Elderly users' acceptance of socially assistive robots in healthcare

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Abstract

Socially assistive robots assist elderly users in living independently, improving their quality of life, preventing emergencies, and supporting their social interactions. This research study aims to extend the Unified Theory of Acceptance and Use of Technology (UTAUT) model by referring to the theory of positive emotions and examining the factors of subjective well-being (SWB) on the UTAUT model for the elderly intention to use and use behavior of socially assistive robots. This research conducted a questionnaire survey method and the data were collected from 153 elderly users of socially assistive robots in India. The result indicated that the hypothesis and moderator factors positively supported the direct effects. Thus, the study makes a new standpoint among elderly users on the evolved adaptive significance of positive emotions, also elderly users who fail to resist the robots are sparked by positive emotions to explore and thereby consequence received a positive note of future usage of elderly users.

Keywords: Socially assistive robots, Subjective well-being, elderly users, UTAUT model.

Synopsis

Background

Elderly users want to care for themselves and stay in their home environment for as long as possible. Also, due to Staff shortages and increasing healthcare expenses socially assistive robots can support the needs for independence aging in place. However, the use of this technology is much lower than expected.

Problem

The cost of purchasing AI robots, ethical consideration, and other influencing factors such as Performance Expectancy (PE), Effort Expectancy (EE), Behaviour Intention (BI), Use Behaviour (UB) and moderators affecting factors such as Subject well-being (SWB) are a notable impact on elderly users of assistive robots. We lack the knowledge and understanding of the factors that influencing elderly users' acceptance of socially assistive technology. To fulfill the gap, we aim to conduct research to identify and investigate the factors through a theoretical foundation and quantitative approach to provide statistically proven inferences.

Research Question

The research question is formulated as follows - What factors influence elderly users' acceptance of socially assistive robots? The main purpose of this RQ is to test (statistical analysis) the model of acceptance of Socially Assistive Robots, especially in India.

Method

The survey is chosen as a research strategy. Data collection has been done through questionnaires with the use of Google Forms. The data from the questionnaire has been uploaded to the SPSS –AMOS package. The main analysis was done through steps of construct validity, measurement model, and hypothesis testing using structural equation modeling (SEM).

Result

The findings of the research have demonstrated that the hypotheses were positively supported that the elderly participants' BI towards assistive robots was positively affected by PE, and not significantly affected by EE, and the elderly users' UB towards socially assistive robots was positively affected by BI and not significantly affected by FC. The moderator factor of SWB effects on the relationship between PE, EE, and BI may strengthen it but is not statistically significant.

Discussion

The findings of the research indicate that the hypothesis was partially supported and there are also some previous studies specified to had no significant results on the hypothesis that the elderly participants' BI towards assistive robots was positively affected by PE, EE, and FC, and the elderly users' UB towards socially assistive robot was positively definite and affected by FC and BI. Some previous studies show that PE and EE do not significantly affect BI and FC did not significantly affect UB. The moderating factor of SWB on the relationship between PE, EE, and BI was also studied. The results showed that the SWB was statistically not significant but strengthen the relationship and supports the hypothesis. The results indicated that the designers of assistive robot products and services must consider how to meet the elderly user's requirements to satisfy, educate and spread widely among elderly users about the intention to use assistive robots.

Acknowledgment

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List of Abbreviations

AR	-	Assistive Robot
TAM	-	Technology Acceptance Model
UTAUT	-	Unified Theory of Acceptance and Use of Technology
STAM	-	Senior Technology Acceptance Model
PE	-	Performance Expectancy
EE	-	Effort Expectancy
FC	-	Facilitating Conditions
SWB	-	Subject Well-being
BI	-	Behaviour Intention
UB	-	Use Behaviour
PU	-	Perceived Usefulness
PEOU	-	Perceived Ease of Use
CFA	-	Confirmatory Factor Analysis
SEM	-	Structural Equation Modelling
CR	-	Composite Reliability
AVE	-	Average Variance Extracted
RMSEA	-	Root Mean Square Approximation of Error
CFI	-	Comparative Fit Index
XLS	-	Excel Sheet

1 Introduction

The world population of elderly users' growing rapidly. There is increased growth of elderly individuals living independently [1]. Despite the importance of efforts to improve care delivery at home, living at home alone until the end of life remains a promise. Hence, to deal with this situation, socially assistive robots have been proposed to address the well-being of elderly users'.

Socially assistive robots are defined as artificial intelligence systems equipped with welfare to improve the daily functioning of elderly users' [1]. It helps the elderly live independently, improve their quality of life, support their social interactions, and prevent emergencies [2]. Moreover, socially assistive robots can help at different levels such as by supporting users' cognitive abilities (e.g.: monitoring, reminding tasks, navigation aids), mobile robotic telepresence, communication, and social applications, companionship[32]. Moreover, assistive robots provide remote and continuous monitoring of users' health status (for instance, fall detection sensors or blood pressure), and finally, they even educate the users on improving nutrition and physical activities. They differ from other robots as designed to interact with humans using social rules of human behavior[3]. Therefore, to motivate and adopt and use socially assistive robots, it is important to study the factors affecting the elderly users' acceptance and use of assistive robots[4,16]. Thus, this study focuses on extending the technology acceptance theory and use considering the subjective well-being of elderly users'.

Several studies conducted on Assistive robots (AR) among elderly users' have shown that many robot-related variables appear to positively influence technology acceptance and there is an intention to use these systems [32]. For instance: A key construct of UTAUT is Performance expectancy (enhancing safety at home, facilitating care at home, and determining will the technology achieve goals), effort expectancy (Ease of use of new technology), facilitating conditions (determining the infrastructure supports the technology). Subjective well-being (quality of life and technology satisfaction for elderly people). Moderators include age and gender. Hence, this paper extends the UTAUT model and with gerontechnology (STAM) constructs a hypothesis in the context of the elderly acceptance of using assistive robots [32].

Despite numerous types of research on the potential benefits of socially assistive robots, only few are known about the factors that can influence the acceptance of elderly users' of this emerging technology. According to the theory [23, 33] of positive emotions, Fredrickson debate that elderly user with positive emotions broaden the scopes of cognition and attention and build physical, intellectual, and social resources. Moreover, acceptance is based on elderly users' factors affecting influences towards assistive robots. As a consequence, technology acceptance needs feedback/comments from elderly users' regarding the acceptance of socially assistive robots, so that elderly users benefit, and the entire system can develop according to the principles of technology acceptance.

1.1 Research Problem

The research problem is that the “identified barrier to uptake the socially assistive robot is cost, and the initial cost of purchasing was brought as a facilitating conditioning barrier” [34]. There is a lack of government support, elderly users' have to purchase on their own [5, 6]. As there is an increased cost of the robot, lack of interest, and ethical concerns that fail to meet customer needs, some companies struggled to tackle difficult situations [6].

The significance of the problem plays a major role in the acceptance of socially assistive robots. To help and enhance the cost support and other moderator affecting factors (PE, EE, SWB, BI, and UB) of assistive robots benefit elderly users', we decided to conduct research that will identify the moderator factors which are the most downbeat to socially assistive robots in India. The aim is to assess the factors that can influence the acceptance of socially assistive robots daily by the general elderly users in India.

Therefore, a theoretical foundation is important for understanding the acceptance process's underlying psychological, social, and behavioral mechanisms. This is confirmed by Blackman [7]. Thus, quantitative approaches are examined to understand the importance of acceptance factors, identify relationships, and make statistically proven and valid inferences about their influence on the acceptance of assistive robots. Developing a strong theoretical and statistically proven understanding of elderly users' acceptance of assistive robots research will improve conceptualization and development [35]. And also it will increase the likelihood of future acceptance by intended elderly users'.

The empirical research is examined to identify the factors which impact assistive robot acceptance by elderly users.

1.2 Research Question

This study aims to develop a theoretical understanding/background of the model and empirically test the model of acceptance of Socially Assistive Robots in India. Thus the research question is as follows

What factors influence elderly users' acceptance of socially assistive robots?

1.3 Limitations

The respondents of the questionnaires were convenience sampling and as a consequence sub-problems have occurred such as the lack of degree of respondent honesty, researcher bias where some people do not want to talk with us or fill out an online survey, and lack of accuracy in their answers. Moreover, the main limitation of this research was the small size of the sample, a fact that leads to bias.

1.4 Thesis disposition

This research consists of five chapters. The first chapter introduces the thesis to make the reader familiar with socially assistive robot technology. The necessary definitions, as well as the intended goal, have been presented with the research problem and research question. The second chapter describes the literature review, explains different technology acceptance models, and constructs the factors responsible for accepting socially assistive robots. The third chapter discusses and debates how the research strategy is chosen, the data collecting method, and the data analysis method used in this study. An in-depth analysis of the statistical models selected to support this method and then statistical tests have been performed concerning the subject. Also, covered alternative methods and research ethics. The fourth chapter presents results and data analysis. The fifth chapter includes a discussion and findings of the research. This chapter summarizes the conclusions and emphasizes elderly users' usefulness. Finally, proposal models are presented that include how to use the results of the research for the further study of socially assistive robots technology.

2 Extended Background

Socially assistive robots that aim to support the independence and well-being of elderly users and people with disability are being introduced into care settings. However, the acceptance of assistive robots varies among people, and the rate that which robots are deployed into real-time practice is currently low. Thus, this chapter defines attitudes toward assistive robots and provides an overview of the different technology acceptance models, factors, and hypotheses influencing elder users' acceptance of assistive robots.

2.1 Attitudes towards Socially Assistive Robots

Research on socially assistive robots for eldercare can be mainly found in two areas such as in concerns with social robots and involves companion robots or robot-assisted therapy [9]. An example of the therapeutic use of a socially assistive robot has received increasing attention among elder users' and patients with dementia care. Most of these studies have focused on Paro [10]. Paro can have the same beneficial effects on elder users' as real pets, a sense of well-being, and health improvement. This social companionship robot has been employed to encourage social behavior and reduce stress among dementia persons. Moreover, assistive robots are used to help children build clinically relevant skills and provide instructions and supervision to users in activities such as weight loss or physical activities/exercises.

The physical appearance of a robot is the most important factor: A humanoid (human-like) robot is a robot that resembles the human body shape, machine-like robots are structured with an unequivocal mechanical and computer-like aspect, and animals like robots simulate morphology and animal behavior. Mobility is another common mechanical feature. When available, locomotion allows the robot to move in and around the environment and follow or locate a user or an object either by operating at distance or autonomously guided [32].

Several studies explain that the user experience has recently gained a lot of attention in research and design. In general, it deals with the cognitive and affective aspects a person experiences when interacting with the technology like aesthetics, enjoyment, and a desire for repeated use [11]. Therefore, where usability focuses on the realistic qualities of technology, many studies said that the user experience is concerned with its qualities and reactions after some usage period. Different factors that contribute to the user experience of interacting with the socially assistive robot have been explored in past studies [32]. For instance which includes a robot and end-user personality, empathy, and appearance.

However, other robot-related factors have been identified as the negative impact of socially assistive robot acceptance such as lack of trust in the robot (based on safety and quality of life concerns), space concern for the robot (requirement of size), sometimes robot may fail to convey to users because of stigmatizing aesthetic, robot appearance, technology perceived as complex, costs are high (accessibility issues), and ethical consideration [12][32]. Though there is a limited sample of the studies available on the interaction of elderly users with socially assistive robots, the work on elder users' responses to robot care suggests that a robot’s social behaviors are important. Thus, different acceptance models have examined many factors such as TAM or UTAUT or Almere, or

Gerontechnology (Senior Acceptance Technology Model) to predict and explore aspects that contribute to the acceptance and use of robot technology.

2.2 Traditional technology models and the Acceptance of Socially assistive robots

TAM perceived usefulness and perceived use of technology are the main factors that influence the user's "intent to use" the system and predict the actual use [16].

