ABSTRACT

Virtual Assistants are becoming increasingly sophisticated, showing potential as a platform for a variety of collaborative activities in various future context. This exploratory study examines user's intentions to use the Virtual Assistants and the factors associated with the intentions. Based on Technology Acceptance Model (TAM), flow theory, and extended models of TAM, a research model is proposed with seven factors. The model is tested through a survey administered through personal network who have prior experience in using services from Virtual Assistants. Results show that there is significant inter-correlation between all elements of TAM and extended TAM. An analysis from this research found that computer anxiety is an important factor to explain the variation in trust. Results also indicated that perceived ease of use have significant impacts on user's trust and trust is significant direct antecedent to behavioural intentions to use Virtual Assistants. Additionally, computer anxiety and perceived of usefulness are shown as important predictors to behavioural intention of use. Implications and limitations are discussed.

Keywords: Virtual Assistants, conversation, Flow theory, Technology Acceptance Model, Trust

1 Introduction

The victory of Google's AlphaGo in a game of Go with a world champion human player, Lee Sedol was a major milestone in Artificial Intelligence (AI) research. There is a continuous expansion of AI technology not only in complex games, but also widely introduced to various areas nowadays especially in healthcare, entertainment, smartphones, banking and finance, transportation, security, smart home devices and many other industries.

In the past, concerns about the negative consequences of implementation of AI technology in workplace have been raised many times. The debate showed that the societies are still uncomfortable with radial changes caused by disruptive technology, miserable about their future workplaces and fear to be replaced by a machine. Marria (2019) reported many business and individuals are optimistic about the AI-driven shift in the future workforce transformation and believe that AI will bring a positive impact on the economy by creating jobs that require skills set to implement new systems.

Today, we are able to speak with a machine in a natural way like we speak to another human and it could help us to perform a variety of tasks without supervision. Virtual Assistant (VA), also known by various names such as virtual personal assistant, digital personal assistant, conversational interface, mobile assistant, voice assistant, conversational technology or chatbots (McTear, Callejas and Griol, 2016). Nevertheless, the fundamental concept remains the same, that is to execute and achieve some result by communicating with a machine in a dialogic manner using natural language. The two main interaction styles that currently practiced by human to interact with these VA are through voice and text.

The most significant voice-operated intelligent virtual assistants from the Big Four tech giant companies: Google's Assistant, Apple's Siri, Amazon's Alexa and Microsoft's Cortana. Thousands of text-based conversational chatbots with specific functionalities are built by open source for most of the widely used messaging platforms. Many industries believe this technology could revolutionise how we interact with devices, websites and applications in near future.

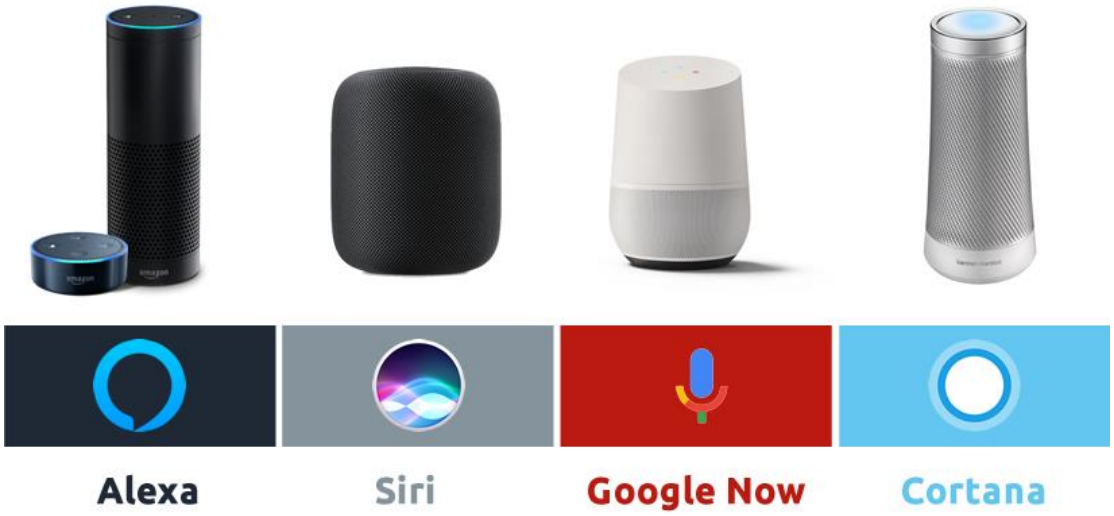

Figure 1. Home assistants and its brand name. Source: https://geeksfl.com/blog/best-voice-assistant/

