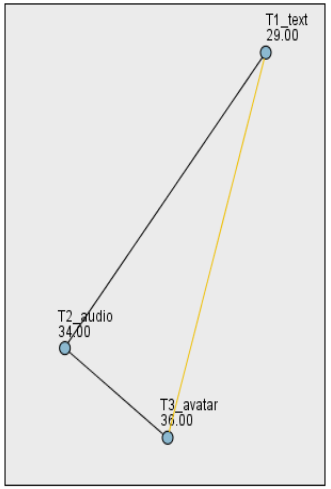


Figure 5.12: Percentages of task completion.

Descriptive Statistics						
	N	**Mean**	**Std. Deviation**	**Minimum**	**Maximum**	**Mean Rank**
T1 (text)	36	.81	.401	0	1	5.15
T2 (audio)	36	.94	.232	0	1	5.78
T3 (avatar)	36	1.00	.000	1	1	6.03
T4 (text)	36	.56	.504	0	1	4.03
T5 (audio	36	.86	.351	0	1	5.40
T6 (avatar)	36	.97	.167	0	1	5.90
T7 (text)	36	.28	.454	0	1	2.78
T8 (audio)	36	.61	.494	0	1	4.28
T9 (avatar)	36	.92	.280	0	1	5.65
N	**36**					
Chi-Square	**93.072**					
df	**8**					
Asymp. Sig.	**.0001**					

Table 5.13: Friedman Test of task completion rate.

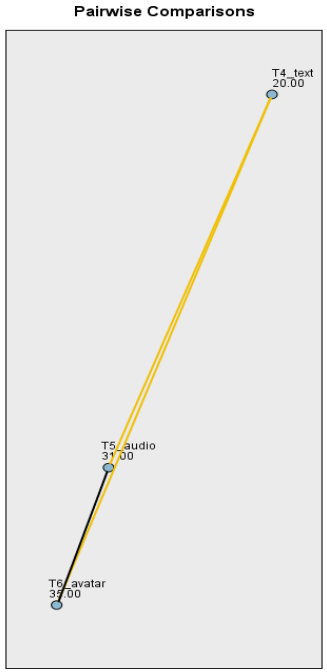
Simple level	Moderate Level	Complex Level



Each node shows the sample number of successes.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
T1_text-T2_audio	-.139	.068	-2.041	.041	.124
T1_text-T3_avatar	-.194	.068	-2.858	.004	.013
T2_audio-T3_avatar	-.056	.068	-.816	.414	1.000

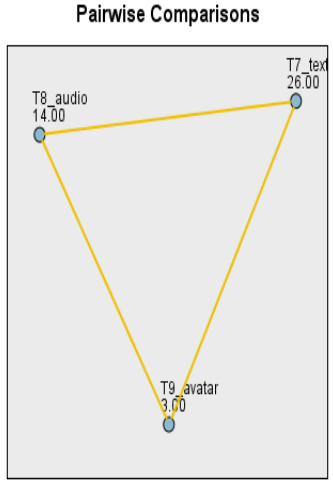
Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.



Each node shows the sample number of successes.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
T4_text-T5_audio	-.306	.099	-3.091	.002	.006
T4_text-T6_avatar	-.417	.099	-4.215	.000	.000
T5_audio-T6_avatar	-.111	.099	-1.124	.261	.783

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.



Each node shows the sample number of successes.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
T9_avatar-T8_audio	.306	.126	2.420	.016	.047
T9_avatar-T7_text	.639	.126	5.059	.000	.000
T8_audio-T7_text	.333	.126	2.640	.008	.025

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

Figure 5.13: Pairwise comparison of task completion rate.

5.8.2 User Satisfaction

User satisfaction was measured via a post-experimental questionnaire. The questionnaire had ten statements. All users rated their experience with their corresponding condition. The range of the scale was from 1 to 5 with 1 representing a strong user agreement, 5 a strong user disagreement and 3 being neutral (see also section 4.9.3 for method of SUS). The statements of the questionnaire were:

Statements	**Code**
'I think that I would like to use this system frequently'.	USF
'I found the system unnecessarily complex'	SUC
'I thought the system was easy to use'	SEU
'I think that I would need the support of a technical person to be able to use this system'	TSU
'I found the various functions in this system were well integrated'	FSI
'I thought there was too much inconsistency in this system'	INC
'I would imagine that most people would learn to use this system very quickly'	LVQ
'I found the system very cumbersome to use'	CUM
'I felt very confident using the system'	CON
'I needed to learn a lot of things before I could get going with this system'	GGS

Table 5.14: User Satisfaction statements [4].

All users were given ten statements to rate their experiences with the interface. Generally, the noteworthy point was the significant enhancement in user satisfaction from the interface of TSI to AVSI in respect of system usability scale.

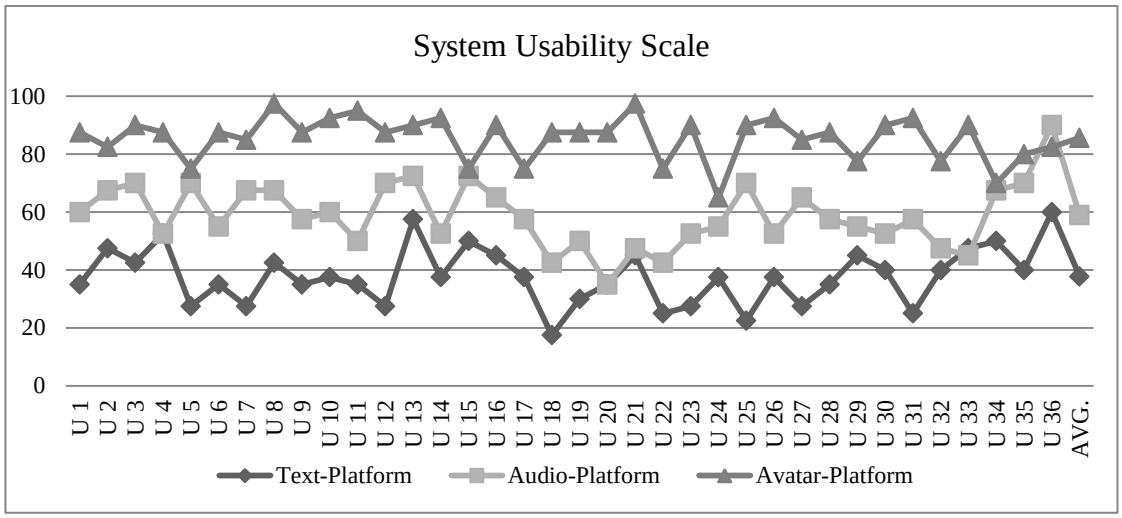
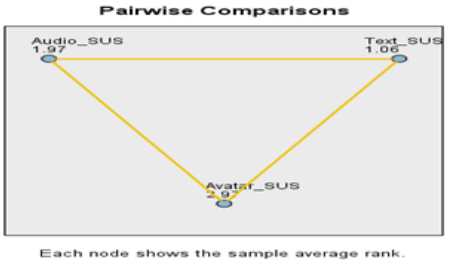


Figure 5.14: System usability scale per user.



Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Text_SUS-Audio_SUS	-.917	.236	-3.889	.000	.000
Text_SUS-Avatar_SUS	-1.917	.236	-8.132	.000	.000
Audio_SUS-Avatar_SUS	-1.000	.236	-4.243	.000	.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

Figure 5.15: Pairwise comparison of system usability scale.

Figure 5.15 shows a pairwise comparison of the system usability scale (SUS). A significant difference was identified amongst the three conditions. The statistically significant differences were between text and audio conditions ($p<0.05$), text and avatar ($p<0.05$), and avatar and audio conditions ($p < 0.05$).

5.8.3 User Perception of social presence

Subsequent to the experiment, users were asked to express their views regarding their perception of social presence with five-point five-item Likert-type scale, ranging from agree to disagree; one and two was regarded as agree, three was neutral, and four and five were disagree. These five statements would measure the users' feelings regarding

human contact, individualism, sociability, human warmth, and human sensitivity [27, 139].

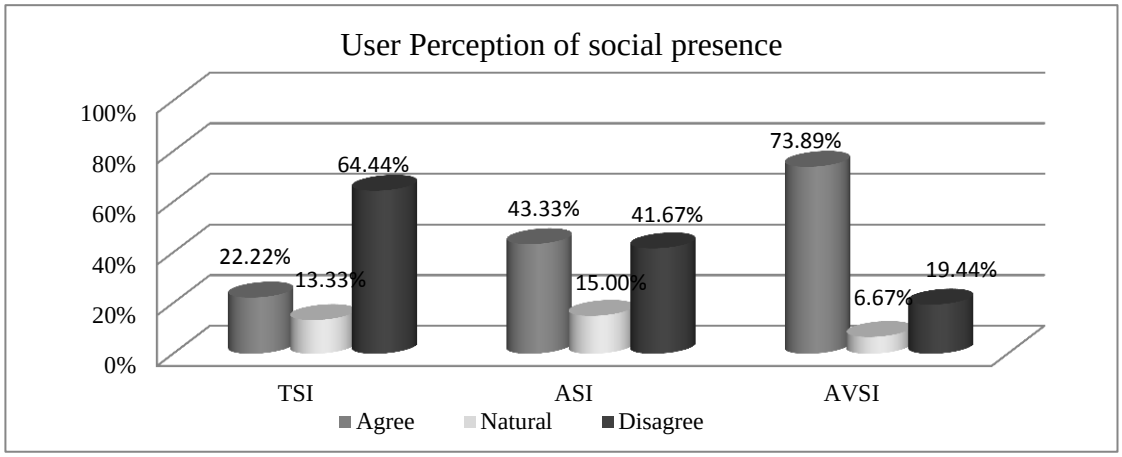


Figure 5.16: Users perception of social presence.

Figure 5.16 shows an overall viewpoint of users subjective opinion with regard to their perception of social presence. Most users (73.89%) strongly agreed that the AVSI condition was the strongest in terms of social presence. The results of the other two conditions. 15% of the ASI users were undecided (neutral) and the rest of the user sample was broadly split with an approximate difference of about 2% in favour of agreement. The TSI condition was broadly the reverse of the AVSI condition with 64.44% of users disagreeing with the feeling of social presence.

Statements	**Code**
'There is a sense of human contact in the website.'	**SP1**
'There is a sense of individualism in the website'	**SP2**
'There is a sense of sociability in the website'	**SP3**
'There is a sense of human warmth in the website.'	**SP4**
'There is a sense of human sensitivity in the website'	**SP5**

Table 5.15: Perceived Social Presence statements coding (Source [44]).

SP- code	1		2		3		4		5	
TSI(SP1)	6	16.67%	2	5.56%	3	8.33%	8	22.22%	17	47.22%
TSI(SP2)	4	11.11%	3	8.33%	6	16.67%	14	38.89%	9	25.00%
TSI(SP3)	3	8.33%	5	13.89%	7	19.44%	10	27.78%	11	30.56%
TSI(SP4)	7	19.44%	5	13.89%	4	11.11%	8	22.22%	12	33.33%
TSI(SP5)	4	11.11%	1	2.78%	4	11.11%	15	41.67%	12	33.33%
ASI(SP1)	4	11.11%	10	27.78%	5	13.89%	7	19.44%	10	27.78%
ASI(SP2)	8	22.22%	9	25.00%	4	11.11%	9	25.00%	6	16.67%
ASI(SP3)	7	19.44%	10	27.78%	8	22.22%	6	16.67%	5	13.89%
ASI(SP4)	5	13.89%	9	25.00%	7	19.44%	8	22.22%	7	19.44%
ASI(SP5)	6	16.67%	10	27.78%	3	8.33%	9	25.00%	8	22.22%
AVSI(SP1)	11	30.56%	15	41.67%	4	11.11%	2	5.56%	4	11.11%
AVSI(SP2)	12	33.33%	17	47.22%	2	5.56%	2	5.56%	3	8.33%
AVSI(SP3)	14	38.89%	13	36.11%	3	8.33%	2	5.56%	4	11.11%
AVSI(SP4)	14	38.89%	12	33.33%	2	5.56%	3	8.33%	5	13.89%
AVSI(SP5)	10	27.78%	15	41.67%	1	2.78%	4	11.11%	6	16.67%

Table 5.16: Frequencies of perceived social presence.

5.8.4 User Evaluation of different interaction modes

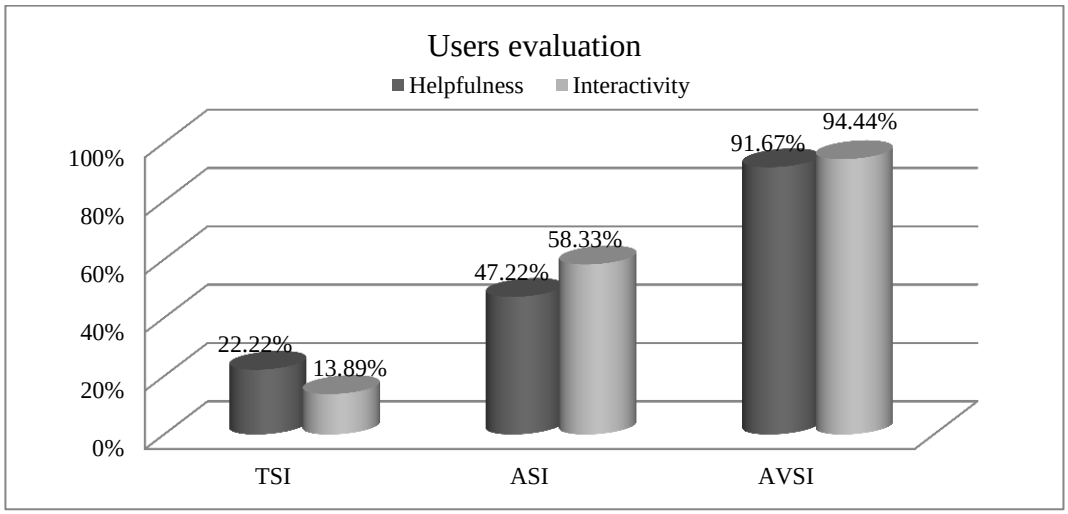


Figure 5.17: Users evaluation of different interaction modes.

Post-experimental users' views were also gathered for the three experimental conditions in terms of 'usefulness' and 'interactivity'. Users were explained that helpfulness is defined as the expected fraction of people who will find the review helpful [140]. Interactivity was defined as "the degree to which two or more communicating parties

can act on each other, on the communication medium, and on the message and the degree to which such influences are synchronized" [141, 142]. Table 5.17 shows the pairwise comparison of the user response for these two parameters.

Due to the nature of the experiment and the multimodal metaphors that has been adopted for each condition, it can be seen that the text with graphics condition achieved the lowest scored in term of both interactivity (13.89%) and helpfulness (22.22%). The lack of social interactivity was one of the main factors influencing these results. The audio condition achieved higher results with the interactivity (58.33%) increased as well as the helpfulness (47.22%). The results on the avatar condition increased significantly to over 90% for both parameters. This shows that the condition was interactive and helpful.