In general, TAM has been introduced to evaluate the acceptance of technology and the model has been adapted and expanded to UTAUT which incorporates the most reliable constructs [8]. The UTAUT offers a social psychological approach that can explain 80% of acceptance variance [36]. It has the independent variable such as perceived usefulness (PU) (the expectation the users have about the performance of the system (performance expectancy)), perceived ease of use (PEOU) (the expectations the user has about the effort that is wanted to use the system (effort expectancy)), and other factors that have been incorporating are social influence. The independent variables affect the dependent variables: Intention to use and actual usage. Attitude, self-efficiency, and anxiety were not found to directly influence intention to use whereas age, gender, education, and technology experience were found to be a moderate effect. The model has been applied to investigate the acceptance of a socially assistive robot [14, 36]. These studies found that people were more likely to accept the expressive robot (extrovert) compared with an introvert robot. The UTAUT model is to explore factors that determine and validate human-robot interaction between elder users' acceptance of social robots. The UTAUT has been criticized as not being penurious and for combining highly correlated variables which provide an artificially high variance. All of the traditional acceptance models cannot adequately explain the acceptance of robots and can also not fully enable the evaluation of pleasure-oriented factors which are necessary to motivate people to use robots [36].

2.2.1 Acceptance model adapted for socially assistive robots

The Almere model [28] has been used to explore the levels of acceptance and engagement with a human interaction robot. The model of a social acceptance robot was developed by expanding and adapting the theory of planned behavior using a few elements of the UTAUT and constructs factors relevant to robots. De Graff's model was tested for constructs for both users' attitudes (example: hedonic attitudes (evaluations of emotions, enjoyment, and pleasure using the robot), utilitarian attitudes (perceived usefulness, perceived ease of use, adaptability, embodiment, and robot design/personality), cause less worry about privacy) and control beliefs (self-efficiency, previous expectations, prior expectations, anxiety, prior expectations, and users' beliefs about resources). However, only self-efficiency impacts user intention to use the assistive robot. De Graaf model [15] concludes that the model is useful to guide and identify the acceptance of variables but it needs further development and testing.

Since one limitation for applying the Almere model and the model of socially assistive robots acceptance to elderly users and people living with dementia may need additional concerning technology usage. It has been debated that psychosocial functioning is a better predictor of robot acceptance than chronological [16]. There are few impacts on the usage of technology. People with dementia may experience declining touch sensitivity and less ability to execute accurate movements, and learning new technologies can be difficult with symptoms of dementia (reduce memory, lack of ability, and speed). Therefore, traditional models of technology acceptability may be inadequate to assess or explain the acceptance factors related to elderly users and with a disability or dementia persons. Hence models of Gerontechnology acceptance have been developed which consider both physical and cognitive health. Gerontechnology is defined as digital or electronic products or services that can increase independent living and the social participation of elderly users'[36].

2.3 Model development and hypothesized constructs interrelations

From the previous study on the elderly acceptance and use of gerontechnology, which proposed a senior technology acceptance model (STAM) [17], researchers have adopted and extended the TAM and the UTAUT to examine the effects of intentions to use and use gerontechnology by elder users'. As explained in section 2.2 TAM and UTAUT (independent variables, dependent variables, and moderate effects) concepts were extended by adding variables to fit the model and to explain more of the variance. Researchers verified that the STAM could support and explain 68% of the variance in the use of gerontechnology [17]. Zhou [16] extended the TAM and UTAUT, classified the influencing attributes such as user characteristics individually and the factors that affect the elderly users' and people with dementia's intention to use gerontechnology. Therefore, considering the study, the research model is proposed to study the elderly users' intentions to use assistive robots (Figure 1).

2.3.1 Performance expectancy (PE), Effort expectancy (EE), and Behavioural Intention (BI) – potential technical characteristics

In the UTAUT model [8], PU and PEOU were replaced as performance expectancy (PE) and effort expectancy (EE) as independent variables. This study defines behavioral intention (BI) as the strength of elder users' intention to use socially assistive robots, also it refers to the work of the researcher [8] and defines PE as the degree to which the elderly user of assistive technology believes that using the system will help him/her to gain in live performance. Moreover, they explained that the PE construct was pertinent to the perceived usefulness construct in the TAM and PE predicts the intentions as strongly [8][33]. The study [16] [33] defines PE (PU) and EE (PEOU) as positively affecting the elder users' use of assistive robots/assistive technology. From the above-mentioned following hypothesis proposed.

H1: PE positively affects the elderly users' BI towards assistive robots.

H2: EE positively affects the elderly users' BI towards assistive robots.

2.3.2 Facilitating conditions (FC), behavioral intention, and actual use behavior

According to the study [8] [33], FC defines as the degree to which an elderly person believes that an organization and technology would support the use of assistive robots. In the UTAUT, FC directly influences usage by behavioral intentions [8] [33]. In the context of the usage of assistive robots, elderly users' need more proper support and guidance when learning how to use assistive technology. Chen [17] found that FC had more predictive value than attitudinal factors (PU and PEOU) for predicting assistive robots' actual usage. Furthermore, several studies found that BI had positive effects on the actual usage of assistive robots or gerontechnology. Thus, the hypotheses proposed are

H3: FC positively affects the elderly users' actual use behavior toward assistive robots.

H4: The elderly users' BI towards assistive robots positively affects the elderly users' use behavior

2.3.3 Subjective well-being as a moderator users characteristics

Subjective well-being is considered to be a people's psychological evaluation of life. The researchers [19] [33] defined subjective well-being (SWB) as a person's cognitive and affective evaluations of his/her life. And also, Younker [20] SWB is defined as psychological outcomes measured as life satisfaction, self-efficacy, happiness, and positive mood. This study indicates that the SWB of elderly users' is the psychological evaluation of their life satisfaction.

Some studies explained that SWB directly affected elderly users' actual behavioral usage. Chen [17] verified that the elderly users' psychological needs such as their attitudes toward aging and life satisfaction had substantial effects on users' use behavior. The researchers [21] found that the adaption of socially assistive robots among seniors was influenced by psychological factors, for instance, perceived quality of life, which has been defined as a cognitive appraisal of elderly users' overall satisfaction with life [22, 18].

According to [23] the broaden-and-build theory of positive emotions, in the context of the elderly using assistive robots/ assistive technology can lead to paying attention to others' support and appreciating it. To positively explicate their cognitive stress or challenges and to solve problems to enhance their psychological adjustment capacity and positive emotions would be reinforced from the above process. Also, several studies have proposed research models and examined the moderating effects of social well-being. Therefore, referring to the researcher's [33, 23] positive emotions and considering the SWB as a moderator by extending the UTAUT model the following hypotheses are formulated.

H5: SWB moderates the positive effect of PE on the elderly users' BI of assistive robots.

H6: SWB moderates the positive effect of EE on the elderly users' BI of assistive robots.

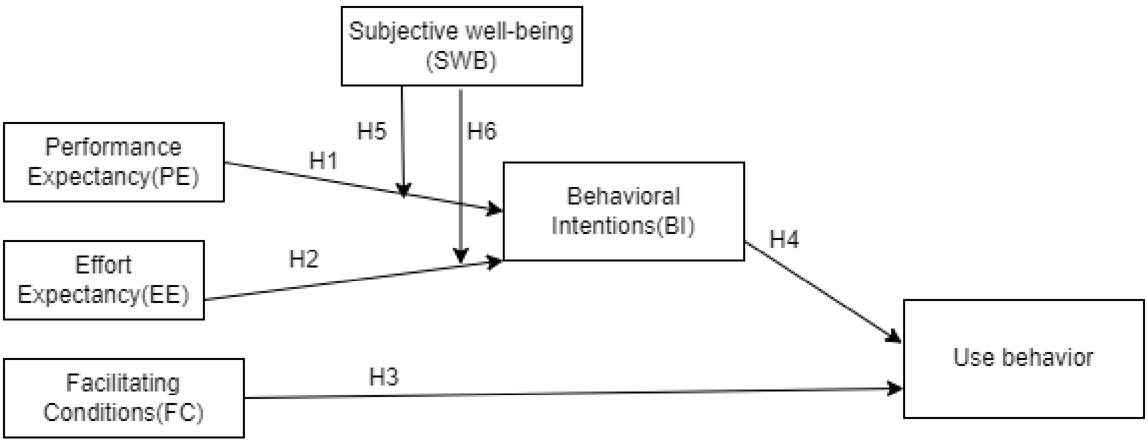


Figure 1: Conceptual model of elderly users' acceptance of socially assistive robots

In line with gerontechnology, the use behavior of socially assistive robots is proposed as the key-dependent variable in our conceptual model, with behavior intentions and facilitating conditions control as direct ascendants (Figure 1). Therefore referring to the authors (Zhou J, Zhang B, Tan R, Tseng ML, Zhang Y,2020)[33, 16] the construct was built and a study model on the influencing attributes of socially assistive robots acceptance behavior will be determined.

3 Method

3.1 Research strategy and choice of method

According to Denscombe [24], A strategy is a sequence of plan of actions designed to achieve the aim or goal of the research. There are various research strategies involved such as surveys, experiments, ethnography, phenomenology, case studies, mixed-methods, and many more. Among many strategies, the one that's suitable, feasible to achieve the aim of the research, and justifiable as a choice of research strategy can be chosen by the researcher. The survey strategy relies on gathering facts or beliefs, and opinions to test the theory and measure the social phenomena. As a part of research aim is to test the model(theory) against empirical data on the acceptance of Socially assistive robots, 'social phenomena', survey strategy is preferred to fulfill the aim of this research.

3.1.1 Choice of method

In this section, we will explain our choice of method for our research by describing the various facets of the survey such as qualitative- that is text or open questionnaire and quantitative- that is questionnaire approaches.

According to O'Leary, Z [25], the main model of the qualitative approach is subjectivism, interpretivism, or constructivism, and it is neither driven by scientific research nor hypothesis testing. Moreover, the qualitative approach is a thematic exploration- an in-depth study, and it is not supportive of statistical results. The time spent on the qualitative approach is longer than the quantitative approach because of the availability of standard statistical procedures to depict results, also implies quantitative data and analysis as non-problematic and enormous time involved in performing qualitative analysis [24].

In our research, we would like to know the measure of satisfaction rate, quality of life, opinions or belief about technology, etc. Although the opinions and beliefs of assistive robots are needed for the research and it can also be done through a qualitative approach, an in-depth study of the focus area is not necessary. This study encompasses statistical analysis, hypothesis testing to analyse the identified relationships, and knowing about the intention of usage from the respondents. According to Denscombe [24], the quantitative approach is empirical and optimistic, driven by a scientific hypothesis that involves a large number of participants. Moreover, the quantitative approach suits the goal of our research as it helps in deriving statistical results for measuring and determining the acceptance of assistive robots or assistive technology.

The previous studies [16] [33] on similar research about the acceptance and usage of assistive technology for elderly users have also opted for the quantitative method where researchers have achieved using the quantitative method in their goals. The results of this study are statistically depicted. Therefore, this kind of study motivated us to choose the questionnaire method.

According to [26,27,45], SEM is considered suitable for the optimistic paradigm that theoretical model framework followed by rigorous testing of these theoretical model against empirical data statistically. This SEM statistical technique is useful in inferential statistics and hypothesis testing to find the relationships among constructs- that is theoretical concepts measured through observed measurement item variables(hypothesized), as specified in priori.

The aim of our study is also to find a theoretical conceptual model and test it against the empirical data for the acceptance and usage of socially assistive robots. As the theoretical conceptual model of elderly users' acceptance of socially assistive robots was found in Section 2.3, SEM can be used to test the conceptual model against empirical data through inferential statistics and hypothesis testing. Moreover, SEM analysis offers flexibility to measure several predictor(observed) variables and simultaneously test the relationships among variables statistically [45]. Hence, the research method used in this thesis is a questionnaire to empirically test the model against data, and SEM statistical analysis is chosen to test the hypothesis drawn in Section 2.3 to find the pattern of relationship among constructs.

3.1.2 Data Collection method

Usually, the research methods scope as questionnaires, interviews, observations, focus groups, and others, we decided to use the quantitative method and collected primary data as a questionnaire online survey. In general, in online surveys, responses can be classified into two categories such as open and closed responses to collect information from respondents. Here, we have chosen the format of closed responses as it includes questions that are defined as question types such as yes/no or among a set of multiple-choice questions or Likert scale questions. It is easy to code and statistically analyze [25]. Moreover, it is easier and quicker for respondents to answer as well as the answers of different respondents are easier to compare. The sample size of approximately 150 is considered suitable for this research towards testing of simple SEM model [26].

The method of the questionnaire was selected as the most suitable concerning our resources and research questions. The complete form of questions used in the questionnaire is enclosed in Appendix c and the questionnaire was available in the English language. From a technical point of view, the data were collected and stored on Google Forms.