1.1 Justification, motivation and benefits

With the advancement of Artificial Intelligence, numerous significant inventions such as self-driving cars, smart assistants, banking and finance, music and media streaming, and social media feeds have changed the way human interact with technology. In this ever-changing era of technology, the growth momentum of AI is highly competitive among technology-leading companies, especially Google, Microsoft, Apple, Facebook and Amazon, which have successfully built their respective virtual assistants, using different approaches to design and advance the dialogue system. In early 2016, many industries believed the automated text-based VA has a promising future, but few expected that voice-based VA would thrive. There are many approaches for innovation, learning to fail fast is the key to getting big fast (De Massis, Frattini and Quillico, 2016). In January 2018, Facebook has shut down its text-based virtual assistant, Messenger M which was trained by supervised learning, in which the computer learned its examples through human trainers (Wagner, 2015). Messenger M was initially launched to offer fully automated

suggestions for payments, planning and more through Facebook Messenger. Most of the new technology fail due to lack of users' recognition.

VA has been getting a lot of attention in recent years, but the amount of non-technical research undertaken on VA is limited. In fact, one of the undiscovered problems it faces is sustainability, specifically the relationship between human and machines or computers, to make VA more practical and more enjoyable experience for long term success. As an Interaction Designer, we must consider the other factors of human-computer interaction in addition to language understanding because humans have emotions, feelings, innate cognitive functions and behaviour that makes each individual unique. Designers and developer might overlook the elements that increase sustainability due to lack of a standard framework that contains the fundamental components that lead to the goal.

This thesis will propose a theoretical framework that aims to improve the sustainability of the desired impact of VA. This framework contains the following components: flow, motivation and trust. The proposed framework will help to guide potential work in the fields of AI and VA.

1.2 Research Questions

This master thesis aims to propose a framework that increases the sustainability of human interaction with Virtual Assistants. The research questions and sub-questions to be addressed in the master thesis are:

1. What are the factors that affecting user adoption in using the Virtual Assistants?
2. How can we design a sustainable virtual assistant for customer services?
    a. What factors must be considered in a virtual assistant in order to meet user needs and expectation?
    b. How to design a sustainable virtual assistant with good interaction?

1.3 Planned Contributions

This thesis aimed to contribute to help designers and developers to the understanding of how to design the conversation for humans' interaction with virtual assistants. The research has adopted several theories, specifically flow theory, technology acceptance model and trust framework. Improving the advancement of technology is not enough to fulfil user needs. However, a good interaction theoretical framework with understanding in human aspects are necessary to develop a service or product that has great user experience. Most importantly, as a interaction designer, we should not only focus on creating a new but temporal technology that only engage user for a short period, but aim to design a technology that sustains and evolves.

1.4 Thesis Outline

The rest of this document includes the following sections:

Chapter 2 – Background and Related Work: In this section, theoretical bases of adherence to human motivation, flow theory, technology acceptance model and trust. The role of artificial intelligence and virtual assistants in adherence to future context are discussed.

Chapter 3 – Methodology: In this chapter the research model, research design, competitive analysis and designing a framework of sustainable virtual assistant.

Chapter 4 – Data collection: This section explains the methods and procedures used for data collection.

Chapter 5 – presents the results from the statistical analysis conducted to interpret the results from the questionnaire survey.

Chapter 6 – This chapter includes the discussion of the implementation of the research model, and a discussion and interpretation of the results from the survey research assessing the external Technology Acceptance Model.

Chapter 7 – Limitations and future implementations are also discussed in this chapter.

Chapter 8 – Conclusion: this section offers a summary and the final conclusions taken from the implementation and the evaluation of the factors from the model. The research questions, and hypotheses, will be answered in this chapter.

2 Theory, Background, Existing Literature

Literature review is performed to understand the scope of research related to interaction between humans and Virtual Assistants. To begin, review of previously done researches and studies are crucial to gain insights in the scope of human motivation, why artificial intelligence is important in the future, evolution of user interfaces, human needs, human trusts and flow theory.