Conditions		Parameter	Chi-Square, p value	Significant
TSI	**ASI**	*Helpfulness*	$x^2 = 6.739\ df = 1, p < 0.05$	Yes
		Interactivity	$x^2 = 20.641\ df = 1, p < 0.005$	Yes
TSI	**AVSI**	*Helpfulness*	$x^2 = 28.373\ df = 1, p < 0.005$	Yes
		Interactivity	$x^2 = 41.696\ df = 1, p < 0.005$	Yes
ASI	**AVSI**	*Helpfulness*	$x^2 = 8.542\ df = 1, p < 0.05$	Yes
		Interactivity	$x^2 = 4.89\ df = 1, p < 0.05$	Yes

Table 5.17: Chi-square results for user evaluation.

5.9 Discussion

Experimental observations indicated that 95% of the users were focused on the interface of the two multimodal conditions. Avatar-based metaphor captured the users' attention from the visual channel towards the interface. Simultaneously, audio-metaphors and further voice-based information were presented to the users. The experimental results were used to compare the three interaction modes in terms of usability from the perspective of efficiency, effectiveness, user satisfaction and social presence.

It was seen that the avatar-condition (AVSI) played a considerable role in the improvement of task accomplishment by attracting user attention, as the interaction in the review with avatar communicate the knowledge, compared to both audio and text conditions. This experimental study was conducted based on the role of multimodal interaction metaphors such as text, audio, and audio-visual avatar with different complexity levels (simple, moderate, and complex) of the e-commerce applications. The results were discussed accordingly to form an understanding of the contributions made by using three multimodal metaphors by one group of users in e-commerce applications from the perspective of usability (efficiency, effectiveness, and satisfaction) and social presence.

The key features of the interaction on the TSI condition were that it used the visual channel of the user for example (text with graphics). The ASI condition used audio metaphors to communicate social and product related information, metaphors used were earcons, adiotory icons, and speech. The AVSI condition used expressive avatar.

During the experiment, users were observed by the experimenter and notes were taken on their reaction towards each condition. Users appeared somewhat confused with the TSI condition and they seem to have less confidence for the accuracy of their decisions. In the ASI condition, users appeared relaxed and confident. On the other hand, the AVSI users were very pleased with the condition as it integrated the avatar into the interfaces and enhanced the communication of information. They felt social presence as created by the avatar and many remarked upon feeling of being socialised and in contact with others. The characteristics of this condition are:

- Avatar condition takes time for simple tasks.

- Using avatar or audio in the simple tasks did not produce noticeable changes.
- Avatar gives the feeling of being with others.
- Using audio to communicate social content like reviews and recommendations was successful in some parts of the interfaces. Earcons was successful in communicating (likes or dislikes).

5.9.1 Efficiency

Figure 5.6 showed that the task completion time across the three interaction modes was less with the avatar condition compared to the text and audio conditions. Also, it was considerably less time consuming for all complexity levels. These findings provide extra support to ***Hypothesis 2***. The assumption of task accomplishment time was satisfied as assessed by Shapiro-Wilk's test ($p>0.05$). Overall, there was a statistically significant difference amongst the conditions and complexity levels on task accomplishment timing, $F(4, 140) = 24.618$, $p < .0005$, partial $\eta 2 = 0.413$. Thus ***hypothesis*** 2 was accepted.

5.9.2 Effectiveness

Figure 5.12 show that users successfully completed 77.16% of tasks in all conditions and complexity levels of tasks. They also show that the percentages of completion in the avatar-condition were higher than the audio condition by almost 16% than the text with graphics condition. There was a variation in task completion rates according to complexity levels as most of the simple tasks were completed successfully (91.67%) compared to 79.63% for moderate tasks and 61.19% for complex tasks.

Friedman test showed that task completion rates were significantly different during the experimental tasks ($x^2(8) = 93.072$ cv $= 1.86, p < 0.05$). Also, pairwise comparisons of all tasks showed a significant difference in complex tasks amongst the three conditions. In the moderate tasks there were no statistically significant differences between audio and avatar; while there was a statistically significant difference between text and audio as well as text and avatar. In simple tasks, there were no statistically significant differences between text and audio or audio and avatar but there was a difference between text and avatar. Thus ***hypothesis*** 2 was accepted.

5.9.3 User Satisfaction and Evaluation

The experimental ***hypothesis*** 4 was confirmed as users were more satisfied with the AVSI condition compared to ASI. The SUS score was significantly higher by 26.7% compared to TSI that had a score of 47.85%. Figure 5.15 offers additional support by presenting the scores of each per condition. The pairwise comparisons show highly significant differences between the three conditions in Figure 5.17.

Table 5.17 and Figure 5.17, confirm ***hypothesis 5*** that users perceived AVSI as being more interactive and helpful than TSI or ASI.

5.9.4 Perceived Social Presence

Figure 5.16 shows that users' perceptions of social presence were the strongest in the avatar-based condition (AVSI). AVSI scored 71.89% compared to 43.33% of the audio-based condition (ASI) and 22.22% for the text-based condition. These findings support the hypothesis 6 (see Section 5.3). The chi-square test confirmed a statistically significant social presence difference in the three conditions.

5.10 Concluding Summary

This experiment investigated the role of three multimodal conditions on socially interactive e-commerce interfaces in terms of efficiency, effectiveness, user satisfaction and perceived social presence. The experiment followed a within-subject design methodology with a group of 36 users. This methodology was useful as each user acts as a control and reduces errors associated with individual user differences.

The use of expressive avatar to communicate product related information, ratings and reviews in a socially interactive context, outperformed the use of audio and text in the same context. The satisfaction, enjoyment and confidence in the decision making process also increased compared to the other two conditions. Similarly, the use of audio outperformed the use of text. Therefore, the use of avatars and to a lesser extent the use of audio were found to contribute significantly to the usability of e-commerce interfaces.

CHAPTER 6 CONCLUSIONS AND EMPIRICALLY DERIVED GUIDELINES

Objectives

- To review the experimental work.
- Provide the main conclusions.
- Provide the guidelines for the design of usable e-Commerce interfaces.
- Provide the limitation and future work.

6.1 Introduction

This Chapter draws the major conclusions on multimodal socially interactive e-commerce interfaces in the light of all the experiments in this Thesis. A set of empirically derived guidelines are also presented. These guidelines will help with the multimodal design and aid social presence. The limitations of these experiments and directions for future work are also discussed.

6.2 Main Conclusions

This research aimed to examine the usability social presence in e-commerce interfaces using innovative combination of multimodal and socially interactive metaphors. This investigation consisted of experimental phases.

The first experimental phase demonstrated that social interaction in e-commerce interfaces outperformed its counterpart interface with static or non-social interaction in terms of the usability parameters except efficiency (see Chapter 3). The efficiency results however had significant differences. Users taken more time and needed more mouse clicks to complete tasks in the presence of a social interactive condition.

The second experimental phase compared an audio-based and an avatar-based socially interactive conditions. The avatar-based social interaction was significantly better than the audio-based condition in terms of usability, social presence, and users evaluation. This comparison highlighted the importance of avatars in the interaction with users in e-commerce interfaces.

The third experimental phase moved the investigation further into a comparison using more detailed specific combinations of multimodal metaphors consisting of text, audio, and avatar.

This section addresses briefly the main conclusions and the limitations of the experimental research results in this thesis. This research involves three experimental phases.

The first experiment (see Chapter 4) demonstrated the following:

- In term of effectiveness and user satisfaction the experimental ISI – Condition has outperformed the other two conditions.
- In term of efficiency the experimental ISI – Condition has consumed more time and more number of mouse clicks comparing to the other two conditions.
- In term of social presence and user evaluation the experimental ISI – Condition has outperformed the other two conditions.

In addition, this experiment however measured the total contribution of social presence in e-commerce applications and the combined effect in terms of usability and the social presence. In this connection, the design of the second experiment was necessary to assess the role of multimodal metaphors on socially interactive e-commerce interfaces.

In the second experimental phase of this research study, the role of multimodal metaphors on socially interactive e-commerce interfaces. It compared the enhanced avatars condition with the enhanced audio condition; the results demonstrated the following facts.

- The avatar condition showed greater efficiency, effectiveness, and user satisfaction compared to using audio condition.
- In terms of social presence and user evaluation, the avatar condition has outperformed the audio condition.

In addition, this experiment however measured the total contribution of the role of multimodal metaphors on socially interactive e-commerce interfaces and the combined effect in terms of usability and the social presence. In this connection, the design of the third experiment was necessary to assess the role of three multimodal metaphors namely (text, audio, and avatar) on socially interactive e-commerce interfaces.

In the third experimental phase of this research study, the role of multimodal metaphors on socially interactive e-commerce interfaces. It compared three multimodal metaphors one is text – condition and the second is audio – condition and the third is avatar – condition; the results demonstrated the following facts.

- The avatar condition showed greater efficiency, effectiveness, and user satisfaction compared to both the audio – condition and the text – condition.
- In term of social presence and user evaluation the avatar condition has outperformed both the audio – condition and the text – condition.

6.3 Empirically Derived Guidelines

The experimental results enabled the formation of an initial set of empirically derived guidelines for the design of more usable e-commerce interfaces with social presence. These guidelines act as a basis and general guidance. They should be read in conjunction with the limitations (see section 6.4) and the experimental results.

On overall, this thesis recommends the use of socially interactive multimodal metaphors in e-commerce interfaces to enhance the usability and social presence, particularly when the users have to perform complex e-commerce transactions. Specifically the guidelines relate to:

1. Designing Interfaces to Aid Social Interaction.
2. Using Audio to Attract the Attention of Users.
3. Combining Audio-Visual Metaphors.
4. Transaction Complexity.

6.3.1 Designing Interfaces to Aid Social Interaction

The introduction of socially interactive metaphors will aid the performance of users (I.e. effectiveness) in moderate to complex e-commerce transactions. It will help users to make more accurate decisions in product selection and be more aware and confident of the associated features of a purchased product. Simple e-commerce transactions are likely to performed equally well by users in the presence or absence of social interactive metaphors. Therefore, the design must be balanced in terms of reducing the presence of social metaphors in simple transactions so they can be completed relatively quickly and involving more as transactions become progressively complex.

Designing interfaces to aid social interaction the designer needs to integrate social media into the interfaces for example reviews, recommendations, and discussions as these forms of interaction will help the interface to be more socially interactive.

Most users are likely to favour this mode as information flow becomes much easier for exchanging views on products, recommendations and so on. The more socially interactive metaphors appropriately utilised, the more user satisfaction and possible

predisposition to trust is expected. For example, an expressive avatar is likely to make users feel at ease as it mimics human contact. Appropriate human contact in a face-to-face commerce is in turn associated with a feeling of human warmth [34]. It therefore expected that the imitation of a real human contact by a well designed expressive avatar will have similar effects. Socially interactive metaphors are also likely to reduce user error. It is however unlikely that user efficiency will improve (see sections 4.1.2 and 4.1.6).

6.3.2 Using Audio to Attract the Attention of Users

Auditory stimuli includes auditory icons (every-day environmental sound), eacons (short musical structures consisting of a few notes) and speech (recorded or synthesised). In general, the output of auditory stimuli has an interrupting effect upon the user interaction. This is due to fact that it is an 'object in time'. This means that by its nature interrupts the presentation of visual and even auditory communication. For example, an earcon can draw user attention to particular parts of a speech message or to an avatar presentation. When a significant amount of auditory stimuli is presented, a pause, review and forward facility is important. This will enable users to review parts that may have been missed or indeed move forward. The move forward facility will aid the efficiency of the user interaction particularly when well experienced users are involved.

The use of synthesised speech will aid the attention, interest and concentration of users. Recorded speech will also work equally well to synthesised speech. Users are likely to take more notice of messages and information. For this reason, user navigation of menu, product, and feature selection are made with user confidence on the selection.

This would also increase user satisfaction. Speech should be used in e-commerce circumstances such as:

1. Presenting reviews about a product.
2. To clarify the description.
3. To guide the customer through the transaction steps.

The combination of environmental sound, speech, and rising pitch metaphors was used to aid interfaces users to the targets actions. These results are in agreement with other reported results in the literature that audio metaphors are better than visual only metaphors.

Results shows that using audio metaphors has an impact on efficiency, effectiveness, and satisfaction of users with the interfaces (see Sections 4.2 and 5.7). Also; results suggest that using earcons and auditory icons helped users to navigate and choose accurate actions. The use of auditory icons was preferred by most of the users as it aids the navigation process.

Designers must not avoid the appropriate use of auditory stimuli on its own or in combination with each other. In an e-commerce user interface context, it will speed up the understanding of users compared to a typical text with graphics interface.

6.3.3 Combining Audio-Visual Metaphors

A combination of audio-visual avatars to aid usability and social presence is a task of balance. Each multimodal metaphor must communicate specific allocated information. The metaphors must be used sparingly and for a purpose. During the design stage, designers must take into account issues such as:

- User information overload.

- The volume of social presence needed for the task.

Multimodal metaphors can support users to complete tasks accurately with less time and feeling of being socially active. This would be noticeable with more substantial and complex tasks rather than with 'straight forward' simple tasks. The overuse of multimodal metaphors (despite the presence of absence of social presence) for a rather simple task or the inappropriate use of those metaphors may result into an unnecessary user information overload. This overload is likely to cause user confusion and affect the use performance and satisfaction. Therefore, the aim would be for designers to balance between the complexity of the task, possible risks to user overload and the use of multimodal metaphors.

Audio metaphors (e.g. recorded or synthesised speech, auditory icons and earcons) sounds contribute positively in increasing the degree of social presence in an e-commerce interface. The obtained results demonstrated the contribution of recorded speech to communicate the product related information. However, a clear and understandable spoken auditory message is just the basis for the development of social presence.

The addition of an expressive will significantly improve the ability of users to understand the communicated spoken message and by extrapolation he social presence of the interface. The use of the avatar will enable users to stay focus and will prevent them from switching their attention to other parts of the interface.

Furthermore, the avatar will guide users to the indented interaction roadmap. The resulting effect is likely to be accurate and faster tasks or transactions within the interface. Users are also likely to be more satisfied and enjoy the interaction. The

contribution of interaction novelty will also contribute to user satisfaction. The overall guideline is to produce a design that attracts the attention of users, keeps users focused and the metaphors used are proportionate to the task or transaction performed by the user.

6.3.4 Transaction Complexity

The complexity of an e-commerce transaction is a key factor for the successful use of multimodal communication metaphors.

Another dimension of complexity is the value of the transaction. Users are likely to find difficult to make decision when purchasing high value products (although the transaction by itself may be simple).

Designers must exercise judgment and discretion when determining the presence and volume, or absence of multimodal metaphors to each interaction instance.

1- The length of the task.
2- Steps required to accomplish the task
3- Number of visited pages.
4- Does it require the user to think beyond the content,
5- Type of potential users.
6- Skills Required.