3.1.3 Sampling Strategy

In general, samples are an easier way to collect the data because it is convenient, cost-effective, and manageable. According to Denscombe [24], researchers select a sample from a population either as exploratory samples or representative samples. In this study, exploratory samples have opted because the surveys are associated largely and the use of quantitative data by involving a cross-section of the population, and time boundness. Moreover, a representative sample allows the researcher to gather information and provides accurate conclusions. According to Denscombe [24], there are two types of sampling such as probability and non-probability sampling. Probability sampling is tedious and time-consuming, particularly with larger samples. In line with our research questions, we aim to determine the acceptance of socially assistive robots by elderly users and elderly users as relatives or caregivers in India. Since our thesis is time-bound, we have cross-sectioned our samples within India and opted for non-probability. The non-probability sampling signifies convenience sampling. Convenience sampling is selected based on the researcher's convenient sources of data, lack of English knowledge and social assistive robot knowledge. The key advantage of this sampling is that it is quick, easy, and cheap. Moreover, it works best with the population by yielding good quantitative data. The survey was distributed on basis of convenience sampling to elderly participants in our living place in India as a choice selection for collecting responses. This sampling technique helped us in saving time for our data collection process.

3.2 Alternate Method

As there are multiple methods to collect data such as focus group interviews, observations, etc. we opted for a questionnaire. Other than the questionnaire, focus group interviews particularly do not help in deriving results such as measurements and exploring the factors that influence to determine the acceptance of assistive robots. Since it involves only a lesser number of groups, we might need to conduct several focus groups interview to reach a larger audience. This can be time-consuming in terms of time and cost taken to reach a specific place for elderly users and difficult to conduct interviews. The process of interview analysis is time-consuming and tedious, as it involves transcribing the interview and analysis of extracting codes [24]. Also, the interview prefers an in-depth analysis of the focus area, which is not suitable for this research. Hence, focus groups interview are rejected. The observation of data collection is attainable but due to time constraints, resource constraints, and the measurement in observational studies, which needs an expert to analyze the visual footage, would take the form of the researcher's un-quantified perceptions rather than quantitative measures. The observation also needs prior authorization and ethical approval. Therefore, this method of application may not be suitable.

Thus, we decided on the questionnaire and quantitative method as we need methods that generate numbers from a research process to obtain a form of results in a similar way to the mentioned previous research, we chose the quantitative research approach, and we used the questionnaire method. Hence the research method used in the thesis is the quantitative survey as discussed in section 3.1 and subsection [25].

3.3 Method Application

3.3.1 Questionnaire

According to O'Leary, Z [25], we have formulated our questionnaires and our survey has background information and questionnaires for research. We have used the Likert scale usage on questionnaires to measure the acceptance of socially assistive robots by elderly users'. The rate of the Likert scale is defined based on the nature of the questionnaire. The questions formulated in our survey are straightforward, simple, and bound to the research topic without any biasing. All our research questionnaires were composed of closed responses such as yes or no and an interval response scale. Moreover, we have provided detailed information on the questionnaire for the necessity of taking the survey, guaranteed confidentiality, and a thanking message for acknowledging the time and effort of the participants.

The questions developed in the survey are based on the previous studies to understand how socially assistive robots can be benefitted by using an Artificial Intelligent system as an engagement tool. The questionnaire helps to identify the factors which affect the acceptance of assistive robots among elderly users'.

3.3.2 Survey tool

According to O'Leary, Z [25], an online survey tool will simply offer flexibility, with low costs administration and a user-friendly interface. The respondent's replies are stored in the database automatically and represent statistical analysis based on the responses. Therefore, considering the above-stated advantage we preferred to use Google forms as the survey tool for data collection. In a tool responses to questions can be configured with various options such as measuring scale, choosing from a list, yes or no questions, and mandatory options or skipping certain questions from the respondents. We opted to be configured in our study to handle duplicate responses and for better quality data.

3.3.3 Data Collection

We have a questionnaire that was sent via the internet with the use of Google forms and shared online to fill in the required number of answers in a shorter period. The survey link was distributed on basis of convenience sampling to participants in India (common elderly users) along with detailed information about the research study and informed the closing period of the survey to the participants. We have circulated our survey links on WhatsApp, and Facebook messenger to all elderly users and other participants. The data collection went on for two weeks, with the survey starting from April 29th, 2022, to May 15th, 2022. We have closed the accept responses in the google survey form after the deadline passed and ensured that no responses were logged in.

3.3.4 Data Analysis and software used

The questions in the online survey include ordinal, nominal, and interval scales. We use the quantitative analysis method to assess the factors that affect elderly users' behavioral intentions and use the behavior of socially assistive robots.

Measurements

Construct	Measurement Items	Supporting References
Performance Expectancy (PE) Performance Expectancy is the usefulness of technology. It is defined as the degree to which elder people believe that using the system would help him /her achieve gains in performance.[8]	PE1: I believe, I would find a Social assistive robot useful in my life. PE2: I think using a socially assistive robot would be convenient in my life. PE3: I think, using a socially assistive robot would help me accomplish things more quickly.	The measurement items used are inspired by performance expectancy of [17] Gerontechnology acceptance model have researched to understand the acceptance of gerontechnology based on Hong Kong, China, [29] acceptance of Social Assistive Robot developed and tested for elderly care environment, and [31] acceptance of virtual reality headset designed for fall prevention in elder adults.
Effort Expectancy (EE) Effort Expectancy is defined as the degree to which the technology would be ease to use.[8]	EE1: I think, I could learn quickly how to use the socially assistive robot. EE2: I think it would be easy for me to become skilful at using social assistive robots.	The measurement items used are inspired by effort expectancy of the research done on [29] social assistive robots developed and tested for elderly care environment and

	EE3: I think, I could use the robot if there was someone around to help me. EE4: I think, I could use the robot if I have a good manual. EE5: I believe socially assistive robots are easy to use in my life.	[30] customer acceptance of mobile internet technology, and [31] acceptance of virtual reality headsets designed for fall prevention in elder adults.
Facilitating Conditions (FC) Facilitating Conditions are defined as the degree to which objective factors in the environment facilitate the act of use of the system [8,17]	FC1: I think I have the knowledge necessary to use the socially assistive robot system. FC2: A specific person (or group) is available for assistance with technical difficulties. FC3: The financial status does not limit my activities in using social assistive robot technology. FC4: I think when I want/need to use the assistive robot they are accessible to me. FC5: The family and friends would support that I should use the socially assistive robot.	These measures are inspired by facilitating items who have researched on [17] Gerontechnology acceptance model, to understand the acceptance of gerontechnology based on Hong Kong, China and [30] customer acceptance of mobile internet technology.
Behaviour Intention (BI) Behaviour intention is the intention to use the system. [8]	BI1: I plan to use social assistive robots. BI2: I would use social assistive robots in my home. BI3: I would use the Social assistive robots in my personal life (Not at all, in the distant future, in near future (about 4 to 6 years))	The measurements are inspired by the behavioral intention of [29] acceptance of Social Assistive Robot developed for elderly care environment, [30] customer acceptance of mobile internet technology, and [31] acceptance of virtual reality headset designed for fall prevention in elder adults.
Usage Behaviour (UB) Usage behaviour is the behaviour associated with the actual use of the system.[8]	UB1: Have you used assistive robots for home and daily living to support home and daily tasks? UB2: Have you used assistive robots for communication to support communication with others? UB3: Have you used assistive robots such as health and sports robot or telecare to manage health? (Never, have been using, used)	This measurement item is inspired by the usage behavior of [17] Gerontechnology acceptance model, to understand the acceptance of gerontechnology based in Hong Kong, China and [30] acceptance and use of mobile internet technology.
Subject well-being (SWB) SWB is defined as psychological outcomes that	SWB1: Do you feel as you get older you are less useful? SWB2: How satisfied are you with your quality of life?	The measurement items are inspired by the positive emotions of SWB [23], to achieve psychological growth

evaluate the quality-of-life satisfaction, self-efficacy, happiness, and positive mood [20].		and improved well-being over time with acceptance and use of socially assistive robots based on American Psychologist.

Table 1: Measurements items of elderly users' acceptance of social assistive robot

All the items were measured on a 5-point Likert scale ranging from 1 to 5 (Strongly disagree to strongly agree).

SEM is a statistical technique encompasses both Confirmatory Factor Analysis (CFA) or measurement model and structural path analysis, which examines relations among constructs- unseen hypothesized variable items and used to find the strengths of relationships among constructs as in the hypothesis [26]. Initially, [46, 47] to examine the reliability and validity of the scales, Cronbach's alpha coefficient, Composite Reliability (CR), and Average Variance Extracted are used. Cronbach's alpha coefficient is an internal consistency measure, which depicts that the data is consistent in results. The value of 0.90 and above depicts excellent reliability, 0.70-0.90 represents high reliability, 0.50-0.70 states moderate reliability, and 0.50 and below depicts low reliability. CR depicts how good constructs are served with underlying variables. It is estimated based on the factor loadings. The reliability coefficient value of 0.6 and higher signifies reliability. The validity is done to assess that the measurement variable items are associated with the identified latent construct. This is established using the Average Variance Extracted (AVE), which should be greater than or equal to 0.5 to estimate the validity.

According to Hoe [26], the CFA determines the adequacy (good or weak) of the model fit against data. These are measured through several fit indices such as Chi-squared fit index, Root Mean Square Approximation of Error (RMSEA), and Comparative Fit Index (CFI). The chi-square fit/df(degree of freedom) indicates the amount of difference between expected and observed covariance matrices. A p-value of above 0.05 is considered significant. The CFI relates to the discrepancy function adjusted for sample size. The CFI value of 0.90 or above is considered a good model. RMSEA indicates the residual in the model, in which the value of 0.06 or less indicates good fit, values up to 0.08 reasonable fit, and values between 0.08 and 0.10 indicate mediocre fit.

The structural path analysis is used to look at the path among the constructs as identified by the hypothesis. It's evaluated in terms of statistical significance of a value of 0.05 or less and a strength of 0.20 and above is considered significant to confirm the hypothesis.

Histogram- This is used to compare data to each other. It is used to check the normal distribution. Normal distribution confirms the validity of the data. The systematic shape of the curve means that variables are normally distributed without any extreme values.

The above steps are used for the analysis of the hypothesis.

Software used:

For the data analysis process, IBM statistical package is a suite of programs for statistical data analysis. SPSS provides plenty of basic statistical functions such as cross-tabulations, frequencies, and bivariate statistics. Moreover, SPSS Amos is used to validate and predict the model using advanced statistical procedures. The results generated from our questionnaire online survey are exported to SPSS propriety using .SAV format via Microsoft Excel and that data were cleaned and the string values are converted to numerical values of each variable and make the process easy to analyze. No corrupted data or missing values will be found as every question required an answer by design. Also, SPSS will automatically set and imported the variable names, titles, value labels, and variable types. In addition, it deals with complex data sets and provides a customizable.

3.4 Research Ethics

When conducting research, we researchers are required to consider all the ethical issues which may arise. The researcher must ensure that the answers provided by the participants are protected and privacy is maintained. In addition, according to Denscombe [24], four key principles are applied in the research such as

- Participants of the survey are not exposed to any risks. The questions in the survey are formed politely without psychological and physical harm to contribute to the research.
- Participants should be always voluntary or never be forced to help with research and provide sufficient information to make a judgment whether to participate or not, in the research study (based on informed consent).
- Researcher should be open and explain a detailed summary of the targets of the research and honestly announce to the participant about the outcomes and potential benefits of this research topic
- Researcher must ensure that the research conducted is within the law and avoid copyright matters.

From the above-mentioned key principles, we have used google forms to conduct the survey and handled the data. Moreover, the participants are informed about the details of the research, the nature of the questions, and the outcome of the study. Also, they are ensured that confidentiality and anonymity are maintained, which means none will be able to identify the participant who has contributed their responses to the research study. This is implemented by not collecting information such as names, email addresses, and IP addresses. The participants are also announced that they have an opportunity to cancel their participation in the survey at any time before submission. They are also informed that the data will no longer be stored than required or necessary to complete the research study and limited data access is maintained. The consent form is disclosed/ attached in Appendix A. To maintain the data quality and avoid duplication of data, we formed a rule that no participant can participate in the survey more than once.