2.1 Human motivation – where does it comes from?

Human life is composed by a continuous stream of activities, and motivation is an essential element in every aspect of human behaviour and usually referred as an energising force behind an action (Pinder, 2014). Human motivation is always one of the factors to study when involves behavioural changes in various contexts, which generally discussed in education, entertainment and new technology. Many studies have been conducted to understand how motivation works, that lead the researchers to explore in the different perceptions in terms of psychological value people attribute to their goals, people's anticipations about achieving goals, and the mechanisms that keep people working toward particular goals (Deci and Ryan, 2000).

According to Reeve (2009), motivation studies attempted to answer two primary questions: (1) what causes behaviour and (2) why does behaviour vary in its intensity. Behaviour is observable, but the reasons or causes that underlie behind the initiation of their behaviour. The first question can be prolonged into a series of five specific questions:

- Why does behaviour start?
- Once begun, why is behaviour sustained over time?
- Why is behaviour directed toward some goals yet away from others?
- Why does behaviour change its direction?
- Why does behaviour stop?

(Reeve, 2009)

These five questions have a connection from how a behaviour can change by the start of motivation, persistence that keeps behaviour sustainable, goal directedness and eventual termination. Motivation theory explains the processes of giving behavioural energy and direction, where energy indicates that behaviour has strength and direction indicates that behaviour has purpose (Zhang, 2008). For example, a motive energises a person to hold strong determination to work towards a goal by repeating the same actions or routines; a motive could also direct a person to change his or her behaviour in order to reach a goal.

According to Reeve (2009), there are two clusters of motivation sources: internal motives and external events. Motive is an internal experience and process that energises an individual's approach and directs behaviour which involves needs, cognitions and emotions. Meanwhile, external events refer to the capacity to attract or repel the involvement of an individual to involve or not to involve in specific actions which most likely affect by environment, social and cultural.

2.1.1 Needs and motivation

Needs are a personal condition that is essential to sustaining life and fostering growth and well-being. This serves the organism by inducing demand, desire and effort to motivate any behaviour needed to sustain life and promote well-being and growth. In addition, (Heckhausen and Heckhausen (1991) claimed that as long as the needs remain unsatisfied, it can activate and influence behaviour while behaviour carried out from within an individual are not as motivated in comparison to the external consequences of their satisfaction.

According to Reeve (2009), there are three types of needs: physiological needs, psychological needs and social needs. Zhang (2008) summarises psychological needs are inherent in the operation of biological systems; psychological needs stimulate a proactive attitude and behaviour to discover and to interact in an environment to promote well-being, vitality and growth; social needs activate the emotional and behavioural potential that gained through experience, socialisation and development when responses to a need-relevant incentives.

Table 1. Summary of needs with examples.

Needs	Example
Physiological needs	Thirst, hunger, sex
Psychological needs	Autonomy, competence, relatedness
Social need	Achievement, intimacy, power

2.1.2 Maslow's Hierarchy of Needs

Maslow's theory of human motivation is a motivational hierarchy in psychology consist of a 5-tier model of human needs – physiological, safety-security, belongingness, esteem, and self-actualisation (McLeod, 2017). The 5-tier model can be further divided into two categories: deficiency needs and growth needs. Physiological needs, safety needs, belongingness and love needs, and esteem needs are categorised as deficiency or the basic needs, meanwhile self-actualisation which located at the highest level in the pyramid is known as growth needs.

Maslow's model is based on the principles of relative priorities in motive activation (Heckhausen and Heckhausen, 1991). The theory is depicted as hierarchical levels within a pyramid, where human most basic needs for physical survival are often recognised as the most essential element that motivates our behaviour. An individual must fulfil the lower level of deficit needs before progressing on meeting higher level of growth needs (Maslow, 1943). In other words, an individual will be motivated with determined behaviour to move forward to achieve the higher needs after the lower needs are fulfilled.

Physiological needs are the demand that is usually the starting point of the motivation theory, which covers the biological requirement for human survival such as air, water, food, shelter, warmth and sleep. Maslow considered these basic needs for human survival are the most essential because human body will be unable to function properly if these needs are not satisfied. The next stage,

safety needs signifies the ability of an individual to protect themselves from harm and freedom from fear. Today, human is chasing for better life as a community that values personal security, stability of employment, personal health, and law enforcement.