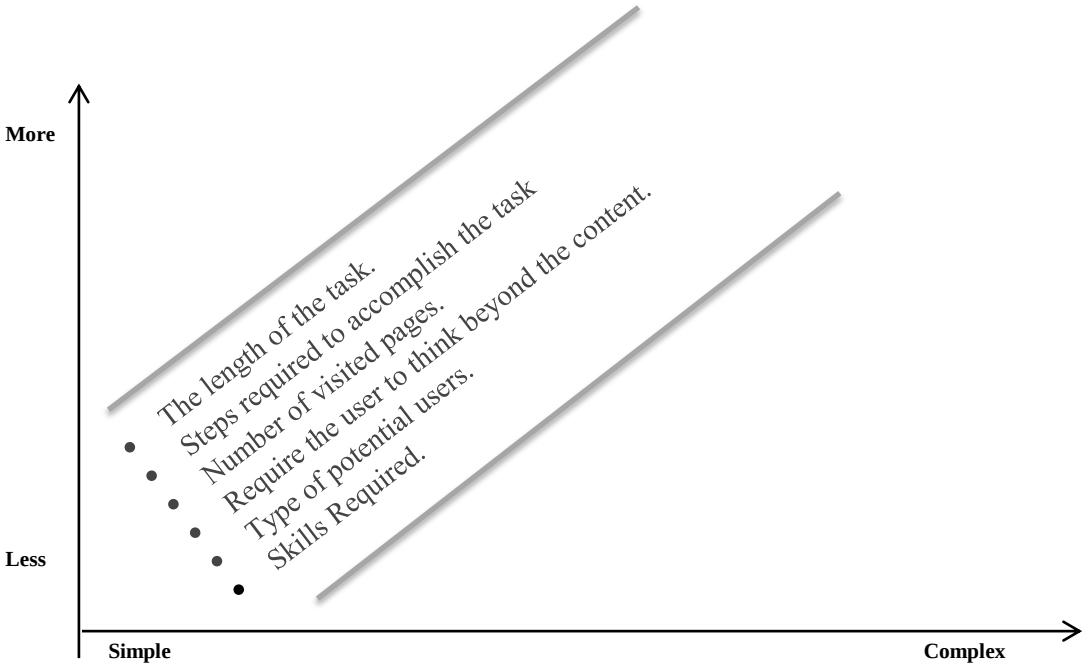


Figure 6.1: Complexity vs. factors.

The performance of socially interactive metaphors is affected by the type and complexity of the task. Social presence improved the effectiveness and user satisfaction. The results demonstrated that the socially interactive conditions were more effective and satisfied compared other conditions (see sections 4.1.7 and 4.1.8). Furthermore, the second experiment compared audio condition with avatar when they were applied to socially interactive e-commerce interfaces. The combination of avatars contributed to substantially enhance the efficiency in the three task complexity levels. However, effectiveness of user performance can be significantly improved by using expressive avatars in moderate and complex tasks (see sections 4.2.2 and 5.9.2). On the other hand, user satisfaction with all types of tasks improved considerably when a combination of audio and avatars were used (see section 5.8.2).

6.4 Limitations

This section discusses the limitations of the experiments performed in this thesis. These limitations are first discussed and linked with the future work section that follows.

- **User Sample**

The user sample was opportunistic and limited. The experiment gathered a snapshot of user activity, empirical data and user views. The conclusions, discussions and guidelines are based on this sample. The data may well change (probably improve) with regular use and repeated measurements. The experiments were in vitro. Users pursued simulated tasks in the laboratory. Probably results will be similar in vivo but this needs to be demonstrated.

- **Customisation and Personalisation of Avatar**

This research has used fixed expressive avatars that could not be altered by the user. Also, the experimental platform offered no facilities to the user for customisation or personalisation. The use of different faces, ethnicities and cultural aspects were beyond the scope of this work.

- **Virtual communities to strengthen social presence**

The experimental platform and it's associated conditions did not involve live or simulated interaction of the users with virtual communities. This interaction was beyond the scope of this work. However, it is acknowledged that interaction with virtual communities is at the core of social presence within an interface.

6.5 Future Work

This section suggests directions for further work based on the experience gained in pursuing this research study, limitations of the work produced and developments in the literature. It is not an exhaustive list but represents some of the key the areas that social interactive e-commerce interfaces will develop.

6.5.1 Virtual Communities to Aid Social Presence

The third experiment investigated the use of virtual communities with users being able to create a single character to demonstrate their discussions. Further experiments can be undertaken to examine additional multi-character virtual communities (similar to real life). The expected outcomes would enable the peer-review of products and enable users to obtain a maximum benefit from participating in these communities. Loyal and dedicated users of a product are likely to influence less loyal customers.

6.5.2 Intelligent Avatars

The application of Artificial Intelligence (AI) in the interaction process between the user and the avatar is an area that requires further research. As portable wireless biofeedback devices [143] are coming to the market, an intelligent avatar will be able to adjust its behaviour based on the psychological state of the user. Biofeedback requires only a few non-intrusive sensors connected to the user in order to obtain a dynamic and continues feed of user data into the system. Also, there are other less intrusive user data gathering that can be used as input into the system to help shape the behaviour of an intelligent avatar. An eye-tracking system combined with an intelligent analysis of the users facial expressions could also help.

6.5.3 Cultural Aspects: Customisation and Personalisation

The influence of cultural parameters (e.g. gender, voice and accent, ethnicity, dress, and age) on expressive avatars cultural need to be taken into account in order to internationalise the guidelines and in turn the interfaces produced based on those guidelines. These parameters may affect the perception, acceptability, satisfaction and pre-disposition to trust of users both positively and negative. Cultural issues are important in the internationalisation of e-commerce and are very likely to be important when avatars are used in social interactive interfaces.

This type of research enquiry is likely to move towards an individualised customisation or indeed a personalisation process for the interface that uses avatars. However, it will require the user to devote time for the customisation or indeed spent sufficient time with the interface for a sufficient personalisation. Several e-commerce interfaces are not used by regular users and organisations constantly compete to enlarge their customer base. Thus; the need for universally acceptable guidelines are not significantly mitigated by either the customisation or personalisation process.

6.6 Epilogue

This research explored the effect of multimodal metaphors on social presence in e-commerce interfaces. The experiments have aided the following:

a) Obtain an overall viewpoint of the suitability of multimodal metaphors for creating the feeling of social presence.

b) Identify the user interactive context under which multimodal metaphors can be used with most impact. The audio and avatars as the task complexity level increase the need for multimodality increases.

c) Establish guidelines for using multimodal designs

d) Acceptance of metaphors used.

Contributed significantly to the research literature by relating three unrelated fields which are social presence, multimodal metaphors, and e-commerce.

This thesis has demonstrated a prima-facie case in support that specific multimodal designs aid the user to perceive social presence, make faster decisions in complex e-commerce transactions, being more satisfied and predisposed to trust the interface. Multi modality however is not the answer to every usability issue or to be used at every single interaction instance. It is the effective design that at times is aided by multi modality at particular interface instances and user perceptual contexts. This is the beginning of to what in the future will be a larger body of research as e-commerce interfaces take a more pre-dominant role in everyday transactions. Larger longer-term experiments that track the activity of users in vitro. This type of enquiry will produce a richer set of data that can be used improving the use of socially interactive e-commerce interfaces.

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APPENDICES

Objectives

• **Appendix A** demonstrates the initial survey.

• **Appendix B** demonstrates the first experiment scenario and row data (Phase I & II).

• **Appendix C** demonstrates the second experiment scenario and row data (Phase III).

APPENDIX A INITIAL SURVEY

Participant Information Sheet

You are invited to take part in the research study: Investigation for achieving and evaluating the sociality and usability of Social Interactive e-commerce environments interfaces and the effect of multimodality. Before you decide it is important for you to understand why the research is being done and what it will involve.

I. Which data will be collected?

The data that will be collected is the data from the attached questionnaire which involve some of these practices:

- The use of e-commerce environment.
- The Shopping Experiences.
- Level of social presence in e-commerce interfaces.
- The Multimodality experiences in e-commerce environment.
- The level of engagement with e-commerce tools.

II. How the data will be collected?

The data will be collected via answering the questionnaire from random sample of online shoppers that will be involved. It is up to the participant to decide whether or not to take part.

III. Where the data will be stored?

The data will be stored manually for research purposes. No personal information will be stored only analysis of the data.

IV. Who will have access to the data and for what purposes?

The data will be kept private so no access for the data. Anonymous results of the study will be used in my PhD thesis.

CONSENT FORM

By : Majed Aborokbah – Research student at De Montfort University

Please Initial Box

I confirm that I understand the research study and have had the opportunity to ask questions. ☐

I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason. ☐

I agree to take part in the above study. ☐

Participant number: ( ).

……

……

Majed Aborokbah

Name of Researcher	Date	Signature

Please answer all the questions as truthfully as possible

Thank you for completing the following questionnaire

Section one : Personal Information : ***Please answer the following questions***

1. What is your gender ? ***(Please tick one answer)***

Male Female

2. Which category below includes your age? ***(Please tick one answer)***

17 or younger

18-20

21-29

30-39

40-49

50-59

60 or older

3. Do you shop on-line ? ***(Please tick one answer)***

- Yes
- No *(if no please do not complete this survey)*

4. What is your marital status? ***(Please tick one answer)***

- Single
- Married
- Other …..

5. What is your highest education level? ***(Please tick one answer)***

- High School
- Undergraduate level
- Postgraduate level
- Other .....

<u>Section two : Shopping Experiences Information :</u> Please answer the following questions

6. How often do you use the internet? ***(Please tick one answer)***

- Daily
- 3 - 4 times a week
- Once a week
- Once a month
- Every six months
- Never

7. What are you using the internet for? ***(More than one answer are accepted)***

- Browsing
- E-mails
- Buying goods
- Selling goods.
- Other.

8. How often do you buy products online? ***(Please tick one answer)***

- Extremely often
- Very often
- Moderately often
- Slightly often
- Not at all often
- Never

9. If you are looking for a product and you find it on-line at the same price of your local shop. Would you buy it on-line? ***(Please tick one answer)***

- Yes
- No

10. If you are looking for a product and you find it on-line cheaper than your local shop. Would you buy it on-line? ***(Please tick one answer)***

- Yes
- No
- Maybe

11. How easy is it to find advice about products when you shop on-line? ***(Please tick one answer)***

- Extremely easy
- Very easy
- Moderately easy
- Slightly easy
- Not at all easy

12 . How easy is it to find the information of specification you are looking for on on-line websites? ***(Please tick one answer).***

- Extremely easy
- Very easy
- Moderately easy
- Slightly easy
- Not at all easy

13. How easy is it to find the product description you are looking for on on-line websites? ***(Please tick one answer)***

- Extremely easy
- Very easy
- Moderately easy
- Slightly easy
- Not at all easy

14. How easy is it to find someone opinion on a specific product online? ***(Please tick one answer)***

- Extremely easy
- Very easy
- Moderately easy
- Slightly easy
- Not at all easy

15. In order to buy a product. Would you first try to find someone who bought the same product? ***(Please tick one answer)***

- Yes
- No

16. Which of the following you think is your main source of recommendation about specific product you are looking to buy ? ***(more than one answer are accepted)***

- Friends
- Family
- Sales people
- Internet reviews

Section three : Multimodal Experiences Information : Please answer the following questions

Speech : recorded using human or generated by speech synthesizers (Voice)

Non-speech : can be musical notes or surrounding sound from everyday life such as glass breaking sound.

17.When you shop online do you like in the multimedia presentation of the following:

1-Speech output o Yes o No	**2-Graphics** o Yes o No
3-Animated face o Yes o No	**4-Animated body** o Yes o No

18. Do you miss the face-to-face contact in your online shopping environments?

- Yes
- No

19. Do you think that multimedia (speech, non-speech, graphics, and animation) might help you with your shopping experiences?

- Yes
- No

Thank you for your time .

APPENDIX B First Experiment Scenario and Row Data Phase I & II

Pre-Experimental Questions

I. What is your age group?

- 17 or under.
- 18 - 24.
- 25 - 34.
- 35 - 44.
- 45 - 54.
- 55 +.

II. What is your highest level of education?

- High school.
- 1st year under-graduate
- Under-graduate.
- Post-graduate (Courses)
- Post-graduate (Research).

III. How often you use the internet (average)?

- Never.
- Rarely (1-2 times in 3 month).
- Occasionally (1-2 times a month).
- 1-2 times a week.
- 3-5 times a week.
- More than 5 time a week.

IV. How many hours do you use the internet (average) per week?

- Never.
- Less than 1 hour.
- 1-5 hours.
- 6-10 hours.
- More than 10 hours.

V. How often you purchase a product over the internet?

- Never.
- Rarely (1-2 times in 3 month).
- Occasionally (1-2 times a month).
- 1-2 times a week.
- 3-5 times a week.
- More than 5 time a week.

Please follow these tasks carefully.

Task 1 scenario (Simple social interactive product selection)

You are required to identify a laptop that satisfied at least the following requirements:

Assume that you are looking for a laptop, which should be compatible with particular preferences you have. Say that your preferences are: The laptop price is less than £ 400. The laptop Hard drive at least 500GB. Also it should have RAM of 2.0 GB. After applying these preferences you need to look to two reviews of the product that you have chosen and you can read any two.

T1 Requirements :

The laptop price must be evaluated (Price< £ 400).

The laptop Hard drive must be evaluated (HDD> 500GB)

The laptop RAM must be evaluated (RAM= 2.0 GB)

Two reviews of the chosen laptop to be read (read reviews = 2).

Specification	**condition**
Price	Less than 400
HDD	Greater than 500 GB
RAM	Equal to 2.0 GB
Product review	Equal to 2

Task 2 scenario (Simple social interactive product selection)

You are require to identify a laptop that satisfied at least the following requirements :

Assume that you are looking for a laptop, which should be compatible with particular preferences you have. Say that your preferences are: The laptop price is equal to £ 300. The laptopHard driveis 500GB. Also it should have RAM of 3.0GB. After applying these preferences you need to look to three reviews of the product .After applying these preferences you need to look to two reviews of the product.

T2 Requirements :

- The laptop price must be evaluated (Price= £ 300).
- The laptop Hard drive must be evaluated (HDD> 500GB)
- The laptop RAM must be evaluated (RAM= 3.0 GB)
- Two reviews of the chosen laptop to be read(read reviews = 2).

Specification	**condition**
Price	Equal to 400
HDD	Greater than 500 GB
RAM	Equal to 3.0 GB
Product review	Equal to 2

Task 3 scenario (Simple social interactive product selection)

You are requiring identifying a laptop that satisfied at least the following requirements:
Assume that you are looking for a laptop, which should be compatible with particular preferences you have. Say that your preferences are: The laptop price is less than £ 400. The laptop Hard drive at least 500GB. Also it should have RAM of 2.0 GB. After applying these preferences you need to look to two reviews of the product .

T3 Requirements :

- The laptop price must be evaluated (Price< £ 400).
- The laptop Hard drive must be evaluated (HDD> 500GB)
- The laptop RAM must be evaluated (RAM= 2.0 GB)
- Two reviews of the chosen laptop to be read (read reviews = 2).

Specification	**condition**
Price	Less than to 400
HDD	Greater than 500 GB
RAM	Equal to 2.0 GB
Product review	Equal to 2

Task 4 scenario (Moderate social interactive product selection)

You are requiring identifying a laptop that satisfied at least the following requirements:
Assume that you are looking for a laptop, which should be compatible with particular preferences you have. Say that your preferences are: The laptop price is less than £ 800. The laptop Hard drive at least 500GB. Also it should have Up to 7 hours battery life and weight 1.5kg.After applying these preferences you need to look to three reviews of the product.