4 Results

4.1 Data Collection and Analysis

The data collection began with collecting responses from elder users. As the intended response sample size couldn't be reached due to various reasons, responses were also collected from elderly users' perspective as relatives/caregivers in India. The total number of participants's collected was 153. The responses from each participant are valid. After data collection had been completed, cleaning began with 153 responses, where the complete datum(row) was found blank, therefore, to remove missing values, excluded the blank datum(row) and proceeded with a valid 152 sample size. Also, Data cleaning has been done where we removed the word string and replaced it with an integer number as shown in Appendix B.

Finally, after data collection and data cleaning, the data were exported from Google forms as .XSLX files and imported to the SPSS statistics tool, - converted into .SAV format and at last imported those datasets into SPSS AMOS graphics tools and performed the confirmatory factor analysis and structural equation model to test whether the model is fit or not.

The responses of users' age is categorized into 60-69 years old, 70 and above 70 years old, and less than 60 years old (elderly users' caregivers or relations). From 152 responses, the responses of users 60-69 years old was 13.8% (21), 70 and above years old was 2.6% (4), and less than 60 years old was 83.6% (127).

The responses of gender is classified as Male (0), Female (1) and prefer not to say (2). From 152 responses, 44.1% (67) of males, 54.6% (83) of females, and 1.3% (2) prefer not to say had participated.

4.2 Findings

The main focus of this research was to determine in what ways factors such as PE, EE, FC, etc. affect the acceptance of assistive robots.

4.2.1 Measurement Model Analysis

Descriptive Statistics

	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
PE1	152	3.82	.854	-1.070	.197	1.588	.391
PE2	152	3.78	.883	-1.136	.197	1.579	.391
PE3	152	3.88	.868	-1.120	.197	1.673	.391
EE1	152	3.87	.803	-1.079	.197	1.879	.391
EE2	152	3.73	.861	-.961	.197	1.136	.391
EE3	152	3.68	.939	-.867	.197	.324	.391
EE4	152	3.95	.867	-1.194	.197	1.954	.391
EE5	152	3.66	.892	-1.082	.197	1.275	.391
FC1	152	3.71	.904	-1.140	.197	1.406	.391
FC2	152	3.70	.846	-.772	.197	.665	.391
FC3	152	3.41	1.069	-.514	.197	-.436	.391
FC4	152	3.68	.902	-.922	.197	.892	.391
FC5	152	3.63	.926	-.774	.197	.461	.391
BI1	152	2.18	.672	-.225	.197	-.791	.391
BI2	152	2.15	.698	-.215	.197	-.926	.391
BI3	152	2.08	.696	-.107	.197	-.912	.391
UB1	152	1.43	.725	1.343	.197	.246	.391
UB2	152	1.45	.708	1.243	.197	.112	.391
UB3	152	1.37	.687	1.601	.197	1.037	.391
SWB1	152	3.05	1.155	-.182	.197	-.913	.391
SWB2	152	4.03	.829	-1.178	.197	2.443	.391
Valid N (listwise)	152						

Table 2: Descriptive Statistics of variable Items

Initially, in SPSS tool, the data set were assessed for outliers, and none identified. Skewness and Kurtosis refers to the measure of deviation from normality. According to [48, 49], skewness and kurtosis values ranges between -2 and 2 are considered acceptable. From Table 2, it depicted that the item variables of skewness and Kurtosis statistic range between -2 and 2. Hence, all the variables were found acceptable to proceed with CFA [50].

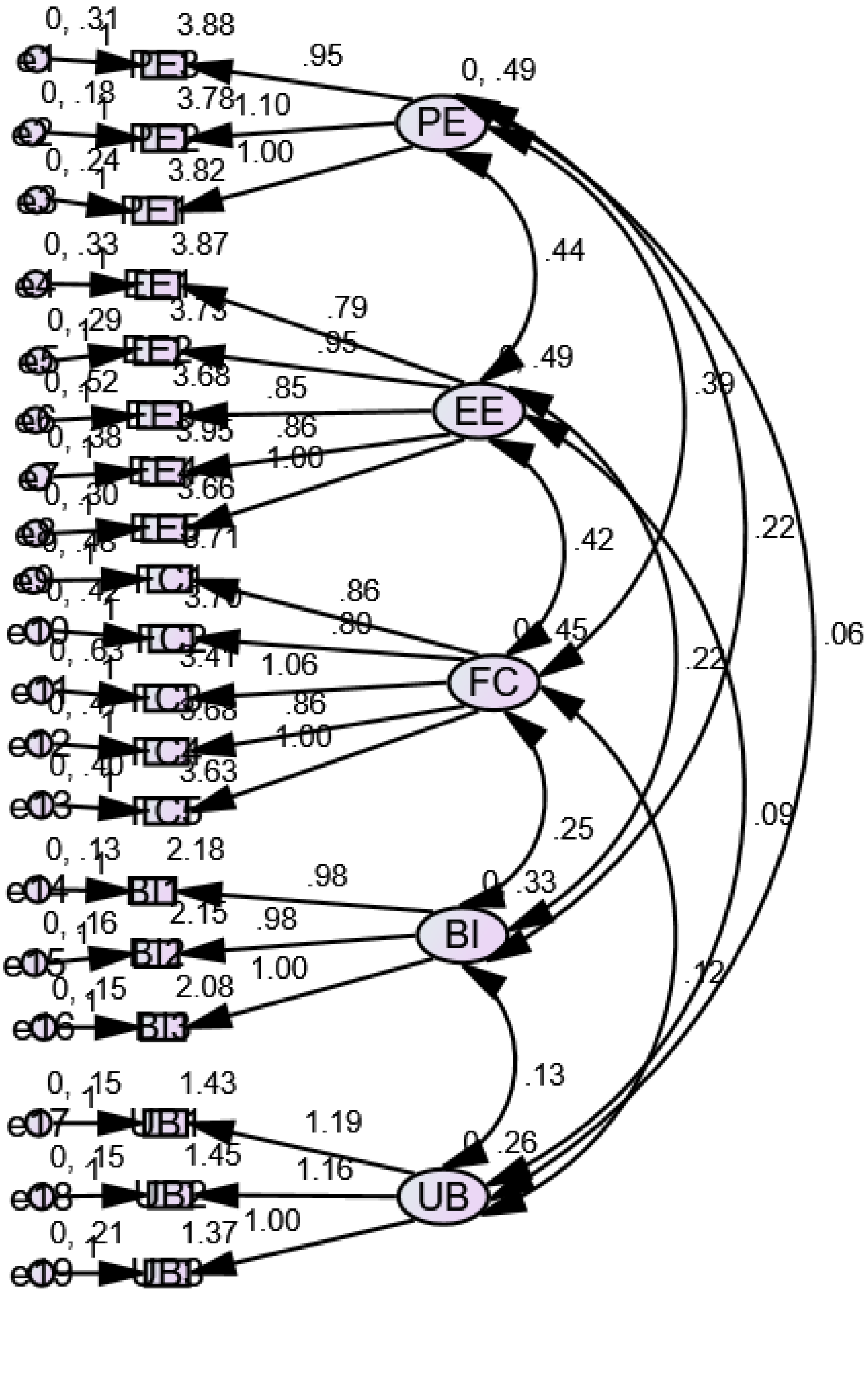


Figure 2: Path Coefficient to determine measurement model fit path diagram (without SWB)

Initially, the measurement model indices observed for Figure 2 were Chi-square/df=1.850, CFI=0.921, NFI=0.847, IFI=0.923, TLI=0.894, CFI=0.921, RMSEA=0.075, indicates a weak model fit. According to Hair et al. [50], the below steps are followed to improve and obtain an acceptable or good model fit,

1.the factor loadings with values less than 0.6 can be eliminated,

2. error terms of latent variables are combined [45] and

3. eliminate item variables in the latent variable.

From Figure 2, it's observed, that the factor loadings of each item variable are above 0.8 and acceptable. To improve the model, error terms of PE1, PE3 and EE1, EE5 are correlated based on covariance suggestions in AMOS, and EE3, FC4, FC5 are eliminated based on regression weights by preserving the model framework.

Then, the overall fit of the model summary was reasonably good. The indices for all the participants were chi-square/df = 1.347 minimum was achieved, CFI=0.974, NFI=0.910, IFI=0.975, TLI=0.962, RMSEA=0.048 all were reasonably good. Thus, the statistics of measurement model indicated that the model fit the data was good.

4.2.2 Reliability and Validity

As the model has achieved adequacy fit, the validity and reliability assessments are done to estimate the validity and reliability of the model.

Latent Construct Variable	Cronbach's Alpha	CR	AVE
PE	0.856	0.874	0.8353
EE	0.839	0.8563	0.7727
FC	0.688	0.6936	0.655
BI	0.867	0.8669	0.8273
UB	0.853	0.8541	0.8123

Table 3: Reliability and validity of Construct Measures

The reliability of the latent construct is assessed using Cronbach's Alpha and Composite Reliability. From Table 3, it's observed that the Cronbach's Alpha value of latent construct variables are above 0.50, indicates moderate reliability, explains reasonable internal consistency of the data in the construct. The Composite Reliability (CR) measures that the item variables are served with the identified constructs. [51] It is estimated based on the factor loadings observed in the measurement model as

$$CR = \frac{(\sum \lambda_i)^2}{(\sum \lambda_i)^2 + (\sum \epsilon_i)}$$

Where λ is the standardized factor loading for item variable i, ϵ is the respective error variance for item variable i.

ϵ is the error variance term calculated based on standardized factor loading as

$$\epsilon = 1 - \lambda_i^2$$

From Table 3, it's observed that the CR value of latent Construct variable are 0.7 and above computed using above formula, which signifies reliable.

According to Hair et al. [50],[47], the validity is done to assess that the measurement variable items mutually covary and are associated with the identified latent construct. It is identified using convergent and discriminant validity. The convergent validity examines that the measured item variables are correlated and theoretically associated to measure the identified latent construct. This is established using the Average Variance Extracted (AVE), which should be greater than or equal to 0.5 to estimate the validity [51]. It is calculated based on the standardized factor loadings and the number of items associated with the identified latent construct.

$$AVE = \frac{\sum_{i=1}^{n} \lambda_i^2}{n}$$

Where λ is the standardized factor loading

From Table 3, it's depicted that AVE of latent construct variable are above 0.6, calculated using above formula, which indicates that the constructs are valid.

The discriminant validity is to assess that the constructs are mutually correlated [51] i.e. they are not highly correlated and distinct from each other. The square root of AVE of specified construct should be greater than correlation with other constructs observed from AMOS, implies constructs are distinct.

	PE	EE	FC	BI	UB
PE	0,9139				
EE	0,832	0,879			
FC	0,771	0,879	0,8093		
BI	0,554	0,508	0,513	0,905	
UB	0,169	0,213	0,324	0,427	0,90125

Table 4: Discriminant Validity Measure

From Table 4, it's depicted that construct values are greater than other (below) constructs, indicates constructs are distinct.

The Common Method Bias is done to assess bias in the model [50].