Furthermore, the third level of needs covers the aspects of social and emotions. Feeling of love and belongingness also refer to the psychological needs, because human are intrinsically social (Young, 2008). From the perspective of social anthropology, human social life is about building friendships and alliances (Mithen, 1996), receiving and giving affection, trust and love (McLeod, 2017). Besides that, Maslow suggested that the need for respect or reputation is utmost important for children and adolescents and takes priority over true self-esteem or dignity. Maslow classified the esteem needs into two categories: (1) esteem for oneself (dignity, mastery, achievements, independence and (2) the desire for reputation for respect from others (status, power, reputation). The result of satisfying the self-esteem needs lead to feelings of self-confidence, worthiness, capability, strength and efficacy of being useful and necessary in the world (Maslow, 1943).

The highest level of the theoretical hierarchy is self-actualisation, it is one of the most difficult needs to define and is more abstract concept compared to the rest. It has been known as an outcome of need satisfaction, and be defined as a value. Heckhausen and Heckhausen (1991) claimed that every need is directed to the accomplishment of this value, the satisfaction of every needs will bring the individual closer to it. Hence, self-actualisation attracts behaviour but the power and demand that it develops are essentially different from the driving effects of needs.

Although the theory of motivation has generated a lot of interest, but it has always been a theory to debate because the theory gathers both criticism and support responses from researchers and scientists. For instance, some critiques claimed that the theory lacks of scientific data as not the theory is not built upon scientific experiment but solely Maslow's observation and ideas on human needs and motivation (Gawel, 1997). Besides that, Yang (2003) criticised that the theory is culturally biased as the double-Y model (collectivistic needs and individualist needs) signifies that it is systematically attempted to integrate the biological and cultural influences on basic motivational state and tendencies, both theoretically and empirically. On the other hand, some

argued that the theory is gender biased (Cullen and Gotell, 2002) but some think that it is related to both genders (Coy and Kovacs-Long, 2005).

"Motivation theory is not synonymous with behaviour theory. The motivations are only one class of determinants of behaviour. While behaviour is almost always motivated, it is also almost always biologically, culturally and situationally determined well." (Maslow, 1943)

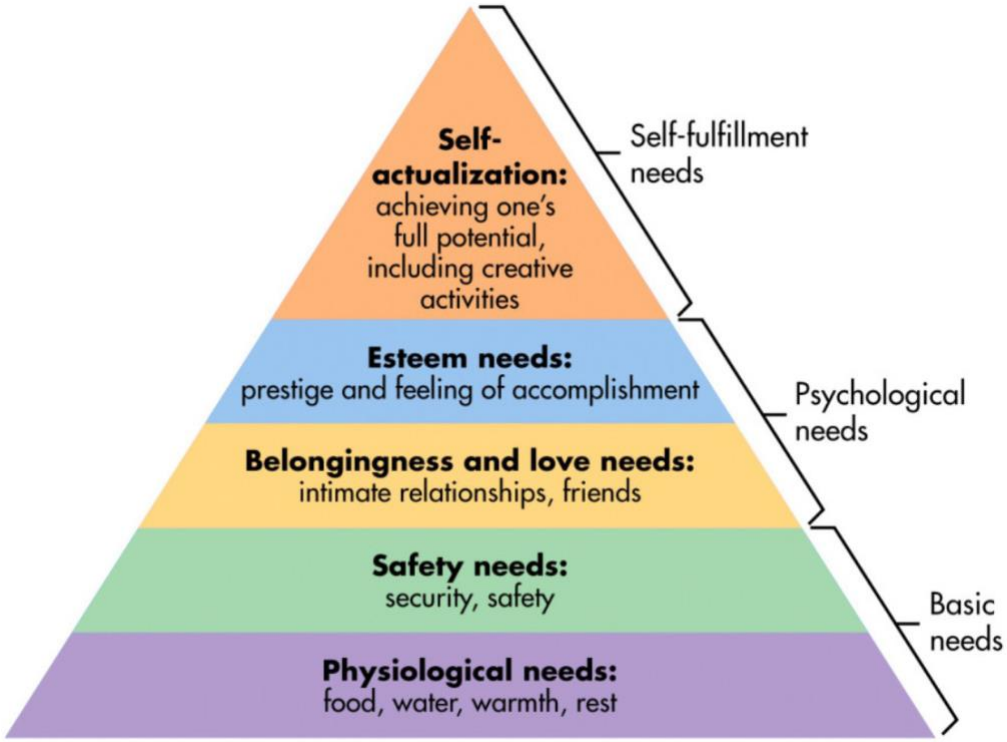

Figure 2. The original 5-tier hierarchy of needs.