T4 Requirements:

- The laptop price must be evaluated (Price< £ 800).
- The laptop Hard drive must be evaluated (HDD> 500GB)
- Up to 7 hours battery life.
- Weight: 1.5 kg
- Three reviews of the chosen laptop to be read (read reviews = 3).

Specification	**condition**
Price	Less than to£ 800
HDD	Greater than 500 GB
Battery life	Up to 7 hours
weight	Equal to 1.5 kg
Product review	Equal to 3

Task 5 scenario (Moderate social interactive product selection)

You are require to identify a laptop that satisfied at least the following requirements :

Assume that you are looking for a laptop, which should be compatible with particular preferences you have. Say that your preferences are: The laptop price is less than £ 400. The processor is Intel Core i5processor. The laptopHard driveat least 500GB. Alsothe laptop must come with windows 8 genuine. After applying these preferences you need to look to three reviews of the product .

T5 Requirements:

- The laptop price must be evaluated (Price< £ 900).
- Intel Core i5 processor.
- The laptop Hard drive must be evaluated (HDD> 500GB)
- The laptop must come with windows 8 genuine.
- Three reviews of the chosen laptop to be read (read reviews = 3).

Specification	**condition**
Price	Less than £ 900
Processor	Processor is Intel Core i5.
HDD	Greater than 500 GB
Windows	Windows 8 genuine
Product review	Equal to 3

Task 6 scenario (Moderate social interactive product selection)

You are require to identify a laptop that satisfied at least the following requirements :

Assume that you are looking for a laptop, which should be compatible with particular preferences you have. Say that your preferences are: The laptop price is £ 429.99. The laptop Hard drive: 700GB. Also it should have a memory of 6.0 GB. Weight should be not more than 1.45kg.After applying these preferences you need to look to three reviews of the product.

T6 Requirements :

- The laptop price must be evaluated (Price= £429.99).
- The laptop Hard drive must be evaluated (HDD = 750GB)
- The laptop memory must be evaluated (Memory= 6.0 GB)
- Weight: 1.45 kg
- Three reviews of the chosen laptop to be read (read reviews = 3).

Specification	**condition**
Price	Equal to£ 800
HDD	Equal to 500 GB
RAM	Equal to 6.0 GB
weight	Equal to 1.45 kg
Product review	Equal to 3

Task 7 scenario (complex social interactive product selection)

You are require to identify a laptop that satisfied at least the following requirements :
Assume that you are looking for a laptop, which should be compatible with particular preferences you have. Say that your preferences are: The laptop price is less than £ 400. The laptop processor is Dual-core AMD E2-1800 processor. The laptop Hard drive at least 500GB. Also it should have memory space of more than 4.0 GB. The laptop Graphics is: AMD Radeon™ HD 7340. After applying these preferences you need to look to three reviews of the product.

T7 Requirements:

- The laptop price must be evaluated (Price< £ 400).
- The laptop processor is Dual-core AMD E2-1800 processor
- The laptop Hard drive must be evaluated (HDD> 500GB)
- The laptop RAM must be evaluated (Memory > 4.0 GB)
- The laptop Graphics is: AMD Radeon™ HD 7340
- Four reviews of the chosen laptop to be read (read reviews = 4).

Specification	**Condition**
Price	Less than £ 400
Processor	Dual-core AMD E2-1800
HDD	Greater than 500 GB
RAM	Greater than 4.0 GB
Graphics	AMD Radeon™ HD 7340
Product review	Equal to 4

Task 8 scenario (Complex social interactive product selection)

You are required to identify a laptop that satisfied at least the following requirements:
Assume that you are looking for a laptop, which should be compatible with particular preferences you have. Say that your preferences are: The laptop color is silver. The laptop processor is IntelCore i5-2537M processor. The operating system is Genuine Windows 8 .The laptop Hard drive is 128 GB SSD. Also it'sRAM space of more than 3.0 GB DDR3.After applying these preferences you need to look to four reviews of the product.

T8 Requirements :

- The laptop color is silver.
- The laptop processoris Intel Core i5-2537M processor.
- The operating system is Genuine Windows 8

- The laptop Hard drive must be evaluated (HDD = 128GB SSD)
- The laptop RAM must be evaluated (Memory >3.0 GB DDR3)
- Four reviews of the chosen laptop to be read (read reviews = 4).

Specification	**Condition**
Color	Equal to Silver
Processor	Intel Core i5-2537M
HDD	Equal to 128 GB SSD
RAM	Greater than 3.0 GB DDR3
Operating System	Genuine Windows 8
Product review	Equal to 4

Task 9 scenario (Complex social interactive product selection)

You are required to identify a laptop that satisfied at least the following requirements:

Assume that you are looking for a laptop, which should be compatible with particular preferences you have. Say that your preferences are: The laptop color is silver. The laptop processor is Intel Core i5-2537M processor. The operating system is Genuine Windows 8 .The laptop Hard drive is 128 GB SSD. Also it RAM space of 3.0 GB DDR3.After applying these preferences you need to look to four reviews of the product.

T9 Requirements :

- The laptop color is silver.
- The laptop processor is Intel Core i5-2537M processor.
- The operating system is Genuine Windows 8
- The laptop Hard drive must be evaluated (HDD = 128GB SSD)
- The laptop RAM must be evaluated (Memory =3.0 GB DDR3)
- Three reviews of the chosen laptop to be read (read reviews = 3).

Specification	**Condition**
Color	Equal to Silver
Processor	Intel Core i5-2537M
HDD	Equal to 128 GB SSD
RAM	Greater than 3.0 GB DDR3
Operating System	Genuine Windows 8
Product review	Equal to 4

Post Experiment questionnaire

Do you agree or disagree with the following statements ?

I. **The reviews motivated me to make the purchase decision.**
   - Agree
   - Disagree

II. **I feel the reviews were generally trustworthy.**
   - Agree
   - Disagree

III. **Having more communications with the review writer would be beneficial.**
   - Agree
   - Disagree

IV. **I generally trust people who have used a product more than companies who try to sell it.**
   - Agree
   - Disagree

V. **I see the review page good place for advice or unknown problems with products in general.**
   - Agree
   - Disagree

Post task Questions:

I. **How many negative and positive reviews have been written about your laptop?**
   - Positive > Negative
   - Positive < Negative
   - Positive = Negative

II. **The reviews were not very helpful.**
   - Agree
   - Disagree

III. **The interactions on the reviews were very helpful.**
   - Agree
   - Disagree

IV. **Write down one of the pros and one of the cons, people have written on the reviews?**

……

……

User	Interaction Mode	Complexity Level	Task	Time	Number of Mouse Clicks	Task Completion	User Evaluation
1	NSI	Simple	1	5.27	15	1	
1	SSI	Simple	2	4.50	17	1	1
1	ISI	Simple	3	7.28	22	1	2
1	NSI	Moderate	4	5.43	12	0	0
1	SSI	Moderate	5	6.02	13	1	0
1	ISI	Moderate	6	8.25	25	1	1
1	NSI	Complex	7	6.12	18	0	0
1	SSI	Complex	8	7.33	21	0	1
1	ISI	Complex	9	8.55	27	1	2
2	NSI	Simple	1	4.21	13	1	
2	SSI	Simple	2	5.00	16	1	2
2	ISI	Simple	3	6.39	19	1	2
2	NSI	Moderate	4	5.21	11	0	0
2	SSI	Moderate	5	5.50	14	1	1
2	ISI	Moderate	6	7.12	18	1	1
2	NSI	Complex	7	6.32	16	0	0
2	SSI	Complex	8	6.56	21	1	1
2	ISI	Complex	9	7.50	23	1	0
3	NSI	Simple	1	3.11	10	1	
3	SSI	Simple	2	5.50	19	1	2
3	ISI	Simple	3	6.21	18	1	1
3	NSI	Moderate	4	5.38	13	1	0
3	SSI	Moderate	5	6.22	17	0	1
3	ISI	Moderate	6	7.39	21	1	2
3	NSI	Complex	7	6.02	15	0	0
3	SSI	Complex	8	6.52	20	1	1
3	ISI	Complex	9	8.11	23	1	2
4	NSI	Simple	1	4.29	11	0	
4	SSI	Simple	2	6.30	15	1	1
4	ISI	Simple	3	7.14	16	0	2
4	NSI	Moderate	4	6.21	10	1	0
4	SSI	Moderate	5	6.46	16	0	1
4	ISI	Moderate	6	6.55	19	1	2
4	NSI	Complex	7	7.30	13	1	0
4	SSI	Complex	8	7.58	18	0	1
4	ISI	Complex	9	7.40	21	1	2
5	NSI	Simple	1	3.50	9	1	
5	SSI	Simple	2	5.21	12	1	2
5	ISI	Simple	3	7.34	23	1	2

5	NSI	Moderate	4	6.29	12	1	0
5	SSI	Moderate	5	5.55	17	1	1
5	ISI	Moderate	6	8.03	20	1	2
5	NSI	Complex	7	6.48	16	0	0
5	SSI	Complex	8	7.34	19	0	1
5	ISI	Complex	9	8.32	22	1	2
6	NSI	Simple	1	4.14	10	1	
6	SSI	Simple	2	5.07	14	1	2
6	ISI	Simple	3	8.16	19	1	2
6	NSI	Moderate	4	5.33	15	0	0
6	SSI	Moderate	5	7.21	16	1	2
6	ISI	Moderate	6	7.18	21	1	2
6	NSI	Complex	7	8.11	14	0	0
6	SSI	Complex	8	8.38	17	1	0
6	ISI	Complex	9	8.57	24	1	1
7	NSI	Simple	1	4.44	14	0	
7	SSI	Simple	2	5.37	15	0	2
7	ISI	Simple	3	6.02	20	1	1
7	NSI	Moderate	4	5.38	16	0	0
7	SSI	Moderate	5	6.33	18	0	1
7	ISI	Moderate	6	8.22	22	1	1
7	NSI	Complex	7	7.43	17	0	0
7	SSI	Complex	8	7.11	18	1	0
7	ISI	Complex	9	8.45	21	1	1
8	NSI	Simple	1	3.54	12	1	
8	SSI	Simple	2	4.57	16	1	2
8	ISI	Simple	3	7.32	18	1	2
8	NSI	Moderate	4	6.11	15	0	0
8	SSI	Moderate	5	6.53	17	1	2
8	ISI	Moderate	6	7.13	23	0	2
8	NSI	Complex	7	6.25	18	1	0
8	SSI	Complex	8	7.26	20	1	1
8	ISI	Complex	9	7.40	24	1	1
9	NSI	Simple	1	2.33	11	1	
9	SSI	Simple	2	5.50	17	1	2
9	ISI	Simple	3	6.35	19	1	2
9	NSI	Moderate	4	6.24	16	1	0
9	SSI	Moderate	5	6.43	19	1	2
9	ISI	Moderate	6	7.41	20	1	2
9	NSI	Complex	7	5.12	15	0	0
9	SSI	Complex	8	7.39	20	0	2
9	ISI	Complex	9	8.00	22	1	2

10	NSI	Simple	1	3.55	14	0	
10	SSI	Simple	2	5.23	15	1	1
10	ISI	Simple	3	7.19	18	1	1
10	NSI	Moderate	4	5.34	16	0	0
10	SSI	Moderate	5	5.58	18	1	0
10	ISI	Moderate	6	6.24	19	1	2
10	NSI	Complex	7	6.27	16	0	0
10	SSI	Complex	8	7.02	19	0	1
10	ISI	Complex	9	7.32	21	0	0
11	NSI	Simple	1	5.13	12	1	
11	SSI	Simple	2	4.29	14	0	1
11	ISI	Simple	3	7.55	20	1	2
11	NSI	Moderate	4	4.35	14	0	0
11	SSI	Moderate	5	6.11	17	0	1
11	ISI	Moderate	6	6.43	21	1	2
11	NSI	Complex	7	6.45	15	0	0
11	SSI	Complex	8	7.28	20	0	1
11	ISI	Complex	9	8.09	23	1	1
12	NSI	Simple	1	3.53	13	1	
12	SSI	Simple	2	5.33	16	1	1
12	ISI	Simple	3	7.44	22	1	1
12	NSI	Moderate	4	6.39	15	1	0
12	SSI	Moderate	5	5.11	20	0	1
12	ISI	Moderate	6	7.50	24	1	2
12	NSI	Complex	7	7.21	14	1	0
12	SSI	Complex	8	6.21	21	0	1
12	ISI	Complex	9	7.57	25	1	0
13	NSI	Simple	1	4.40	15	1	
13	SSI	Simple	2	4.28	18	1	1
13	ISI	Simple	3	6.42	19	1	2
13	NSI	Moderate	4	7.26	13	0	0
13	SSI	Moderate	5	7.44	15	1	1
13	ISI	Moderate	6	7.58	21	1	1
13	NSI	Complex	7	6.55	13	1	0
13	SSI	Complex	8	8.05	16	1	1
13	ISI	Complex	9	8.04	17	1	0
14	NSI	Simple	1	4.33	13	1	
14	SSI	Simple	2	4.44	15	1	1
14	ISI	Simple	3	5.32	20	1	2
14	NSI	Moderate	4	5.12	11	0	0
14	SSI	Moderate	5	6.23	14	1	1
14	ISI	Moderate	6	7.55	19	1	2

14	NSI	Complex	7	5.58	14	0	0
14	SSI	Complex	8	6.56	18	0	0
14	ISI	Complex	9	8.12	19	1	1
15	NSI	Simple	1	4.00	11	0	
15	SSI	Simple	2	5.29	16	1	2
15	ISI	Simple	3	7.21	20	0	2
15	NSI	Moderate	4	4.28	12	1	0
15	SSI	Moderate	5	5.34	18	1	0
15	ISI	Moderate	6	6.40	23	0	2
15	NSI	Complex	7	6.18	15	0	0
15	SSI	Complex	8	6.14	19	1	2
15	ISI	Complex	9	7.52	21	0	2
16	NSI	Simple	1	4.18	13	1	
16	SSI	Simple	2	6.11	18	1	2
16	ISI	Simple	3	6.34	19	1	1
16	NSI	Moderate	4	6.13	14	1	0
16	SSI	Moderate	5	6.55	19	1	0
16	ISI	Moderate	6	7.23	20	0	1
16	NSI	Complex	7	6.32	15	0	0
16	SSI	Complex	8	7.12	20	0	1
16	ISI	Complex	9	7.36	25	1	2
17	NSI	Simple	1	3.27	12	1	
17	SSI	Simple	2	4.36	17	0	2
17	ISI	Simple	3	8.02	22	0	2
17	NSI	Moderate	4	5.29	16	0	0
17	SSI	Moderate	5	6.00	22	1	1
17	ISI	Moderate	6	6.18	18	1	2
17	NSI	Complex	7	5.34	17	0	0
17	SSI	Complex	8	6.52	23	0	1
17	ISI	Complex	9	7.39	28	0	1
18	NSI	Simple	1	3.44	14	1	
18	SSI	Simple	2	4.57	19	1	1
18	ISI	Simple	3	7.11	21	1	2
18	NSI	Moderate	4	5.34	13	1	0
18	SSI	Moderate	5	5.21	16	0	0
18	ISI	Moderate	6	7.02	19	1	1
18	NSI	Complex	7	6.45	18	0	0
18	SSI	Complex	8	5.54	19	0	1
18	ISI	Complex	9	8.07	20	1	1
19	NSI	Simple	1	4.34	15	0	
19	SSI	Simple	2	5.00	16	1	1
19	ISI	Simple	3	7.04	20	1	2