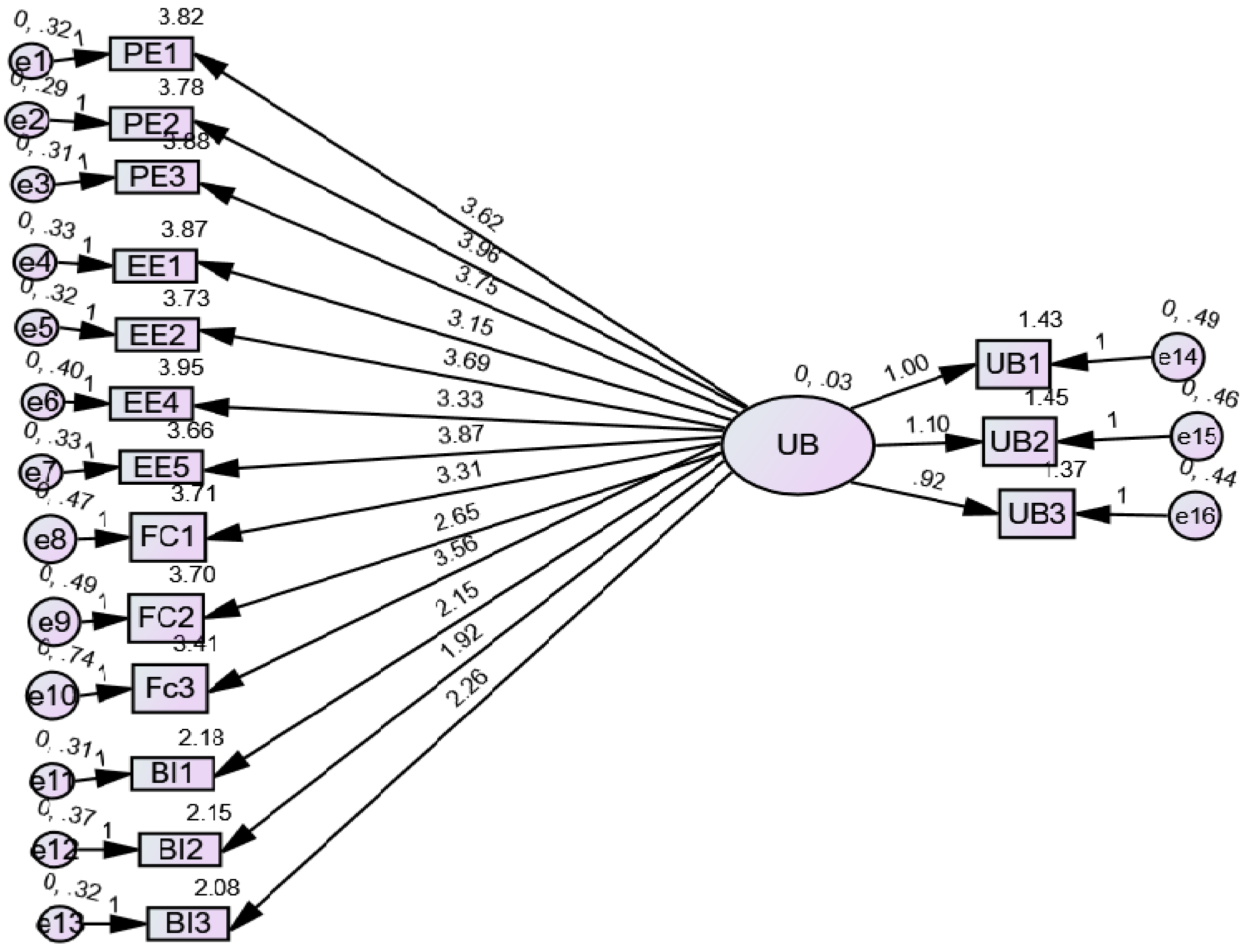


Figure 3: Common Method Bias

From Figure 3, the model indices observed for CMB diagram were chi-square/df = 5.265, CFI=0.653, NFI=0.613, IFI=0.662, TLI=0.537, RMSEA=0.168, which indicates non-existence of bias in the model.

4.2.3 Structural Modelling Results: Hypotheses test

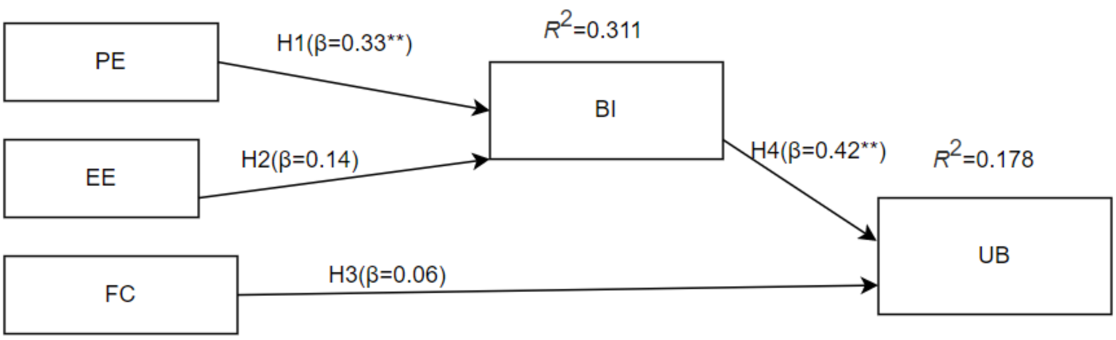


Figure 4: Structural Modelling Diagram

The proposed model hypothesis such as PE, EE, SI, FC, and SWB was calculated and had direct and indirect effects on BI or UB.

Hypothesis	Statements	Results
H1	PE positively affects elderly users BI	Supported (β = 0.329, p = 0.023)
H2	EE positively affects elderly users BI	Not supported (β = 0.139, p = 0.302
H3	FC positively affects elderly users actual UB	Not supported (β = 0.65, p = 0.572)
H4	The elderly users BI positively affects UB	Supported (β = 0.420, p<0.001)

Table 5: Results of Structural Modelling Diagram Path effect

The standardized path coefficients for all elderly users were positively definite. PE positively affected BI (β = 0.329, p = 0.023), and H1 was supported. EE not affected BI (β = 0.139, p = 0.302), and H2 was not supported. FC not positively affected UB (β = 0.65, p = 0.572), and H3 was not supported.BI positively affected UB (β = 0.420, p<0.001), and H4 were supported in Appendix F.

The proposed model explains 31.1% of the variance in BI, and 17.8% of the variance in UB, in Appendix G.

4.2.4 Moderating factor analysis

The study measured the moderating factor of SWB on the relationship between PE and BI. The results showed the positive and non-significant impact of SWB on the relationship between PE and BI (Estimate =0.079, C.R=1.533, p =0.125), supporting H5. The moderation analysis summary for PE is displayed in Table 6.

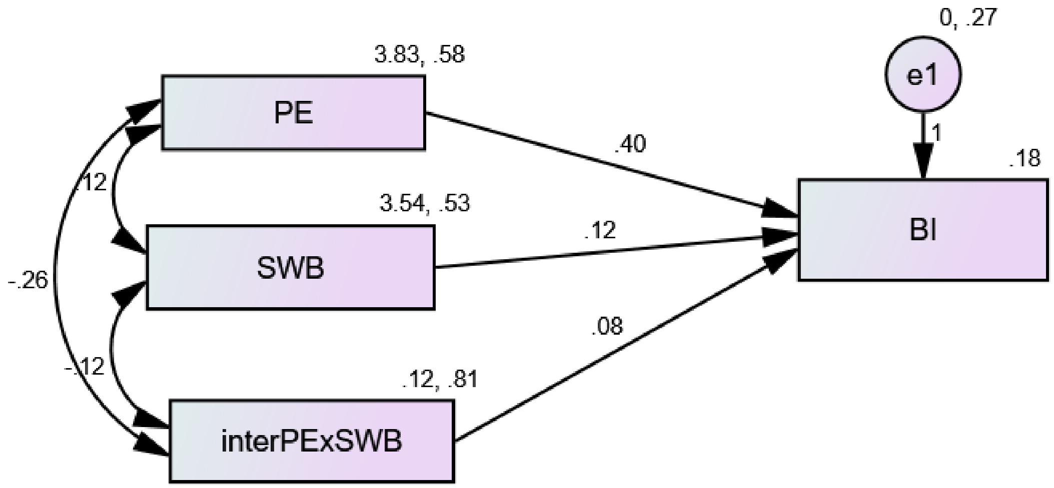


Figure 5: Moderating factor analysis for PE and BI

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
BI	<---	PE	.401	.061	6.569	***	
BI	<---	SWB	.116	.060	1.922	.055	
BI	<---	interPExSWB	.079	.052	1.533	.125	

Table 6: Moderation Analysis Summary for PE and BI.

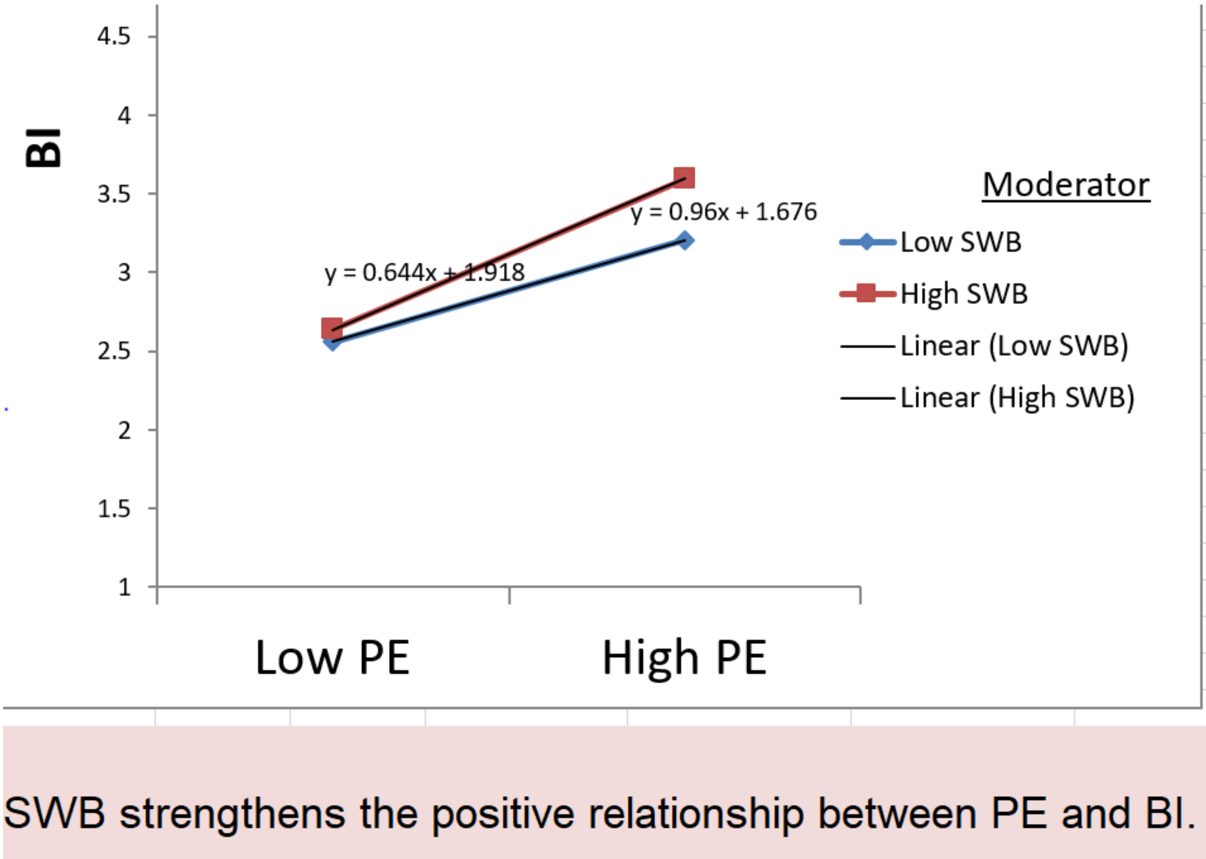


Figure 6: Moderator Graph Analysis (PE and BI)

Above graph shows the results of a simple slope analysis conducted to understand the nature of the moderating effects are shown in figure 6. As presented in figure 6, the line is much steeper for Low SWB, this shows that at Low level of SWB, the impact of PE on BI is much stronger in comparison to high SWB.

From Figure 6, the study measured the moderating factor of SWB on the relationship between EE and BI. The results showed the positive and non-significant impact of SWB on the relationship between EE and BI (Estimate =0.094, C.R=1.651, p =0.099), supporting H6. The moderation analysis summary for EE is displayed in Table 7.

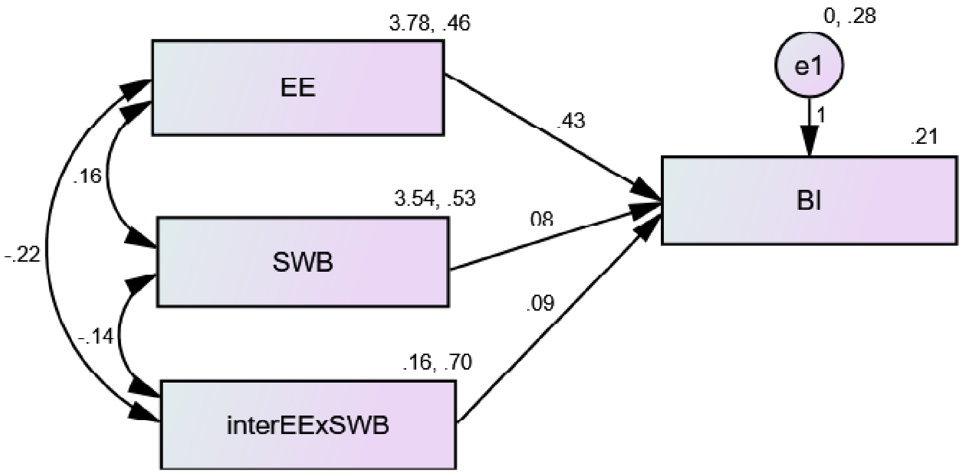


Figure 7: Moderating factor analysis for EE and BI

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
BI	<---	EE	.434	.072	6.014	***	
BI	<---	SWB	.079	.063	1.237	.216	
BI	<---	interEExSWB	.094	.057	1.651	.099	

Table 7: Moderating factor analysis summary for EE and BI

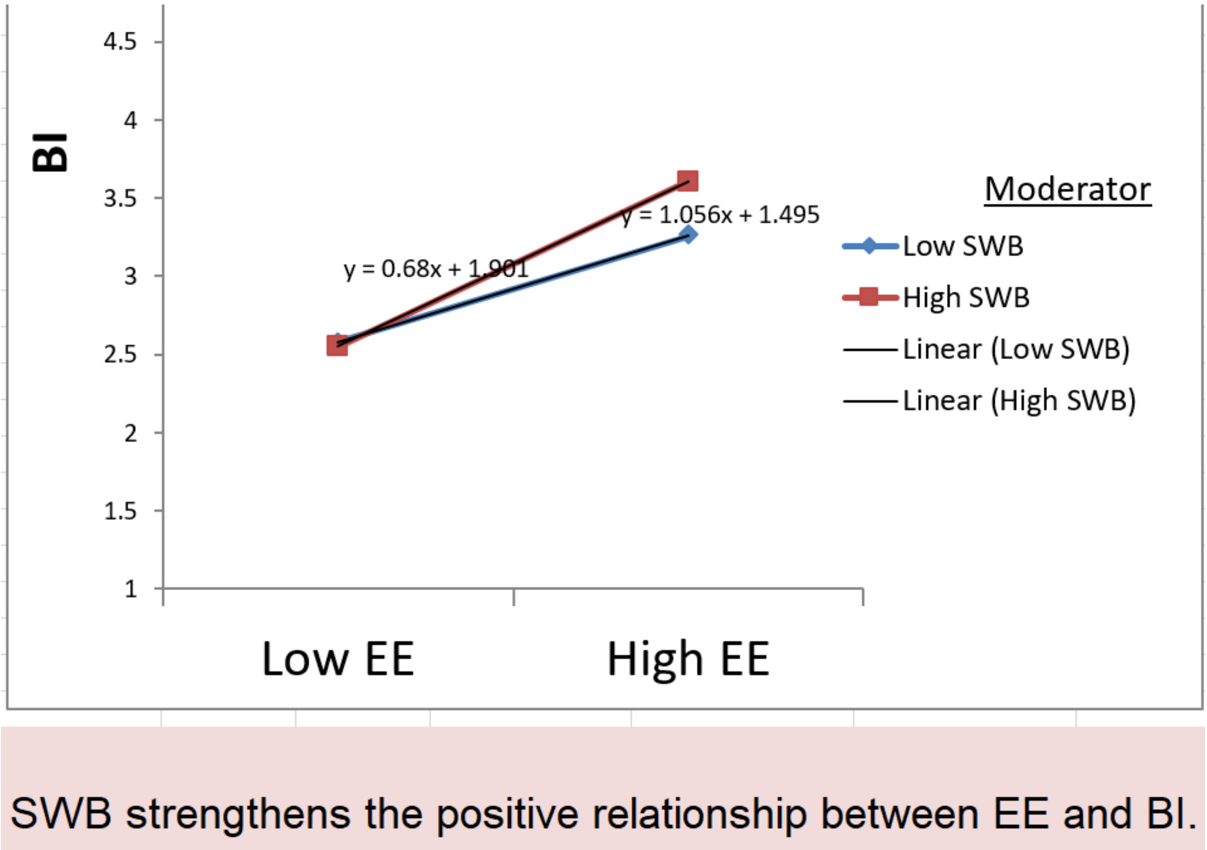


Figure 8: Moderator Graph Analysis (EE and BI)

Above graph shows the results of a simple slope analysis conducted to understand the nature of the moderating effects are shown in figure 8. As presented in figure 8, the line is much steeper for Low SWB, this shows that at Low level of SWB, the impact of EE on BI is much stronger in comparison to high SWB. As shown in figure 8(High SWB), as the level of SWB increased, the strength of EE and BI decreased.

5 Discussions & Conclusion

5.1 Discussions

Firstly, the findings of this study have supported the hypothesis that the elderly participants' BI towards assistive robots was positively affected by PE, EE, and FC, and the elderly users' UB towards socially assistive robot was positively definite and affected by FC and BI. Some previous studies show that PE, EE, and FC did not significantly affect BI [38,42,33] and FC did significantly affect UB [43,41,39,40], but in contrast, most of the results from earlier studies showed that the variables are positively caused and verified mostly the same outcome of direct effects [43,41,39,42,33].

PE had the strongest impact on BI. This result indicated that for elderly participants, perceived usefulness was the most significant factor affecting their intention to use socially assistive robots. In this study, elderly users believe that using assistive robots will be more utilization of their life performance which may motivate their intention to use assistive robots. Therefore, the designers of assistive robots' products and services must consider how to meet the elderly functional requirements [33] (for example. for social interaction, smartphones, and social media apps will be more supportive) and design customizable for elderly users to increase PE.

EE had the strongest impact on BI. This outcome indicated that for the elderly users, perceived ease of use was the second most important factor affecting their intention to use the assistive robots. Therefore, it was suggested that designers of assistive robots products and services must design the product with easy handling and avoid difficulty in operating the device [16, 44, and 33].

FC and BI had positive effects on UB. These findings indicated that the elderly user's use of assistive robots was determined by their intention to use assistive robots and their beliefs and support of assistive robots for elderly users. Therefore, it was suggested to the designers of assistive robots products and services need to educate the elderly users by providing training either as online or offline support systems to help and enhance the elderly learn and motivate them to learn how to utilize gerontechnology [33].

SWB was tested as a moderating variable hypothesis. The findings of the research indicate that the hypothesis was partially supported and the research measured the moderating factor of SWB on the relationship between PE, EE, and BI. The results showed that the SWB was statistically non-significant but strengthen the relationship and supports hypothesis H5 & H6. This outcome demonstrated that the UTAUT model was not significantly definite and affected by PE, EE, and FC, in addition, the use behavior of assistive robots was affected by FC. Therefore the expected UTAUT model considered age and gender as the important moderators, this study debates that SWB should be considered an important effect according to fredicksons [23] to broaden and build a theory of positive emotions.

5.2 Significance and contributions

To facilitate the elderly user's acceptance and use of socially assistive robots, this study extended the UTAUT model by referring to Fredrickson's broad theory [16, 33, 23] of positive emotions and SWB as a moderator. Therefore this study hypothesized that in the context of the elderly using socially assistive robots does directly affect the elderly users' BI or UI, and also does moderate the relationships between the constructs of the UTAUT model. Specifically, the following hypothesis was verified such as PE, EE, and FC affected BI was shown the results as supported by elderly users and the SWB relationship between PE and BI was also supported. Thus, to enhance the model and accept the factors among elderly users, designers of products and services of assistive robots must motivate or educate or train the elderly users about assistive robots. This research can become a reference for other researchers.

5.3 Research Quality

In order to increase objectivity, reliability and validity to get quality data to examine our study we followed few research ethics and principles as stated (Denscombe, 2014) during our data collection process. In our research survey, we clearly mentioned the instructions to the respondents about the study, confidentiality and anonymity of their responses. Thus the characteristics of empirical research has been observed where observable data reduce the likelihood and quality criteria is examined as 'validity'. Moreover, to eliminate duplicate responses from the participant we set an email address rule to avoid repeated responses from the participants. Thereby verifying 'reliability' has been satisfied. In addition to that, the 'objectivity' of data collection was maintained with closed email groups and limited the effects of bias.

5.4 Ethical and Societal consequences

All data used during the research were kept private and there is no ethical consequence can be seen in the process and performance of the study. The data used is anonymous and other identities such as participants' names, gender, and address are kept confidential and not used anywhere.

The results of ethical consequences contribute to the elderly people caring for themselves independently and may help improve care delivery at home. Moreover, it serves as input for future usage of elderly people.

In terms of social consequences, no social consequences were seen. However, the result contributes to a deep knowledge of which factors affect elderly users and that can be primarily focused and the designers of products and services of an assistive robot must plan accordingly and enhance the product, based on customers' needs and satisfaction.

5.5 Limitations and Future research

This study extended the UTAUT model [33, 16] and included SWB as a moderator. But this study did not consider age and gender as moderating factors. Therefore, it is highly recommended to add SWB as a moderator. Secondly, this study adopted a convenience sampling technique to survey the elderly users as this research shows an inability to generalize the results of the survey to the population as a whole, for instance, the outcome may be over or underestimate the representation of the population and biased results may occur due to some reasons, only a few people may participate and some may not be [33]. Therefore, future studies could test with probability sampling techniques. Moreover, the data were collected in India where the different cultural setting's acceptance was unknown. Hence it is highly recommended to test the research model all over the cultural contexts.

The CFA and SEM were used to quantitatively analyze the influencing factors of the acceptance of socially assistive robots [16, 33] based on previous studies a framework of factors affecting assistive robots toward elderly users was proposed. The contribution of studies lies in the use of methods and scientific theories, summarizing the current factors influencing the acceptance of assistive robots (gerontechnology). The results enhance future studies and provide a clear understanding of the needs of elderly users and their awareness of socially assistive robots. The value of each influencing factor can provide insight for future research in the field of assistive robots [16].

References

[1] Bouma H, Graafmans JAM. (Eds.). Gerontechnology. IOS Press, Amsterdam, 1992.

[2] Carmeli E. Aspects of assistive gerontechnology. International Journal on Disability and Human Development. 2009; 8(3): 215-218.

[3] Zhu H, Lu J, Zhang Y. Cui B. Responses to population aging in the new era: a national condition report from China. China Population and Development Studies. 2019; 2: 272–283.

[4] De Regge M, Van Baelen F, Beirão G, Den Ambtman A, De Pourcq K, Dias JC, Kandampully J. Personal and interpersonal drivers that contribute to the intention to use gerontechnology. Gerontology. 2020; 66(2): 176-186.

[5] Moyle W, Bramble M, Jones CJ, Murfield JE, Bowers BJ. “She had a smile on her face as wide as the great Australian bite”: a qualitative examination of family perceptions of a therapeutic robot and a plush toy. Gerontologist. 2017;00:1–9. Available at: https://doi.org/10.1093/geront/gnx180.

[6] Mervin MC, Moyle W, Jones C, Murfield J, Draper B, Beattie E, et al. The cost-effectiveness of using PARO, a therapeutic robotic seal, to reduce agitation and medication use in dementia: findings from a cluster-randomized controlled trial. Journal of the American Medical Directors Association,19(7),619-622.e1. Available at: https://doi.org/10.1016/j.jamda.2017.10.008.

[7] Blackman S, Matlo C, Bobrovitskiy C, Waldoch A, Fang M, Jackson P, et al. Ambient Assisted Living Technologies for Aging Well: A Scoping Review. Journal of Intelligent Systems 2016;25(1):55-69.

[8]Venkatesh V, Michael Morris. G, Gordon Davis. B, Fred D. Davis (2003) User Acceptance of Information Technology: Toward a unified view. MIS Quarterly 27(3):PP.425–478

[9]Hayley. R, Bruce MacDonald. A., Ngaire. K., and Elizabeth. B. (2013). Suitability of healthcare robots for a dementia unit and suggested improvements. Available at: https://pubmed.ncbi.nlm.nih.gov/23098418/.

[10] Shibata. T, Wada. K, Tanie. K (2003) Statistical analysis and comparison of questionnaire results of subjective evaluations of seal robot in Japan and UK. IEEE International Conference on Robotics and Automation.