19	NSI	Moderate	4	6.55	15	1	0
19	SSI	Moderate	5	7.17	18	1	2
19	ISI	Moderate	6	7.21	22	1	2
19	NSI	Complex	7	7.25	15	1	0
19	SSI	Complex	8	7.43	17	1	1
19	ISI	Complex	9	7.56	18	0	1
20	NSI	Simple	1	4.22	14	0	
20	SSI	Simple	2	5.37	15	1	2
20	ISI	Simple	3	7.23	19	1	1
20	NSI	Moderate	4	7.03	17	0	0
20	SSI	Moderate	5	7.40	16	1	2
20	ISI	Moderate	6	8.02	24	1	2
20	NSI	Complex	7	7.23	14	0	0
20	SSI	Complex	8	7.54	18	1	1
20	ISI	Complex	9	8.36	22	0	2
21	NSI	Simple	1	5.30	11	1	
21	SSI	Simple	2	5.54	20	1	2
21	ISI	Simple	3	6.13	18	1	2
21	NSI	Moderate	4	6.39	13	0	0
21	SSI	Moderate	5	6.48	19	1	1
21	ISI	Moderate	6	7.31	21	0	2
21	NSI	Complex	7	7.54	18	0	0
21	SSI	Complex	8	7.34	24	1	0
21	ISI	Complex	9	7.52	26	0	2
22	NSI	Simple	1	3.43	13	1	
22	SSI	Simple	2	4.45	18	1	2
22	ISI	Simple	3	7.06	20	1	1
22	NSI	Moderate	4	7.23	17	0	0
22	SSI	Moderate	5	6.58	20	1	1
22	ISI	Moderate	6	7.20	28	1	2
22	NSI	Complex	7	6.02	16	0	0
22	SSI	Complex	8	7.32	26	1	0
22	ISI	Complex	9	7.59	28	1	1
23	NSI	Simple	1	3.17	15	1	
23	SSI	Simple	2	5.20	17	1	2
23	ISI	Simple	3	7.44	22	0	2
23	NSI	Moderate	4	7.37	18	1	0
23	SSI	Moderate	5	7.45	17	1	1
23	ISI	Moderate	6	8.07	21	1	0
23	NSI	Complex	7	7.12	19	0	0
23	SSI	Complex	8	7.58	19	1	1
23	ISI	Complex	9	8.32	23	1	0

24	NSI	Simple	1	3.25	14	1	
24	SSI	Simple	2	4.55	19	0	1
24	ISI	Simple	3	8.21	24	1	2
24	NSI	Moderate	4	6.28	14	0	0
24	SSI	Moderate	5	6.50	21	1	0
24	ISI	Moderate	6	7.43	19	1	1
24	NSI	Complex	7	7.29	14	1	0
24	SSI	Complex	8	7.06	18	1	0
24	ISI	Complex	9	8.44	24	0	1
25	NSI	Simple	1	5.25	16	1	
25	SSI	Simple	2	4.43	15	1	1
25	ISI	Simple	3	7.23	21	1	1
25	NSI	Moderate	4	6.38	13	1	0
25	SSI	Moderate	5	6.56	17	1	0
25	ISI	Moderate	6	7.21	23	1	1
25	NSI	Complex	7	6.25	17	0	0
25	SSI	Complex	8	7.13	19	0	0
25	ISI	Complex	9	9.52	20	0	0
26	NSI	Simple	1	4.43	14	1	
26	SSI	Simple	2	5.21	16	1	2
26	ISI	Simple	3	8.00	18	1	1
26	NSI	Moderate	4	6.54	14	0	0
26	SSI	Moderate	5	7.02	16	1	1
26	ISI	Moderate	6	7.45	20	0	2
26	NSI	Complex	7	6.38	15	0	0
26	SSI	Complex	8	7.37	18	1	1
26	ISI	Complex	9	9.21	23	1	1
27	NSI	Simple	1	3.23	12	0	
27	SSI	Simple	2	5.22	15	1	2
27	ISI	Simple	3	7.05	17	1	1
27	NSI	Moderate	4	4.42	11	1	0
27	SSI	Moderate	5	5.34	15	0	2
27	ISI	Moderate	6	6.54	19	1	2
27	NSI	Complex	7	6.02	14	0	0
27	SSI	Complex	8	6.18	20	0	1
27	ISI	Complex	9	7.21	26	0	2
28	NSI	Simple	1	3.15	10	1	
28	SSI	Simple	2	6.33	13	1	1
28	ISI	Simple	3	7.11	16	1	2
28	NSI	Moderate	4	5.54	14	1	0
28	SSI	Moderate	5	6.18	10	0	1
28	ISI	Moderate	6	6.40	17	1	2

28	NSI	Complex	7	5.43	15	1	0
28	SSI	Complex	8	7.21	18	1	0
28	ISI	Complex	9	7.54	20	1	1
29	NSI	Simple	1	3.43	13	1	
29	SSI	Simple	2	5.24	16	1	1
29	ISI	Simple	3	7.32	19	1	2
29	NSI	Moderate	4	5.34	15	0	0
29	SSI	Moderate	5	6.43	19	0	1
29	ISI	Moderate	6	7.05	24	1	2
29	NSI	Complex	7	6.12	16	0	0
29	SSI	Complex	8	7.19	19	1	0
29	ISI	Complex	9	8.01	28	1	1
30	NSI	Simple	1	3.21	15	1	
30	SSI	Simple	2	4.15	17	0	2
30	ISI	Simple	3	7.24	20	1	2
30	NSI	Moderate	4	6.23	16	0	0
30	SSI	Moderate	5	7.19	20	1	2
30	ISI	Moderate	6	7.23	23	1	2
30	NSI	Complex	7	6.50	14	0	0
30	SSI	Complex	8	8.45	22	1	1
30	ISI	Complex	9	7.58	26	1	2
31	NSI	Simple	1	4.18	14	0	
31	SSI	Simple	2	4.32	19	1	1
31	ISI	Simple	3	6.45	21	1	2
31	NSI	Moderate	4	5.37	18	0	0
31	SSI	Moderate	5	6.55	23	1	1
31	ISI	Moderate	6	6.54	27	1	1
31	NSI	Complex	7	5.57	18	0	0
31	SSI	Complex	8	7.36	23	1	0
31	ISI	Complex	9	8.15	24	0	1
32	NSI	Simple	1	4.22	16	1	
32	SSI	Simple	2	4.18	18	0	2
32	ISI	Simple	3	7.03	20	1	2
32	NSI	Moderate	4	5.12	15	1	0
32	SSI	Moderate	5	5.34	18	0	0
32	ISI	Moderate	6	7.20	20	1	1
32	NSI	Complex	7	5.42	16	1	0
32	SSI	Complex	8	6.55	20	1	0
32	ISI	Complex	9	7.54	23	1	1
33	NSI	Simple	1	3.09	13	1	
33	SSI	Simple	2	5.24	21	1	2
33	ISI	Simple	3	7.14	18	1	1

33	NSI	Moderate	4	4.43	17	0	0
33	SSI	Moderate	5	5.50	17	1	0
33	ISI	Moderate	6	6.03	23	1	0
33	NSI	Complex	7	6.49	19	0	0
33	SSI	Complex	8	7.03	22	1	1
33	ISI	Complex	9	7.49	27	0	1
34	NSI	Simple	1	3.22	11	0	
34	SSI	Simple	2	4.53	23	1	2
34	ISI	Simple	3	6.01	19	1	2
34	NSI	Moderate	4	6.28	14	0	0
34	SSI	Moderate	5	7.39	19	0	1
34	ISI	Moderate	6	8.11	19	1	1
34	NSI	Complex	7	7.55	16	1	0
34	SSI	Complex	8	7.19	18	0	2
34	ISI	Complex	9	8.02	24	0	0
35	NSI	Simple	1	3.50	10	1	
35	SSI	Simple	2	4.12	16	1	2
35	ISI	Simple	3	8.12	21	1	2
35	NSI	Moderate	4	4.44	13	1	0
35	SSI	Moderate	5	5.39	21	1	1
35	ISI	Moderate	6	6.42	22	1	1
35	NSI	Complex	7	6.43	17	0	0
35	SSI	Complex	8	6.15	20	1	1
35	ISI	Complex	9	7.55	22	1	0
36	NSI	Simple	1	3.29	9	1	
36	SSI	Simple	2	5.22	15	1	1
36	ISI	Simple	3	7.29	24	1	2
36	NSI	Moderate	4	5.23	15	0	0
36	SSI	Moderate	5	6.54	18	1	1
36	ISI	Moderate	6	7.08	21	1	1
36	NSI	Complex	7	6.12	18	0	0
36	SSI	Complex	8	7.06	22	1	1
36	ISI	Complex	9	7.53	26	0	1
			Sum	**2035.89**	**5794.00**	**214.00**	**274.00**
			Average	**6.28**	**17.88**	**0.66**	**0.95**
			Std. Dev.	**1.36**	**3.90**	**0.47**	**0.81**

Table B.1 : Experiment 1 Phase I data.

Tests of Within-Subjects Effects

Measure: Time

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Interaction Mode	***Sphericity Assumed***	***185.595***	***2***	***92.797***	***213.506***	***.000***	***.859***
	Greenhouse-Geisser	**185.595**	**1.385**	**134.041**	**213.506**	**.000**	**.859**
	Huynh-Feldt	185.595	1.423	130.394	213.506	.000	.859
	Lower-bound	185.595	1.000	185.595	213.506	.000	.859
Error(Interaction Mode)	**Sphericity Assumed**	**30.425**	**70**	**.435**			
	Greenhouse-Geisser	30.425	48.461	.628			
	Huynh-Feldt	30.425	49.817	.611			
	Lower-bound	30.425	35.000	.869			
Complexity Level	**Sphericity Assumed**	**226.824**	**2**	**113.412**	**321.820**	**.000**	**.902**
	Greenhouse-Geisser	226.824	1.961	115.639	321.820	.000	.902
	Huynh-Feldt	226.824	2.000	113.412	321.820	.000	.902
	Lower-bound	226.824	1.000	226.824	321.820	.000	.902
Error(Complexity Level)	**Sphericity Assumed**	**24.669**	**70**	**.352**			
	Greenhouse-Geisser	24.669	68.652	.359			
	Huynh-Feldt	24.669	70.000	.352			
	Lower-bound	24.669	35.000	.705			
Interaction Mode * Complexity Level	**Sphericity Assumed**	**39.287**	**4**	**9.822**	**30.388**	**.000**	**.465**
	Greenhouse-Geisser	39.287	3.176	12.369	30.388	.000	.465
	Huynh-Feldt	39.287	3.530	11.129	30.388	.000	.465
	Lower-bound	39.287	1.000	39.287	30.388	.000	.465
Error(Interaction Mode*Complexity Level)	**Sphericity Assumed**	**45.250**	**140**	**.323**			
	Greenhouse-Geisser	45.250	111.170	.407			
	Huynh-Feldt	45.250	123.560	.366			
	Lower-bound	45.250	35.000	1.293			

Table B.2 : Within-subject Phase I data.

Pairwise Comparisons

Measure: Time

(I) Complexity Level	(J) Complexity Level	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
Simple	Moderate	-.780*	.077	.000	-.975	-.586
	Complex	-2.031*	.078	.000	-2.229	-1.834
Moderate	Complex	-1.251*	.086	.000	-1.468	-1.034

Table B.3 : Pairwise Comparisons.

The information in each column of the **Pairwise Comparisons** table has the following meaning:

Column Name	Column Meaning
Mean Difference (I - J)	Mean difference between group I and group J (I minus J)
Std. Error	Standard error of the difference between group I and J
Sig.	Significance level (*p*-value) of the difference between group I and J
Lower Bound	The lower bound (limit) of the 95% confidence interval for the difference between group I and J
Upper Bound	The upper bound (limit) of the 95% confidence interval for the difference between group I and J

Table B.4 : Pairwise Comparisons meaning

Pairwise Comparisons

Measure: Time

(I) Interaction Mode	(J) Interaction Mode	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
NSI	SSI	-1.114[*]	.116	.000	-1.405	-.823
	ISI	-1.840[*]	.073	.000	-2.025	-1.656
SSI	ISI	-.727[*]	.073	.000	-.910	-.543

Table B.5 : *Post-hoc* analysis for Interaction Modes

Tests of Within-Subjects Effects

Measure: Mouse Clicks

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Complexity Level	Sphericity Assumed	577.302	2	288.651	58.168	.000	.624
	Greenhouse-Geisser	577.302	1.951	295.876	58.168	.000	.624
	Huynh-Feldt	577.302	2.000	288.651	58.168	.000	.624
	Lower-bound	577.302	1.000	577.302	58.168	.000	.624
Error(Complexity Level)	Sphericity Assumed	347.364	70	4.962			
	Greenhouse-Geisser	347.364	68.291	5.087			
	Huynh-Feldt	347.364	70.000	4.962			
	Lower-bound	347.364	35.000	9.925			
Interaction Mode	Sphericity Assumed	2774.543	2	1387.272	355.984	.000	.910
	Greenhouse-Geisser	2774.543	1.963	1413.681	355.984	.000	.910
	Huynh-Feldt	2774.543	2.000	1387.272	355.984	.000	.910
	Lower-bound	2774.543	1.000	2774.543	355.984	.000	.910
Error(Interaction Mode)	Sphericity Assumed	272.790	70	3.897			
	Greenhouse-Geisser	272.790	68.692	3.971			
	Huynh-Feldt	272.790	70.000	3.897			
	Lower-bound	272.790	35.000	7.794			
Complexity Level * Interaction Mode	Sphericity Assumed	6.864	4	1.716	.597	.665	.017
	Greenhouse-Geisser	6.864	3.420	2.007	.597	.640	.017
	Huynh-Feldt	6.864	3.835	1.790	.597	.659	.017
	Lower-bound	6.864	1.000	6.864	.597	.445	.017
Error (Complexity Level*Interaction Mode)	Sphericity Assumed	402.469	140	2.875			
	Greenhouse-Geisser	402.469	119.703	3.362			
	Huynh-Feldt	402.469	134.241	2.998			
	Lower-bound	402.469	35.000	11.499			

Table B.6 : Tests of Within-Subjects Effects

Task completed successfully:

Users	Simple			Moderate			Complex			Task complexity level			Task Interaction mode			Total
	T1	T2	T3	T4	T5	T6	T7	T8	T9	Simple	Moderate	Complex	NSI	SSI	ISI	All
U1	1	1	1	0	1	1	0	0	1	3	2	1	1	2	3	6
U2	1	1	1	0	1	1	0	1	1	3	2	2	1	3	3	7
U3	1	1	1	1	0	1	0	1	1	3	2	2	2	2	3	7
U4	0	1	0	1	0	1	1	0	1	1	2	2	2	1	2	5
U5	1	1	1	1	1	1	0	0	1	3	3	1	2	2	3	7
U6	1	1	1	0	1	1	0	1	1	3	2	2	1	3	3	7
U7	0	0	1	0	0	1	0	1	1	1	1	2	0	1	3	4
U8	1	1	1	0	1	0	1	1	1	3	1	3	2	3	2	7
U9	1	1	1	1	1	1	0	0	1	3	3	1	2	2	3	7
U10	0	1	1	0	1	1	0	0	0	2	2	0	0	2	2	4
U11	1	0	1	0	0	1	0	0	1	2	1	1	1	0	3	4
U12	1	1	1	1	0	1	1	0	1	3	2	2	3	1	3	7
U13	1	1	1	0	1	1	1	1	1	3	2	3	2	3	3	8
U14	1	1	1	0	1	1	0	0	1	3	2	1	1	2	3	6
U15	0	1	0	1	1	0	0	1	0	1	2	1	1	3	0	4
U16	1	1	1	1	1	0	0	0	1	3	2	1	2	2	2	6
U17	1	0	0	0	1	1	0	0	0	1	2	0	1	1	1	3
U18	1	1	1	1	0	1	0	0	1	3	2	1	2	1	3	6
U19	0	1	1	1	1	1	1	1	0	2	3	2	2	3	2	7
U20	0	1	1	0	1	1	0	1	0	2	2	1	0	3	2	5
U21	1	1	1	0	1	0	0	1	0	3	1	1	1	3	1	5
U22	1	1	1	0	1	1	0	1	1	3	2	2	1	3	3	7
U23	1	1	0	1	1	1	0	1	1	2	3	2	2	3	2	7
U24	1	0	1	0	1	1	1	1	0	2	2	2	2	2	2	6
U25	1	1	1	1	1	1	0	0	0	3	3	0	2	2	2	6
U26	1	1	1	0	1	0	0	1	1	3	1	2	1	3	2	6
U27	0	1	1	1	0	1	0	0	0	2	2	0	1	1	2	4
U28	1	1	1	1	0	1	1	1	1	3	2	3	3	2	3	8
U29	1	1	1	0	0	1	0	1	1	3	1	2	1	2	3	6
U30	1	0	1	0	1	1	0	1	1	2	2	2	1	2	3	6
U31	0	1	1	0	1	1	0	1	0	2	2	1	0	3	2	5

U32	1	0	1	1	0	1	1	1	1	2	2	3	3	1	3	7
U33	1	1	1	0	1	1	0	1	0	3	2	1	1	3	2	6
U34	0	1	1	0	0	1	1	0	0	2	1	1	1	1	2	4
U35	1	1	1	1	1	1	0	1	1	3	3	2	2	3	3	8
U36	1	1	1	0	1	1	0	1	0	3	2	1	1	3	2	6
Average	27	30	32	15	25	31	9	22	23	89	71	54	51	77	86	214

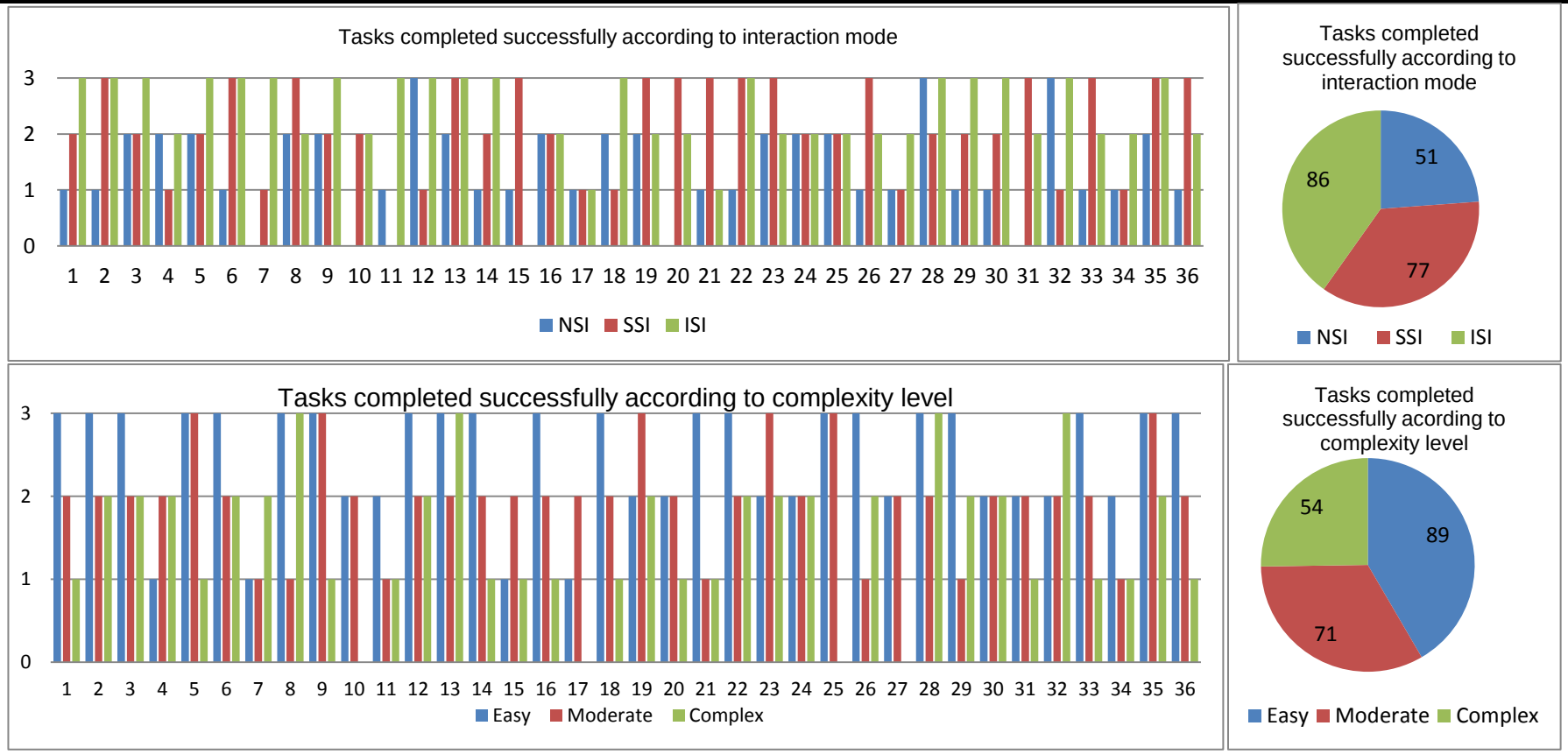

Figure B.1: Task completed successfully

Task Accomplishment time:

Users	Simple			Moderate			Complex			Task complexity level			Task Interaction mode			Total
	T1	T2	T3	T4	T5	T6	T7	T8	T9	Simple	Moderate	Complex	NSI	SSI	ISI	All
U1	5.27	4.50	7.28	5.43	6.02	8.25	6.12	7.33	8.55	17.05	19.7	22	16.82	17.85	24.08	58.75
U2	4.21	5.00	6.39	5.21	5.50	7.12	6.32	6.56	7.50	15.6	17.83	20.38	15.74	17.06	21.01	53.81
U3	3.11	5.50	6.21	5.38	6.22	7.39	6.02	6.52	8.11	14.82	18.99	20.65	14.51	18.24	21.71	54.46
U4	4.29	6.30	7.14	6.21	6.46	6.55	7.30	7.58	7.40	17.73	19.22	22.28	17.8	20.34	21.09	59.23
U5	3.50	5.21	7.34	6.29	5.55	8.03	6.48	7.34	8.32	16.05	19.87	22.14	16.27	18.1	23.69	58.06
U6	4.14	5.07	8.16	5.33	7.21	7.18	8.11	8.38	8.57	17.37	19.72	25.06	17.58	20.66	23.91	62.15
U7	4.44	5.37	6.02	5.38	6.33	8.22	7.43	7.11	8.45	15.83	19.93	22.99	17.25	18.81	22.69	58.75
U8	3.54	4.57	7.32	6.11	6.53	7.13	6.25	7.26	7.40	15.43	19.77	20.91	15.9	18.36	21.85	56.11
U9	2.33	5.50	6.35	6.24	6.43	7.41	5.12	7.39	8.00	14.18	20.08	20.51	13.69	19.32	21.76	54.77
U10	3.55	5.23	7.19	5.34	5.58	6.24	6.27	7.02	7.32	15.97	17.16	20.61	15.16	17.83	20.75	53.74
U11	5.13	4.29	7.55	4.35	6.11	6.43	6.45	7.28	8.09	16.97	16.89	21.82	15.93	17.68	22.07	55.68
U12	3.53	5.33	7.44	6.39	5.11	7.50	7.21	6.21	7.57	16.3	19	20.99	17.13	16.65	22.51	56.29
U13	4.40	4.28	6.42	7.26	7.44	7.58	6.55	8.05	8.04	15.1	22.28	22.64	18.21	19.77	22.04	60.02
U14	4.33	4.44	5.32	5.12	6.23	7.55	5.58	6.56	8.12	14.09	18.9	20.26	15.03	17.23	20.99	53.25
U15	4.00	5.29	7.21	4.28	5.34	6.40	6.18	6.14	7.52	16.5	16.02	19.84	14.46	16.77	21.13	52.36
U16	4.18	6.11	6.34	6.13	6.55	7.23	6.32	7.12	7.36	16.63	19.91	20.8	16.63	19.78	20.93	57.34
U17	3.27	4.36	8.02	5.29	6.00	6.18	5.34	6.52	7.39	15.65	17.47	19.25	13.9	16.88	21.59	52.37
U18	3.44	4.57	7.11	5.34	5.21	7.02	6.45	5.54	8.07	15.12	17.57	20.06	15.23	15.32	22.2	52.75
U19	4.34	5.00	7.04	6.55	7.17	7.21	7.25	7.43	7.56	16.38	20.93	22.24	18.14	19.6	21.81	59.55
U20	4.22	5.37	7.23	7.03	7.40	8.02	7.23	7.54	8.36	16.82	22.45	23.13	18.48	20.31	23.61	62.4
U21	5.30	5.54	6.13	6.39	6.48	7.31	7.54	7.34	7.52	16.97	20.18	22.4	19.23	19.36	20.96	59.55
U22	3.43	4.45	7.06	7.23	6.58	7.20	6.02	7.32	7.59	14.94	21.01	20.93	16.68	18.35	21.85	56.88
U23	3.17	5.20	7.44	7.37	7.45	8.07	7.12	7.58	8.32	15.81	22.89	23.02	17.66	20.23	23.83	61.72
U24	3.25	4.55	8.21	6.28	6.50	7.43	7.29	7.06	8.44	16.01	20.21	22.79	16.82	18.11	24.08	59.01
U25	5.25	4.43	7.23	6.38	6.56	7.21	6.25	7.13	9.52	16.91	20.15	22.9	17.88	18.12	23.96	59.96
U26	4.43	5.21	8.00	6.54	7.02	7.45	6.38	7.37	9.21	17.64	21.01	22.96	17.35	19.6	24.66	61.61
U27	3.23	5.22	7.05	4.42	5.34	6.54	6.02	6.18	7.21	15.5	16.3	19.41	13.67	16.74	20.8	51.21
U28	3.15	6.33	7.11	5.54	6.18	6.40	5.43	7.21	7.54	16.59	18.12	20.18	14.12	19.72	21.05	54.89
U29	3.43	5.24	7.32	5.34	6.43	7.05	6.12	7.19	8.01	15.99	18.82	21.32	14.89	18.86	22.38	56.13
U30	3.21	4.15	7.24	6.23	7.19	7.23	6.50	8.45	7.58	14.6	20.65	22.53	15.94	19.79	22.05	57.78
U31	4.18	4.32	6.45	5.37	6.55	6.54	5.57	7.36	8.15	14.95	18.46	21.08	15.12	18.23	21.14	54.49

U32	4.22	4.18	7.03	5.12	5.34	7.20	5.42	6.55	7.54	15.43	17.66	19.51	14.76	16.07	21.77	52.6
U33	3.09	5.24	7.14	4.43	5.50	6.03	6.49	7.03	7.49	15.47	15.96	21.01	14.01	17.77	20.66	52.44
U34	3.22	4.53	6.01	6.28	7.39	8.11	7.55	7.19	8.02	13.76	21.78	22.76	17.05	19.11	22.14	58.3
U35	3.50	4.12	8.12	4.44	5.39	6.42	6.43	6.15	7.55	15.74	16.25	20.13	14.37	15.66	22.09	52.12
U36	3.29	5.22	7.29	5.23	6.54	7.08	6.12	7.06	7.53	15.8	18.85	20.71	14.64	18.82	21.9	55.36
Average	3.85	4.98	7.05	5.76	6.30	7.16	6.45	7.08	7.9	15.88	19.222	21.45	16.06	18.36	22.11	56.53

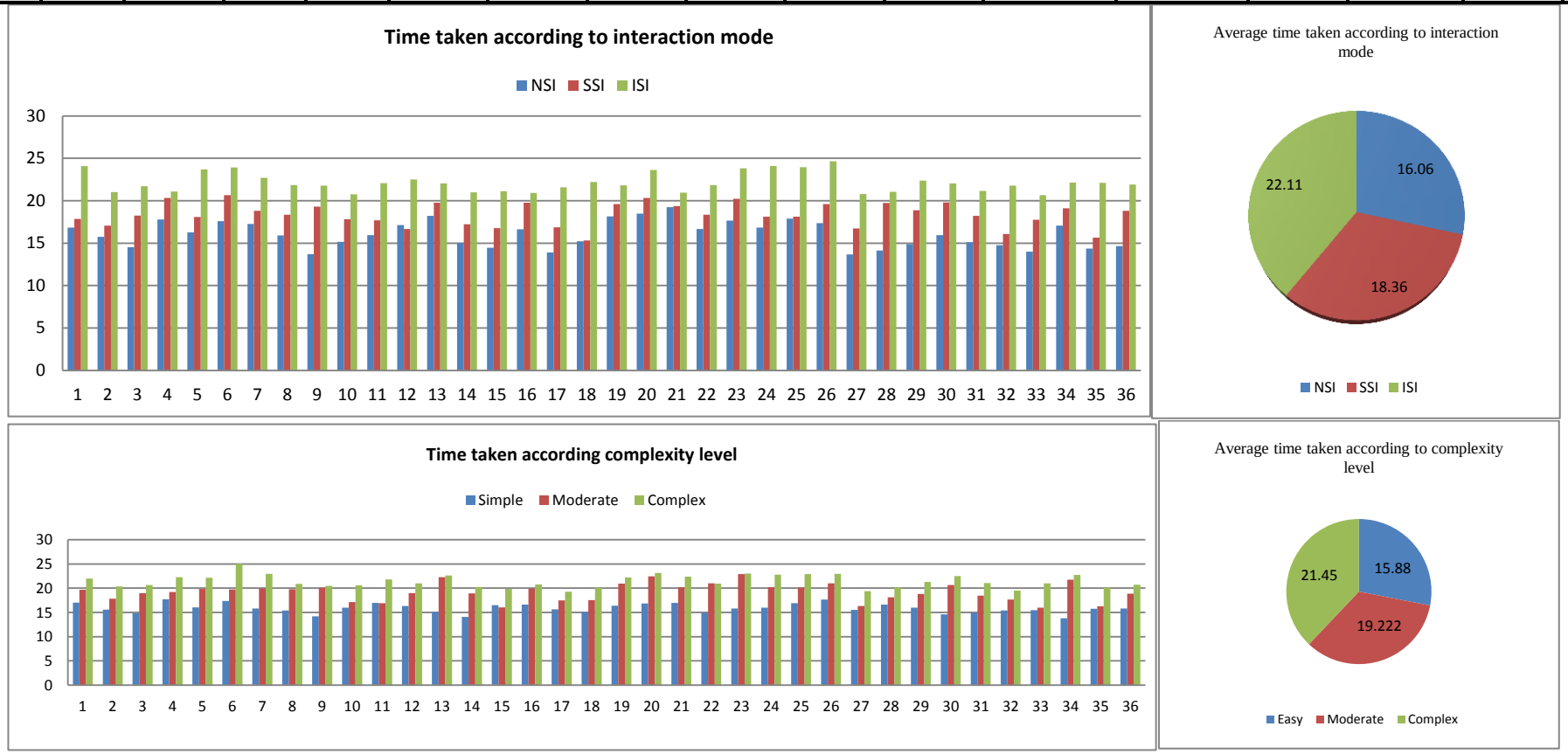

Figure B.2: Time taken to complete tasks

Number of mouse clicks:

Users	Simple			Moderate			Complex			Task complexity level			Task Interaction mode			Total
	T1	T2	T3	T4	T5	T6	T7	T8	T9	Simple	Moderate	Complex	NSI	SSI	ISI	All
U1	15	17	22	12	13	25	18	21	27	54	50	66	45	51	74	170
U2	13	16	19	11	14	18	16	21	23	48	43	60	40	51	60	151
U3	10	19	18	13	17	21	15	20	23	47	51	58	38	56	62	156
U4	11	15	16	10	16	19	13	18	21	42	45	52	34	49	56	139
U5	9	12	23	12	17	20	16	19	22	44	49	57	37	48	65	150
U6	10	14	19	15	16	21	14	17	24	43	52	55	39	47	64	150
U7	14	15	20	16	18	22	17	18	21	49	56	56	47	51	63	161
U8	12	16	18	15	17	23	18	20	24	46	55	62	45	53	65	163
U9	11	17	19	16	19	20	15	20	22	47	55	57	42	56	61	159
U10	14	15	18	16	18	19	16	19	21	47	53	56	46	52	58	156
U11	12	14	20	14	17	21	15	20	23	46	52	58	41	51	64	156
U12	13	16	22	15	20	24	14	21	25	51	59	60	42	57	71	170
U13	15	18	19	13	15	21	13	16	17	52	49	46	41	49	57	147
U14	13	15	20	11	14	19	14	18	19	48	44	51	38	47	58	143
U15	11	16	20	12	18	23	15	19	21	47	53	55	38	53	64	155
U16	13	18	19	14	19	20	15	20	25	50	53	60	42	57	64	163
U17	12	17	22	16	22	18	17	23	28	51	56	68	45	62	68	175
U18	14	19	21	13	16	19	18	19	20	54	48	57	45	54	60	159
U19	15	16	20	15	18	22	15	17	18	51	55	50	45	51	60	156
U20	14	15	19	17	16	24	14	18	22	48	57	54	45	49	65	159
U21	11	20	18	13	19	21	18	24	26	49	53	68	42	63	65	170
U22	13	18	20	17	20	28	16	26	28	51	65	70	46	64	76	186
U23	15	17	22	18	17	21	19	19	23	54	56	61	52	53	66	171
U24	14	19	24	14	21	19	14	18	24	57	54	56	42	58	67	167
U25	16	15	21	13	17	23	17	19	20	52	53	56	46	51	64	161
U26	14	16	18	14	16	20	15	18	23	48	50	56	43	50	61	154
U27	12	15	17	11	15	19	14	20	26	44	45	60	37	50	62	149
U28	10	13	16	14	10	17	15	18	20	39	41	53	39	41	53	133
U29	13	16	19	15	19	24	16	19	28	48	58	63	44	54	71	169
U30	15	17	20	16	20	23	14	22	26	52	59	62	45	59	69	173
U31	14	19	21	18	23	27	18	23	24	54	68	65	50	65	72	187
U32	16	18	20	15	18	20	16	20	23	54	53	59	47	56	63	166

U33	13	21	18	17	17	23	19	22	27	52	57	68	49	60	68	177
U34	11	23	19	14	19	19	16	18	24	53	52	58	41	60	62	163
U35	10	16	21	13	21	22	17	20	22	47	56	59	40	57	65	162
U36	9	15	24	15	18	21	18	22	26	48	54	66	42	55	71	168
Average	12.7	16.6	19.8	14.3	17.5	21.3	15.8	19.8	23.2	49.1	53.03	58.8	42.8	53.9	64.3	161

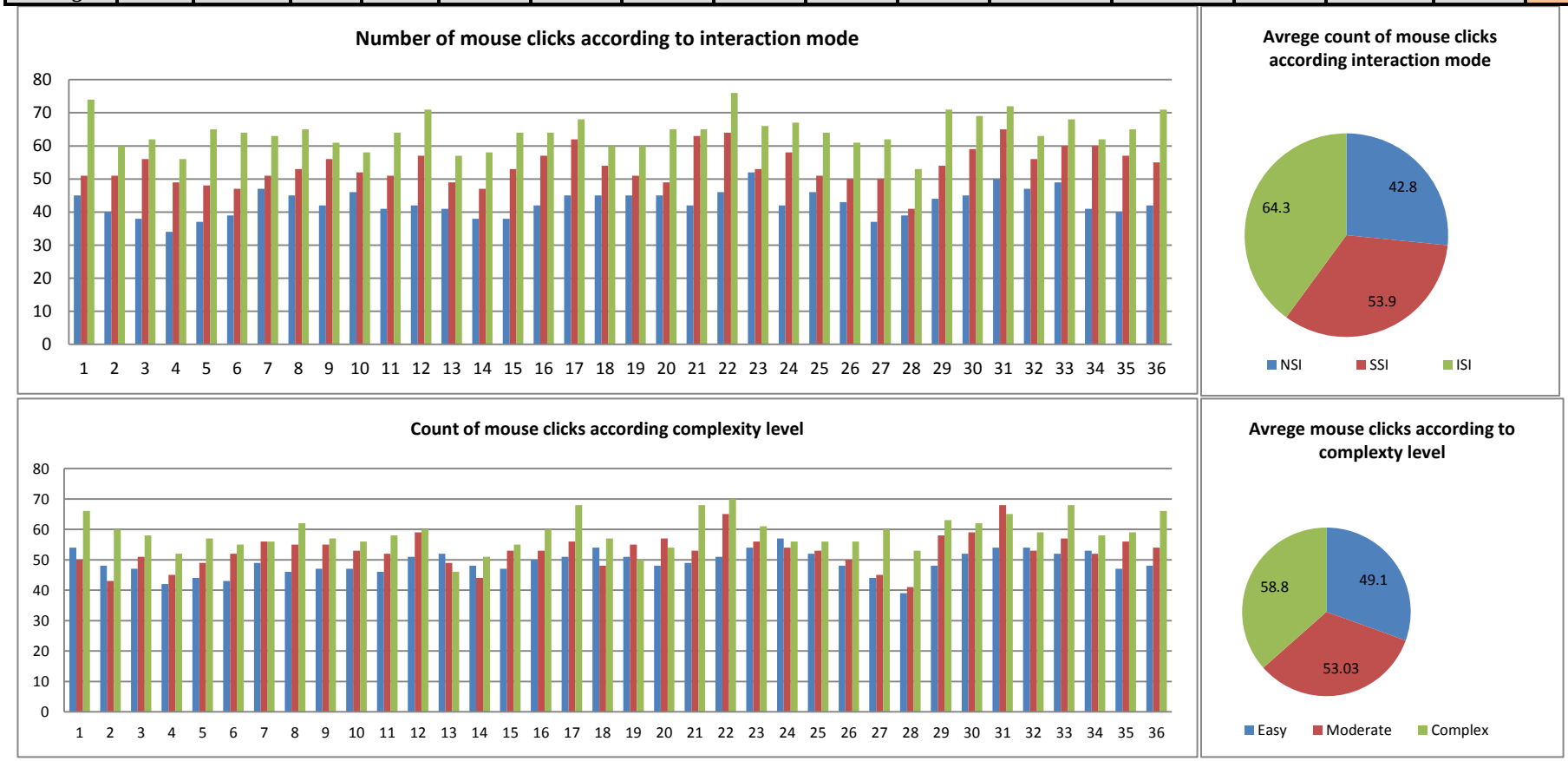

Figure B.3: Task mouse clicks

Experiment 1(phase II)

The second phase of this experimental study was built on the basic of the first phase with incorporating multimodality into the tasks selected. It follow the following order.

1. **Pre-Experimental Questions.**
2.
3. **Task 3 scenario (Simple social interactive product selection).Task 6 scenario (Moderate social interactive product selection).**
4. **Task 9 scenario (Complex social interactive product selection).**
5. **Post Experiment questionnaire**
6. **Post task Questions:**

Tasks accomplishment time for AISI group.

AISI- condition				
Level	Simple	Moderate	Complex	
User ID	Task1	Task2	Task3	Total
1	3.43	6.36	6.03	15.82
2	5.01	5.45	6.47	16.93
3	4.34	6.09	6.12	16.55
4	3.25	5.38	5.44	14.07
5	3.53	5.46	6.03	15.02
6	4.01	4.34	5.37	13.72
7	4.08	6.17	6.23	16.48
8	3.23	5.54	6.12	14.89
9	3.54	4.28	4.29	12.11
10	3.18	5.04	5.17	13.39
11	4.22	4.22	5.02	13.46
12	5.06	5.03	6.29	16.38
13	3.12	5.12	5.58	13.82
14	3.33	5.39	6.8	15.52
15	3.26	5.28	5.3	13.84
16	3.47	4.59	5.11	13.17
17	4.04	5.03	6.17	15.24
18	4.26	5.26	5.4	14.92
Avg.	**3.79778**	**5.223889**	**5.718889**	**14.74**

Table B.7: Tasks accomplishment time for AISI group.

Tasks accomplishment time for AVISI group.

AVISI- condition				
	Simple	Moderate	Complex	
User ID	Task1	Task2	Task3	Total
1	3.23	3.46	4.02	10.71
2	3.42	4.54	3.43	11.39
3	3.24	5.27	4.01	12.52
4	3.43	5.24	6.34	15.01
5	3.09	5.12	5.18	13.39
6	3.21	4.22	6.18	13.61
7	3.44	4.11	6.16	13.71
8	4.11	4.24	5.54	13.89
9	3.23	5.34	5.45	14.02
10	3.02	5.23	5.48	13.73
11	2.43	5.45	5.21	13.09
12	3.34	3.45	6.22	13.01
13	3.21	4.12	6.38	13.71
14	3.25	4.38	6.09	13.72
15	3.43	4.37	5.08	12.88
16	3.07	4.28	4.45	11.8
17	3.01	5.11	5.37	13.49
18	3.16	5.45	6.35	14.96
Avg.	**3.24**	**4.632222**	**5.385556**	**13.26**

Table 0.8: Tasks accomplishment time for AVISI group.

Frequencies of perceived social presence

	Group AVISI					**Group AISI**				
SP- code	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
SP1	4	3	1	4	6	2	4	5	3	4
SP2	3	0	2	6	7	1	5	3	4	5
SP3	1	2	1	6	8	3	4	4	0	7
SP4	2	3	2	5	6	1	4	5	4	4
SP5	2	1	1	5	9	4	5	5	2	2

Table B.9: Frequencies of perceived social presence.

APPENDIX C Experiment 2(Phase III)

T1 Scenario simple (TSI)

Assume that you are looking for a hotel room; you do not have any particular preferences in term of price, nor location. But you are concern about the hotel room reviews and recommendations. Therefore; the hotel room information it must be recommended from at least five users with the rating of more than six out of ten.

T1 Requirements

To accomplish this task, the following requirements need to be fulfilled:

- **The hotel room must be recommended from at least five users(Recommended >= 5)**
  (Tip: see the hotel room main page).
- **The hotel room average rating must be evaluated. (Rating is greater than six point out of ten)**
  (Tip: see the hotel room main page and then find the rating image).

Task ID	Number of reviews	discussions	Likes	Recommended	Rating
Task 1				> 5	> 6

T2 Scenario simple(ASI)

Assume that you are looking for a hotel room; you do not have any particular preferences in term of price, nor location. But you are concern about the hotel room reviews and recommendations. Therefore; the hotel room you chose in term of the reviews it must has at least 8 reviews, two of them must have one discussions each.

T2 Requirements

To accomplish this task, the following requirements need to be fulfilled:

- **The hotel room reviews must be utilised. (Number of reviews > = 8)**
  (Tip: see the hotel room reviews details page).
- **The hotel room reviews rating must be evaluated. (Two of the reviews must have at least 1 discussion)**
  (Tip: see the hotel room reviews details page).

Task ID	Number of reviews	discussions	Likes	Recommended	Rating
Task 2	> = 8	At least one			

T3 Scenario simple (AVSI)

Assume that you are looking for a hotel room; you do not have any particular preferences in term of price, nor location. But you are concern about the hotel room reviews and recommendations. Therefore; the hotel room you chose in term of the reviews it must has 3 reviews, The rating must be of Top 5.

T3 Requirements

To accomplish this task, the following requirements need to be fulfilled:

- **The hotel room reviews must be utilised. (Number of reviews = 3)**
  (Tip: see the hotel room reviews details page).
- **The hotel room reviews rating must be evaluated. (The rating must be of Top 5)**
  (Tip: see the hotel room reviews details page).

Task ID	Number of reviews	discussions	Likes	Recommended	Rating
Task 3	= 3				Top 5

T4 Scenario moderate (TSI)

Assume that you are looking for a hotel room; you do not have any particular preferences in term of price, nor location. But you are concern about the hotel room reviews and recommendations. Therefore; the hotel room you chose in term of the reviews it must has at least 4 reviews. On the other hand looking at the hotel room information it must be recommended from at most three users with a rating of more than seven out of ten.

T4 Requirements

To accomplish this task, the following requirements need to be fulfilled:

- **The hotel room reviews must be utilised. (Number of reviews > 4)**
  (Tip: see the hotel room reviews details page).
- **The hotel room must be recommended from at most three users (Recommended <=3)**
  (Tip: see the hotel room main page).
- **The hotel room average rating must be evaluated. (Rating is greater than seven point out of ten)**
  (Tip: see the hotel room main page and then find the rating image).

Task ID	Number of reviews	discussions	Likes	Recommended	Rating
Task 4	>4			<=3	> 7

T5 Scenario moderate (ASI)

Assume that you are looking for a hotel room; you do not have any particular preferences in term of price, nor location. But you are concern about the hotel room reviews and recommendations. Therefore; the hotel room you chose in term of the reviews, two of them must have at least 2 discussions each, also there must be at least total of five or more likes within the reviews. The hotel room must be recommended from at least six users

T5 Requirements

To accomplish this task, the following requirements need to be fulfilled:

- **The hotel room reviews rating must be evaluated. (Two of the reviews must have at least 2 discussions each)**
  (Tip: see the hotel room reviews details page).
- **There must be at least total of five likes within the reviews (Likes >= 5)**
  (Tip: see the hotel room reviews details page).
- **The hotel room must be recommended from at least six users (Recommended >= 6)**
  (Tip: see the hotel room main page).