[11] Effie L.-C. Law, Paul van Schaik, Modelling user experience – An agenda for research and practice, Interacting with Computers, Volume 22, Issue 5, September 2010, PP 313–322, Available at: https://doi.org/10.1016/j.intcom.2010.04.006

[12]James E Young., Richard Hawkins., Ehud Sharlin, and Takeo Igarashi. (2009). -Toward acceptable domestic robots: Applying Insights from Social Psychology. International Journal of Social Robotics.1, 95–108. DOI: 10.1007/s12369-008-0006-y

[13] Fred Davis. D.: Perceived usefulness, perceived ease of use, and user acceptance of information technology, MIS Quarterly, 1989, pp. 319-340. Available at: https://www.jstor.org/stable/249008

[14] Boris de Ruyter, Privender Saini, Panos Markopoulos, van Breemen.
Assessing the effects of building social intelligence in a robotic interface for the home.2005
17(5) pp: 522-541

[15] de Graaf, M.M.A.: 'Living with robots: investigating the user acceptance of social robots in domestic environments, University of Twente, Enschede, 2015.

[16] Zhou J, Zhang B, Tan R, Tseng ML, Zhang Y. Exploring the systematic attributes influencing gerontechnology adoption for elderly users using a meta-analysis. Sustainability. 2020; 12(7): 2864. Available at: https://doi.org/10.3390/su12072864

[17] Chen K & ChanAHS (2014) Gerontechnology acceptance by elderly Hong Kong Chinese: a senior technology acceptance model (STAM), Ergonomics, 57:5, 635-652, DOI: 10.1080/00140139.2014.895855.

[18] Cruz, M.A., Daum, C., Comeau, A., Salamanca, J.D.G., McLennan, L., Neubauer, N., and Liu, L.: 'Acceptance, adoption, and usability of information and communication technologies for people living with dementia and their care partners: a systematic review', Disability and Rehabilitation: Assistive Technology, 2020, pp. 1-15.

[19] Diener E, Oishi S, Lucas R.E. Subjective well-being: The science of happiness and life satisfaction. In, Lopez, S.J. & Snyder, C. R. (2nd ed.), Oxford Handbook of Positive Psychology. Oxford University Press, Oxford, 2002; pp. 63-73. Available at: http://dx.doi.org/10.1093/oxfordhb/9780195187243.013.0017.

[20] Yonker J.E., Schnabelrauch C.A., Dehaan L.G. The relationship between spirituality and religiosity on psychological outcomes in adolescents and emerging adults: A meta-analytic review. Journal of Adolesc. 2012; 35(2), pp. 299-314. DOI: 10.1016/j.adolescence.2011.08.010.

[21] Vichitvanichphong S., Kerr D., Talaei-Khoei A., Ghapanchi A.H. Assistive technologies for aged care. Information Technology & People.2018; 31(2), pp. 405-427 Available at: https://doi.org/10.3127/ajis.v18i3.880.

[22] Huebner ES, Valois RF, Suldo SM, Smith LC, McKnight CG, Seligson JL, Zullig KJ. Perceived quality of life: A neglected component of adolescent health assessment and intervention. Journal of Adolescent Health. 2004; 34(4), pp. 270-278.DOI: 10.1016/j.jadohealth.2003.07.007.

[23] Fredrickson, BL. The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions. American Psychologist. 2001; 56(3):pp.218-226.

[24] Denscombe, M. (2010). The good research guide 4th edition. pp. 269-270, 305, 330-338. Maidenhead: McGraw-Hill/Open University Press.

[25] O'Leary, Z. (2017). The essential guide to doing your research project 3rd edition pp. 225, 238, 132-135, 244, 269-270. SAGE Publications Ltd.

[26] Hoe, S.L. Issues and procedures in adopting structural equatiomodelingng. Journal of Applied Quantitative Methods. 2008; 3(1), pp.76-83.

[27] Hwang. E. J, Sim. O.I The structural equation modeling of personal aspects, environmental aspects, and happiness among older adults living alone: a cross-sectional study volume 21, Article number: 479 (2021) Available at: https://rdcu.be/cMaPn

[28] Heerink, Kröse, Evers. V, Weilinga B - Assessing Acceptance of Assistive Social Agent Technology by Older Adults: the Almere Model (2010). Available at: https://link.springer.com/content/pdf/10.1007/s12369-010-0068-5.pdf

[29] Heerink, M., Krose, B.J.A. Measuring acceptance of an assistive social robot: A suggested toolkit, IEEE International System on Robot and Human Interactive Communications. 2009, pp. 528-533.

[30] Venkatesh, V., Thong, J.Y.L., Xu, X. Customer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology, MIS Quaterly, 2012, pp.157-178.

[31] Mascret, N., Delbes, L., Voron, A., Temprado, J., Montagne, G. Acceptance of a Virtual Reality Headset Designed for Fall prevention in Older Adults: Questionnaire Study, Journal of Medical Internet Research, 22(12). 2020. Available at: https://preprints.jmir.org/preprint/20691

[32] Pino,M , Boulay,M, Rigaud,S,A, Jouen,F "Are We Ready for Robots That Care for Us?" Attitudes and Opinions of Older Adults Towards Socially Assistive Robots,2015, DOI:10.3389/fnagi.2015.00141

[33] Liu, H, Tu, K, C., The Moderating Effects of Subjective Well-being on the Elderly's Acceptance and Use of Gerontechnology: An Extended UTAUT Model Jan2021 DOI:10.1145/3459012.3459031

[34] Koh, Q, W, Felding, S,A, Budak, Toomey,E, Casey,D, Barriers, and facilitators to the implementation of social robots for older adults and people with dementia: a scoping review Jun 2021 Available at: https://bmcgeriatr.biomedcentral.com/articles/10.1186/s12877-021-02277-9#citeas

[35] Jaschinski, C, Allouch, S, B, Peters, O, Cachucho, Jan A G M Dijk, J, A, G M, V Acceptance of Technologies for Aging in Place: A Conceptual Model, march 2021, vol 23 Available at: https://www.jmir.org/2021/3/e22613/

[36] Whelan.S and Casey.D, Examining Social Robot Acceptability for Older Adults and People with Dementia, June 23rd, 2021, DOI:10.5772/intechopen.98365.

[37] Byrne B. Structural Equation Modelling with AMOS (3rd. ed.). Routledge Academic, New York, 2016.

[38] Nunes A, Limpo T, Castro SL. Acceptance of mobile health applications: examining key determinants and moderators. Frontiers in Psychology. 2019; 10: 2791

[39] Arenas-Gaitán J, Peral-Peral B, Ramón-Jerónimo MA. Elderly and internet banking: An application of UTAUT2. Journal of Internet Banking and Commerce. 2015; 20 (1): 1-23.

[40] Diener E, Oishi S, Lucas RE. Subjective well-being: The science of happiness and life satisfaction. In, Lopez, S.J. & Snyder, C. R. (2nd ed.), Oxford Handbook of Positive Psychology. Oxford University Press, Oxford, 2002: 63-73.

[41] Macedo IM. Predicting the acceptance and use of information and communication technology by older adults: An empirical examination of the revised UTAUT2. Computers in Human Behavior. 2017; 75: 935-948.

[42] Lin CS, Wu S. Exploring antecedents of online group-buying: Social commerce perspective. Human Systems Management. 2015; 34(2): 133-147.

[43] Quaosar GMAA, Hoque MR, Bao Y. Investigating factors affecting elderly's intention to use m-health services: An empirical study. Telemedicine and e-Health. 2018; 24(4): 309-314.

[44] Syed-Abdul S, Malwade S, Nursetyo AA, Sood M, Bhatia M, Barsasella D, Liu MF, Chang CC, Srinivasan K, Raja R & Li YCJ. Virtual reality among the elderly: A usefulness and acceptance study from Taiwan. BMC Geriatrics. 2019; 19: 223

[45] Streiner, D.L. Building a Better Model: An Introduction to Structural Equation Modelling. The Canadian Journal of Psychiatry. 2006; 51(5):317-24 Available at: https://doi-org.ezp.sub.su.se/10.1177/070674370605100507

[46] Said, H., Badru, B.B. & Shahid M. Confirmatory Factor Analysis (Cfa) for testing validity and reliability instrument in the study of education. Australian Journal of Basic and Applied Sciences. 5(12):1098-1103

[47] Jain, R. & Chetty, P. Criteria for reliability and validity in SEM analysis. 2021. Available at: https://www.projectguru.in/criteria-for-reliability-and-validity-in-sem-analysis/

[48] George, D. & Mallery, P. IBM SPSS Statistics 23 Step by Step Guide. 14th edn. New York and London: Routledge. 2016.

[49] Gravetter, F., & Wallnau, L. Essential of Statistics for the behavioral sciences. 2014(8).

[50] Hair, J., Gabriel, M. & Patel, V. AMOS Covariance-Based Structural Equation Modeling (CB-SEM): Guidelines on its application as a marketing research tool. Brazilian Journal of Marketing. 2014; 13(2), 44-55

[51] Fawad, K.H. Assessing Construct Reliability and Convergent Validity Using SPSS AMOS.2022. Available at: https://researchwithfawad.com/index.php/lp-courses/ibm-spss-amos-lecture-series/assessing-construct-reliability-and-convergent-validity-in-spss-amos/

Appendix A – Survey

Informed Consent

You are invited to participate in a survey on Social Assistive robots for elderly users' acceptance based on your interests or knowledge in socially assistive robots. This is a research study done as a part my of master thesis and being conducted by Sundara Lakshmi Paramasivam and Muthupriya Shankaran, students at the University of Stockholm. This research study focuses on people who are 60 years old and above and people as elderly caregivers/ relatives. The responses from the survey may help us learn more about the opinions, beliefs, and behaviors toward the acceptance of socially assistive robots by elderly users', which are meant to assist elderly users'. Also, the survey includes a few psychological questions. The survey should take approximately 2 to 3 minutes to complete.
Your participation in this survey is voluntary. You may refuse to take part in the research study or cancel the survey at any time. The survey responses remain confidential and anonymous, which means none will be able to identify you or your responses. Hence, Google Docs does not collect information like names, and email. The data access will be limited, and it will no longer be stored than required or necessary to complete the research. If you have any concerns regarding the survey, you can feel free to contact us through email at sundaralakshmi.sivam@gmail.com or gmpriyashank@gmail.com.
Please select your choice below: Clicking on agree button, means you have read and agreed to the above information.

- Agree
- Disagree

Survey on Socially Assistive Robot Acceptance

Informed Consent

You are invited to participate in a survey on Social Assistive robots for elderly users' care acceptance based on your interests or knowledge in Social Assistive Robots. This is a research study done as a part of master thesis and being conducted by Sundara Lakshmi Paramasivam and Muthupriya Shankaran, students at the University of Stockholm. This research study focuses on common users, as caregivers/ relatives to elderly people who are above 18 years old and elderly users'. The responses from the survey may help us learn more about the opinions, believes and behaviours towards acceptance of social assistive robots by elderly users', which are meant to assist elderly people. Also, the survey includes few psychological questions. The survey should take approximately 2 to 3 minutes to complete it.

Your participation in this survey is voluntary. You may refuse to take part in the research study or cancel the survey at any time. The survey responses remain confidential and anonymous. Hence, the Google Docs does not collect information like name, email. None will be able to identify you or your responses. The data access will be limited, and it will no longer be stored than required or necessary to complete the research. If you have any concerns regarding the survey, you can feel free to contact us through email sundaralakshmi.sivam@gmail.com or gmpriyashank@gmail.com.

Please select your choice below: Clicking on agree button, means you have read and agreed to the above information. *

- Agree
- Disagree

Next

Clear form

Survey on Social Assistive Robot Acceptance

Background Information

Gerontechnology includes assistive robots, which connects technological development of robots to assist health, communication, mobility and leisure of elderly users, for the independent living and social participations of elderly users in the society. Assistive robots are devices that can sense and process sensory data and information to perform actions that may be useful to most disabled and elderly users in their daily lives. Moreover, socially assistive robots can help at different levels such as by supporting users' cognitive abilities (e.g.: monitoring, reminding tasks, navigation aids), mobile robotic telepresence, communication, and social applications, companionship. Moreover, assistive robots provide remote and continuous monitoring of users' health status (for instance, fall detection sensors or blood pressure), and finally, they even educate the users on improving nutrition and physical activities.

What is your age?

- ◯ less than 60 year
- ◯ 60-69 year
- ◯ 70 year and Above

What is your gender?

- ◯ Male
- ◯ Female
- ◯ Prefer not to say
- ◯ Others

What is your education?

- ◯ Basic School
- ◯ High School
- ◯ Bachelors/ Graduate
- ◯ Masters and Ph.D.