Task ID	Number of reviews	discussions	Likes	Recommended	Rating
Task 5		= 2 in both	>= 5	>= 6	

T6 Scenario moderate (AVSI)

Assume that you are looking for a hotel room; you do not have any particular preferences in term of price, nor location. But you are concern about the hotel room reviews and recommendations. Therefore; the hotel room you chose in term of the reviews it must has at least 6 reviews, also there must be at least total of five likes within the reviews, with a rating of Top ten.

T6 Requirements

To accomplish this task, the following requirements need to be fulfilled:

- **The hotel room reviews must be utilised. (Number of reviews > = 6)**
  (Tip: see the hotel room reviews details page).
- **There must be at least total of five likes within the reviews (Likes >= 5)**
  (Tip: see the hotel room reviews details page).
- **The hotel room average rating must be evaluated. (one of the Top 10)**
  (Tip: see the hotel room main page and then find the rating image).

Task ID	Number of reviews	discussions	Likes	Recommended	Rating
Task 6	**> = 6**		>= 5		Top 10

T7 Scenario complex (TSI)

Assume that you are looking for a hotel room; you do not have any particular preferences in term of price, nor location. But you are concern about the hotel room reviews and recommendations. Therefore; the hotel room you chose in term of the reviews it must has at least 4 reviews, also there must be at least total of eight likes within the reviews. On the other hand looking at the hotel room information it must be recommended from at least six users with a rating of greater than or equal to four point out of ten.

T7 Requirements

To accomplish this task, the following requirements need to be fulfilled:

- **The hotel room reviews must be utilised. (Number of reviews > = 4)**
  (Tip: see the hotel room reviews details page).
- **There must be at most a total of eight likes within the reviews (Likes** < 8**)**
  (Tip: see the hotel room reviews details page).
- **The hotel room must be recommended from at least six users (Recommended > 6)**
  (Tip: see the hotel room main page).
- **The hotel room average rating must be evaluated. (Rating is greater than or equal to four point out of ten)**
  (Tip: see the hotel room main page and then find the rating image).

Task ID	Number of reviews	discussions	Likes	Recommended	Rating
Task 7	> = 4		< 8	> 6	>= 4

T8 Scenario complex (ASI)

Assume that you are looking for a hotel room; you do not have any particular preferences in term of price, nor location. But you are concern about the hotel room reviews and recommendations. Therefore; the hotel room you chose in term of the reviews two of them must have three discussions each, also there must be at least total of five likes within the reviews. On the other hand looking at the hotel room information it must be recommended from at least five users with a rating of more than six out of ten.

T8 Requirements

To accomplish this task, the following requirements need to be fulfilled:

- **The hotel room reviews rating must be evaluated. (Two of the reviews must have at least 3 discussions each)**

  (Tip: see the hotel room reviews details page).
- **There must be at least total of five likes within the reviews (Likes >= 5)**

  (Tip: see the hotel room reviews details page).
- **The hotel room must be recommended from at least five users (Recommended >= 5)**

  (Tip: see the hotel room main page).
- **The hotel room average rating must be evaluated. (Rating is greater than six point out of ten)**

  (Tip: see the hotel room main page and then find the rating image).

Task ID	Number of reviews	discussions	Likes	Recommended	Rating
Task 8		= 3 in two of the reviews	>= 5	>= 5	> 6

T9 Scenario complex (AVSI)

Assume that you are looking for a hotel room; you do not have any particular preferences in term of price, nor location. But you are concern about the hotel room reviews and recommendations. Therefore; the hotel room you chose in term of the reviews it must has at least 6 reviews, also there must be at least total of eight likes within the reviews. On the other hand looking at the hotel room information the hotel room must be recommended from more than seven users with a rating of greater than or equal to five point out of ten.

T9 Requirements

To accomplish this task, the following requirements need to be fulfilled:

- **The hotel room reviews must be utilised. (Number of reviews > = 6)**

  (Tip: see the hotel room reviews details page).
- **There must be at least total of eight likes within the reviews (Likes > 8)**

  (Tip: see the hotel room reviews details page).
- **The hotel room must be recommended from more than seven users (Recommended>7)**

  (Tip: see the hotel room main page).
- **The hotel room average rating must be evaluated. (Rating is greater than or equal to five point out of ten)**

  (Tip: see the hotel room main page and then find the rating image).

Task ID	Number of reviews	discussions	Likes	Recommended	Rating
Task 9	> = 6		> 8	> 7	>= 5

Task accomplishment time

Level	***Simple***			***Moderate***			***Complex***		
Condition	***TSI***	***ASI***	***AVSI***	***TSI***	***ASI***	***AVSI***	***TSI***	***ASI***	***AVSI***
User\ Tasks	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7	Task 8	Task 9
U1	5.38	4.39	3.58	5.03	5.84	4.36	6.87	6.05	4.61
U2	4.75	3.7	3.17	4.90	5.80	3.95	6.46	6.01	4.2
U3	3.58	3.66	2.95	6.13	5.35	2.73	5.24	5.56	2.98
U4	4.41	3.93	2.89	5.85	4.80	3.67	6.18	5.01	3.92
U5	4.35	4.11	3.63	4.92	4.97	3.38	5.89	5.18	3.63
U6	4.32	4.26	2.91	6.07	4.16	3.69	6.2	4.37	3.94
U7	3.73	3.54	2.21	5.54	4.41	3.78	5.5	4.62	4.03
U8	4.38	3.27	2.59	5.76	4.87	3.37	5.88	5.08	3.62
U9	4.32	4.18	3.48	5.49	4.98	4.26	6.77	5.19	4.51
U10	4.65	4.23	3.28	4.81	6.77	4.06	6.57	6.98	4.31
U11	4.04	3.41	4.17	6.32	4.86	4.73	7.46	5.07	4.98
U12	4.15	4.02	2.87	5.00	4.69	3.67	6.16	4.90	3.92
U13	4.03	3.76	3.15	5.88	5.29	3.93	6.44	5.50	4.18
U14	5.02	4.12	3.28	4.65	5.01	4.06	6.57	5.22	4.31
U15	4.29	4.23	2.37	5.00	4.85	3.15	5.66	5.06	3.4
U16	4.73	4.43	2.77	5.86	5.42	3.57	6.06	5.63	3.82
U17	5.3	4.72	3.06	5.91	5.16	3.84	6.35	5.37	4.09
U18	5.11	4.83	3.37	6.08	4.08	4.15	6.66	4.29	4.4
U19	4.23	4.22	3.17	4.85	4.19	4.62	6.46	4.40	4.87
U20	4.38	4.55	3.22	6.68	5.69	4	6.51	5.90	4.25
U21	4.42	3.34	3.88	5.02	3.99	4.66	7.17	4.20	4.91
U22	5.08	3.51	2.84	5.99	4.10	3.62	6.13	4.31	3.87
U23	4.73	4.16	3.48	4.28	5.21	4.26	6.77	5.42	4.51
U24	4.74	4.02	3.99	4.91	4.17	4.77	7.28	4.38	5.02
U25	3.95	3.42	2.37	4.84	4.68	3.15	5.66	4.89	3.4
U26	4.44	3.87	3.22	4.80	4.81	4	6.51	5.02	4.25
U27	4.32	3.43	3.12	4.58	4.95	3.9	6.41	5.16	4.15
U28	4.56	4.11	3.59	4.81	5.21	4.37	6.88	5.42	4.62
U29	4.54	4.37	3.07	5.98	4.98	3.85	6.36	5.19	4.1
U30	5.12	4.23	3.42	5.33	5.19	4.2	6.71	5.40	4.45
U31	4.22	3.65	3.12	5.01	5.09	3.9	6.41	5.30	4.15
U32	5.49	5.09	3.3	4.97	5.07	4.08	6.59	5.28	4.33
U33	4.54	4.34	3.48	5.44	5.09	4.26	6.77	5.30	4.51
U34	3.45	4.38	3.58	5.84	4.19	4.36	6.87	4.40	4.61
U35	4.09	3.55	3.17	5.07	4.76	3.95	6.46	4.97	4.2
U36	4.39	4.17	3.76	5.19	5.03	4.25	7.05	5.14	4.5
Total	**161.23**	**145.2**	**115.51**	**192.792**	**177.711**	**142.55**	**231.92**	**185.171**	**151.55**
Avg.	**4.478611**	**4.03333**	**3.20861**	**5.35532**	**4.93642**	**3.95972**	**6.44222**	**5.14364**	**4.20972**

Table C.10 :Task time phase III

Tasks mouse clicks.

Level	*Simple*			*Moderate*			*Complex*		
Platform	*TSI*	*ASI*	*AVSI*	*TSI*	*ASI*	*AVSI*	*TSI*	*ASI*	*AVSI*
User\ Tasks	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7	Task 8	Task 9
U1	11	7	6	18	13	10	21	15	13
U2	13	8	8	15	15	5	19	17	14
U3	12	7	5	19	11	8	18	19	15
U4	11	9	5	18	14	9	17	17	11
U5	10	8	6	16	12	9	18	16	13
U6	11	7	6	14	14	8	20	15	10
U7	12	8	4	15	11	7	19	14	11
U8	14	10	7	16	14	8	20	15	9
U9	12	9	8	16	14	5	19	15	10
U10	11	7	6	20	12	10	20	19	10
U11	10	6	7	19	14	10	19	18	14
U12	9	7	8	17	15	8	19	16	13
U13	8	8	7	21	14	10	23	17	9
U14	10	6	6	16	16	8	22	15	8
U15	11	10	4	14	15	10	18	13	11
U16	13	9	6	16	14	9	18	14	10
U17	11	5	5	22	15	12	19	18	13
U18	12	8	5	21	12	9	20	17	12
U19	10	6	6	17	14	8	19	15	14
U20	8	8	3	16	16	14	21	13	12
U21	9	5	6	19	17	9	20	14	11
U22	13	8	7	18	15	10	19	18	10
U23	12	9	7	17	13	8	20	16	11
U24	10	6	6	16	14	9	17	16	15
U25	8	7	5	19	12	10	19	15	10
U26	9	7	6	18	17	9	17	18	8
U27	13	8	3	20	14	8	22	14	10
U28	11	9	8	18	13	9	15	15	16
U29	9	8	6	17	14	12	19	19	12
U30	10	10	7	16	16	9	24	16	14
U31	13	9	8	15	15	7	18	18	12
U32	10	6	6	19	13	8	20	17	9
U33	11	9	8	20	12	11	22	16	13
U34	10	6	6	21	13	10	18	15	12
U35	12	8	8	17	16	13	23	16	10
U36	9	6	7	19	15	10	21	19	8
Total	388	274	222	635	504	329	703	580	413
Avg.	10.7778	7.61111	6.16667	17.6389	14	9.13889	19.5278	16.1111	11.4722

Table C.11 :Task mouse clicks phase III

Tasks completed successfully

Level	***Simple***			***Moderate***			***Complex***		
Platform	***TSI***	***ASI***	***AVSI***	***TSI***	***ASI***	***AVSI***	***TSI***	***ASI***	***AVSI***
User\ Tasks	Task 1	Task 2	**Task 3**	Task 4	Task 5	**Task 6**	Task 7	Task 8	**Task 9**
U1	1	1	**1**	1	1	**1**	0	1	**1**
U2	1	1	**1**	1	0	**1**	0	0	**1**
U3	1	1	**1**	1	1	**1**	1	0	**0**
U4	1	0	**1**	0	1	**1**	0	1	**1**
U5	0	1	**1**	1	1	**1**	0	0	**1**
U6	1	1	**1**	0	1	**1**	0	1	**1**
U7	1	1	**1**	1	1	**1**	0	1	**1**
U8	1	1	**1**	0	1	**1**	0	0	**1**
U9	1	1	**1**	1	1	**1**	1	1	**1**
U10	0	1	**1**	0	1	**1**	0	0	**1**
U11	1	1	**1**	1	1	**1**	0	1	**1**
U12	1	1	**1**	0	0	**1**	0	1	**1**
U13	1	1	**1**	1	1	**1**	1	0	**1**
U14	1	1	**1**	1	1	**1**	0	1	**1**
U15	1	1	**1**	1	1	**1**	0	1	**1**
U16	0	1	**1**	1	1	**1**	1	1	**1**
U17	1	1	**1**	0	1	**1**	0	0	**0**
U18	1	1	**1**	1	1	**1**	0	1	**1**
U19	0	1	**1**	0	1	**1**	0	0	**1**
U20	1	1	**1**	0	1	**1**	0	1	**1**
U21	1	1	**1**	1	0	**1**	0	1	**1**
U22	1	1	**1**	0	1	**1**	1	0	**1**
U23	0	1	**1**	1	1	**1**	0	1	**1**
U24	1	1	**1**	1	0	**1**	0	1	**1**
U25	1	1	**1**	0	1	**1**	1	0	**1**
U26	1	1	**1**	1	1	**1**	0	1	**1**
U27	1	1	**1**	0	1	**0**	1	0	**1**
U28	0	1	**1**	1	1	**1**	0	1	**1**
U29	1	1	**1**	0	1	**1**	0	0	**1**
U30	1	1	**1**	0	1	**1**	1	1	**1**
U31	1	1	**1**	1	1	**1**	0	1	**1**
U32	1	0	**1**	0	0	**1**	0	1	**1**
U33	1	1	**1**	0	1	**1**	0	0	**1**
U34	0	1	**1**	1	1	**1**	1	1	**0**
U35	1	1	**1**	0	1	**1**	0	0	**1**
U36	1	1	**1**	1	1	**1**	1	1	**1**
Total	**29**	**34**	**36**	**20**	**31**	**35**	**10**	**22**	**33**
Avg.	**0.80556**	**0.94444**	**1**	**0.55556**	**0.86111**	**0.97222**	**0.27778**	**0.61111**	**0.91667**

Table C.12 :Task completed successfully phase III

System Usability Scale Scores: User satisfaction

SUS	Text-Platform	Audio-Platform	Avatar-Platform
U 1	35	60	87.5
U 2	47.5	67.5	82.5
U 3	42.5	70	90
U 4	52.5	52.5	87.5
U 5	27.5	70	75
U 6	35	55	87.5
U 7	27.5	67.5	85
U 8	42.5	67.5	97.5
U 9	35	57.5	87.5
U 10	37.5	60	92.5
U 11	35	50	95
U 12	27.5	70	87.5
U 13	57.5	72.5	90
U 14	37.5	52.5	92.5
U 15	50	72.5	75
U 16	45	65	90
U 17	37.5	57.5	75
U 18	17.5	42.5	87.5
U 19	30	50	87.5
U 20	35	35	87.5
U 21	45	47.5	97.5
U 22	25	42.5	75
U 23	27.5	52.5	90
U 24	37.5	55	65
U 25	22.5	70	90
U 26	37.5	52.5	92.5
U 27	27.5	65	85
U 28	35	57.5	87.5
U 29	45	55	77.5
U 30	40	52.5	90
U 31	25	57.5	92.5
U 32	40	47.5	77.5
U 33	47.5	45	90
U 34	50	67.5	70
U 35	40	70	80
U 36	60	90	82.5
AVG.	37.77778	58.95833	85.625

Table C.13 :System usability scale phase IIIs