Back Next Clear form

Survey on Social Assistive Robot Acceptance

1. I believe I would find socially assistive robot useful in my life. *

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neither agree nor disagree
- ◯ Agree
- ◯ Strongly Agree

2. I think using a socially assistive robot would be convenient in my life. *

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neither agree nor disagree
- ◯ Agree
- ◯ Strongly Agree

3. I think, using a socially assistive robot would help me accomplish things more quickly. *

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neither agree nor disagree
- ◯ Agree
- ◯ Strongly Agree

4. I think, I could learn quickly how to use the socially assistive robot. *

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neither agree nor disagree
- ◯ Agree
- ◯ Strongly Agree

5. I think it would be easy for me to become skilful at using social assistive robots. *

- ○ Strongly Disagree
- ○ Disagree
- ○ Neither agree nor disagree
- ○ Agree
- ○ Strongly Agree

6. I think, I could use the robot if there was someone around to help me. *

- ○ Strongly Disagree
- ○ Disagree
- ○ Neither agree nor disagree
- ○ Agree
- ○ Strongly Agree

7. I think, I could use the robot if I have a good manual. *

- ○ Strongly Disagree
- ○ Disagree
- ○ Neither agree nor disagree
- ○ Agree
- ○ Strongly Agree

8. I believe socially assistive robots are easy to use in my life. *

- ○ Strongly Disagree
- ○ Disagree
- ○ Neither agree nor disagree
- ○ Agree
- ○ Strongly Agree

9. I think I have the knowledge necessary to use the socially assistive robot system. *

- Strongly Disagree
- Disagree
- Neither agree nor disagree
- Agree
- Strongly Agree

10. A specific person (or group) is available for assistance with technical difficulties. *

- Strongly Disagree
- Disagree
- Neither agree nor disagree
- Agree
- Strongly Agree

11. The financial status does not limit my activities in using socially assistive robot technology. *

- Strongly Disagree
- Disagree
- Neither agree nor disagree
- Agree
- Strongly Agree

12. I think when I want/need to use the assistive robot they are accessible to me. *

- Strongly Disagree
- Disagree
- Neither agree nor disagree
- Agree
- Strongly Agree

13. The family and friends would support that I should use the socially assistive robot. *

- ○ Strongly Disagree
- ○ Disagree
- ○ Neither agree nor disagree
- ○ Agree
- ○ Strongly Agree

14. I plan to use social assistive robots *

- ○ Not at all
- ○ In the distant future
- ○ In near future (about 4 to 6 years)

15. I would use social assistive robots in my home. *

- ○ Not at all
- ○ In the distant future
- ○ In near future (about 4 to 6 years)

17. Have you used assistive robots for home and daily living to support home and daily tasks? *

- ○ Never
- ○ Used
- ○ Have been using

18. Have you used assistive robots for communication to support communication with others? *

- ○ Never
- ○ Used
- ○ Have been using

19. Have you used assistive robots such as health and sports robot or telecare to manage health? *

- ◯ Never
- ◯ Used
- ◯ Have been using

20. Do you feel as you get older you are less useful? *

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neither agree nor disagree
- ◯ Agree
- ◯ Strongly Agree

21. How satisfied are you with your quality of life?

- ◯ Very unsatisfied
- ◯ Unsatisfied
- ◯ Neither satisfied nor unsatisfied
- ◯ Satisfied
- ◯ Very satisfied

We sincerely thank you for the time and effort spent on completing the survey!

Back Submit Clear form

Appendix B – Cleaned data set in XLS file

PE1	PE2	PE3	EE1	EE2	EE3	EE4	EE5	FC1	FC2	FC3	FC4
4	4	5	3	3	4	5	4	3	4	3	4
4	4	4	4	4	4	5	4	4	4	2	4
4	4	5	4	2	5	3	3	4	4	5	5
2	2	2	2	2	2	2	2	2	2	2	2
3	4	4	4	4	4	4	4	4	4	4	4
4	5	4	4	4	4	5	4	3	4	3	4
5	4	4	3	2	5	3	2	1	3	1	5
.	.	.	.	.	.	.	.	.	.	.	.
4	4	4	5	4	4	5	4	4	3	4	4
4	4	4	4	4	4	4	4	4	4	4	4
4	4	5	4	4	3	5	4	3	3	3	2
5	4	4	4	4	4	4	5	4	3	4	4
4	4	4	4	4	4	4	4	4	5	5	5
5	5	4	4	5	4	4	4	5	4	4	4
4	5	4	4	3	4	2	4	4	4	4	4
4	4	5	4	4	4	4	4	5	3	4	3
3	4	5	4	3	3	4	3	4	4	5	5
3	4	5	5	4	5	5	4	5	4	4	3
4	4	5	3	4	4	5	4	4	4	3	4
3	3	3	3	3	3	3	3	3	3	3	3
4	4	3	4	4	2	4	3	4	4	3	3
4	2	4	5	4	2	3	1	3	5	2	1
4	4	5	4	4	5	4	4	4	4	4	4
3	4	4	4	4	2	4	4	4	4	2	3
4	4	3	4	3	2	4	4	3	2	3	3
3	4	4	4	3	3	4	3	4	3	3	3
4	4	3	4	4	3	4	4	3	4	4	3

5.5.1.1.1

FC5	BI1	BI2	BI3	UB1	UB2	UB3	SWB1	SWB2
5	3	3	3	1	1	1	4	3
4	2	3	1	1	1	1	1	4
4	2	3	3	1	2	2	5	5
2	1	1	1	1	1	1	2	2
4	2	2	2	1	1	1	4	4
4	2	2	2	2	2	2	2	4
4	3	3	3	1	1	2	2	2
.	.	.	.	.	.	.	.	.
3	2	2	2	1	1	1	2	4
4	2	2	2	2	2	2	4	4
4	2	2	1	1	1	1	2	4
4	3	3	2	1	2	1	3	4
5	3	3	3	1	1	1	5	4
4	2	2	2	2	1	1	3	3
4	2	2	2	1	1	1	3	4
4	2	3	2	1	2	2	3	4
5	3	3	3	3	3	3	4	4
3	3	3	3	3	2	2	3	4
4	2	2	2	1	1	1	3	3
3	2	2	2	1	1	1	3	4
3	3	3	3	1	1	1	4	4
4	2	3	2	2	1	3	3	4
4	3	3	3	2	2	3	4	4
4	2	2	1	1	1	1	1	5
3	2	2	2	1	1	1	1	5
4	1	1	1	1	1	1	2	5
3	3	2	1	1	1	1	2	5

Appendix C– Summary Response of Users' Age

Age

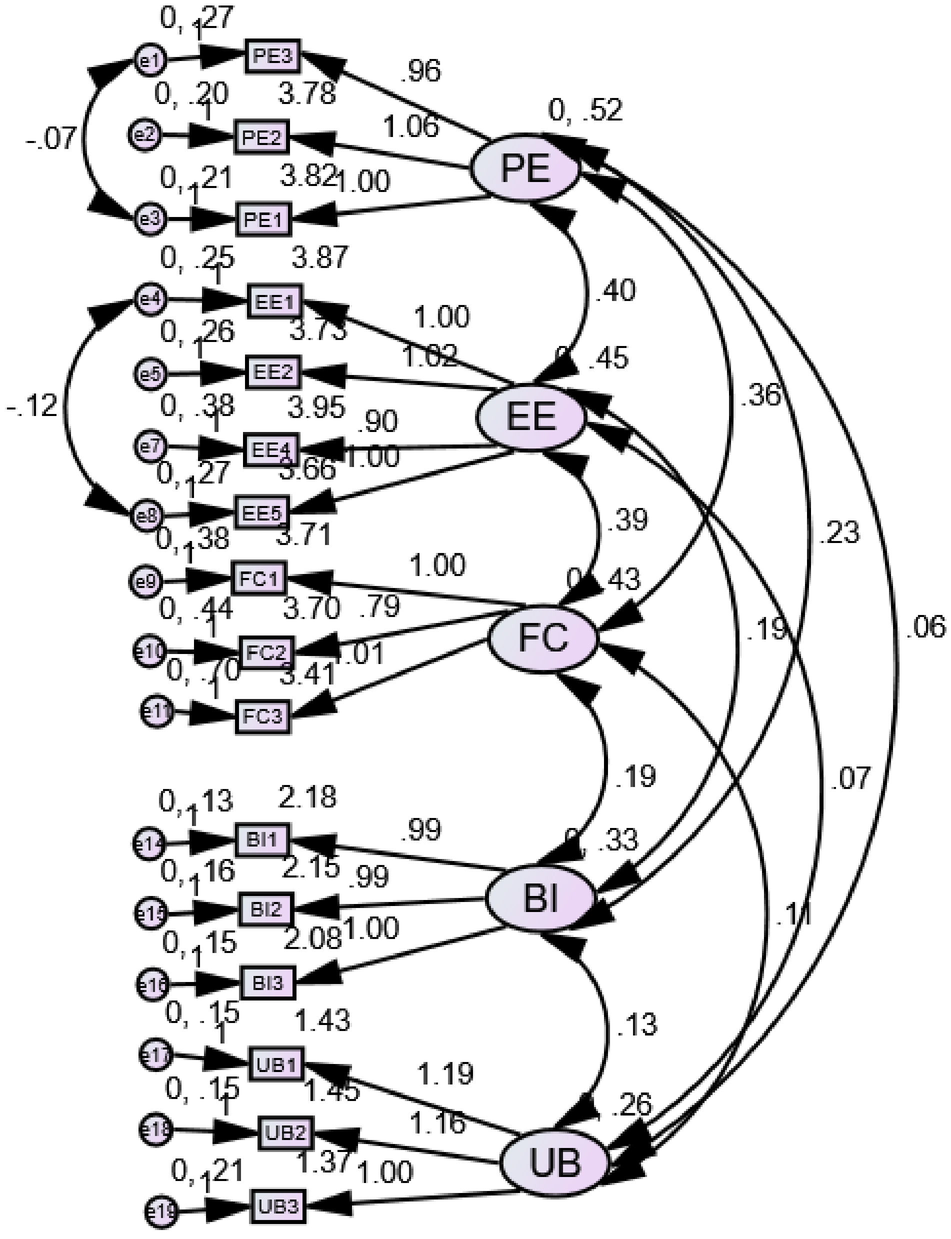
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	60-69 year	21	13.8	13.8	13.8
	70 year and Above	4	2.6	2.6	16.4
	less than 60 year	127	83.6	83.6	100.0
	Total	152	100.0	100.0	

Appendix D– Summary Response of Gender

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	67	44.1	44.1	44.1
	1	83	54.6	54.6	98.7
	2	2	1.3	1.3	100.0
	Total	152	100.0	100.0	

Appendix E– Improved Measurement Model Fit Diagram



Appendix F– Path Diagram Regression Weights

			Estimate	S.E.	C.R.	P	Label
BI	<---	PE	.329	.145	2.269	.023	par_12
BI	<---	EE	.139	.134	1.033	.302	par_13
UB	<---	BI	.420	.116	3.622	***	par_14
UB	<---	FC	.056	.099	.565	.572	par_15
PE1	<---	PE	1.046	.105	10.008	***	par_1
EE5	<---	EE	1.000				
EE4	<---	EE	.828	.090	9.163	***	par_2
EE2	<---	EE	.940	.087	10.830	***	par_3
EE1	<---	EE	.848	.097	8.748	***	par_4
FC3	<---	FC	1.000				
FC2	<---	FC	.782	.131	5.983	***	par_5
FC1	<---	FC	1.016	.148	6.849	***	par_6
BI1	<---	BI	1.000				
BI2	<---	BI	1.002	.091	11.053	***	par_7
BI3	<---	BI	1.005	.090	11.122	***	par_8
UB1	<---	UB	1.000				
UB2	<---	UB	.972	.092	10.518	***	par_9
UB3	<---	UB	.844	.087	9.667	***	par_10
PE2	<---	PE	1.099	.100	10.966	***	par_11
PE3	<---	PE	1.000				

Appendix G– Path Diagram Variances Explained

Squared Multiple Correlations: (Group number 1 - Default model)

	Estimate
BI	.311
UB	.178
UB3	.565
UB2	.707
UB1	.714
BI3	.675
BI2	.667
BI1	.716
FC1	.549
FC2	.371
FC3	.379
EE1	.597
EE2	.639
EE4	.488
EE5	.673
PE1	.720
PE2	.743
PE3	.636

Appendix H– Reflection Documents