2.2 Interaction and User Interfaces

In the past few decades, software engineers have developed different types of interfaces to interact with various computer systems, which have had significantly influence user behaviour interacting with new technologies like touch gesture and voice command (Myers, 1998).

2.2.1 Conversational User interface

A conversational-based interface offers a more natural way of interaction with a computer system in comparison to a traditional graphic user interface. A conversational interface supports the ability to interact with computer system, by mimicking the way human interact with each other. Computer systems attempt to understand natural language sentences and operate on user input (Zue and Glass, 2000). According to Bieliauskas and Schreiber (2017), there are different types of conversational-based interfaces: Assistant systems and Chatbots.

a) Assistant systems

   The assistant system is a more typical software agent than the chatbot in most of the use cases. The assistant systems tend to direct the problems to the right subsystem instead of solving problems by themselves (Klopfenstein *et al.*, 2017) and the assistant platforms are opened to integrate with third-party functions. For instance, Google provided an open-source platform for software developers, as well as a programming interface that requires simple programming to integrate custom application into Google Assistant.

b) Chatbots

   With the rise of messaging platforms such as Skype, Slack and Facebook Messenger, where these platforms allow the integration of third-party software components via API. Besides that, chatbots act in a variety of ways like human in a chat conversation. Chatbots respond to natural language sentences and try to manipulate them based on users' input. Typically, chatbots are designed for more specific tasks than assistant systems. For example, a customer service chatbot from a bank will only be able to answer questions related to banking and financial services, meanwhile an assistant system would be able to handle any type of questions as it is connected to a larger database. During a conversation, the chatbot

tracks the context to perform more complex operations (Zue and Glass, 2000), like the weather bots use information gained from previous request to get a new request without asking the user's location again.

2.2.2 The Evolution of User Interfaces

Table 2. Wixon (2008) proposed four progressive interfaces and their respective characteristics (Hinman, 2012).

	CLI	**GUI**	**NUI**	**OUI**
Characteristics	Static	Responsive	Evocative	Fluid
	Disconnected	Indirect	Unmediated	Extensive
	High - Low	Double Medium	Fast Few	Constant Zero
	Directed	Exploratory	Contextual	Anticipatory
	Recall	Recognition	Intuition	Synthesis

1. Command Line interfaces

Command line interfaces (CLIs) are generally considered as the first generation of computer interfaces. CLIs reflect the philosophies and attributes of ancient Greek Classicism by creating a static paradigm based on classification premise (Hinman, 2012). The text-based interfaces are built around the psychological function of recall which require users' memory to learn the text-based commands in order to manipulate the computer's functionality. Each command line is unique in calling out different functions and the system will not respond if there is any mistakes in the command line. In addition, user's interaction with the system via command lines leaves a disconnected and abstract experience towards the computer. CLIs have a lot of commands but fewer ways to interact with the system.

2. Graphical User Interfaces

Graphical user interfaces (GUIs) use graphics as information representation that built around the psychological functions of recognition. Instead of memorising system commands like CLIs, users can easily explore and interact with computer system via graphical icons, menus and floating tool palettes. A GUI is a virtual world for information to live in and interact with, incorporating visual interfaces and interaction languages that represent information as a physical object and rules of physics that reflected the real world (Hinman, 2012). GUI systems offer a high number of accessible commands and supplemented by indirect responsive interactions using a mouse and a keyboard. This enhance the double medium interaction experience for users. GUIs reflect ideas and attributes of Newtonian science by focusing on how things are built and worked, by relying on the principles that all objects have absolute quality in complete time and space.

3. Natural User Interfaces

Based on the GUI concept, a graphic or an icon represents an information object, while the natural user interfaces (NUIs) describes information as objects in space. Unlike GUIs practice of what you *see* is what you *get*, NUIs rely on human innate senses to the physical world, where what you *do* is what you *get*. The term "natural" in design referred as the way users with and feel about the product, or more precisely, their behaviour and feeling while using the product (Wigdor and Wixon, 2011). Furthermore, NUIs are highly contextual because the systems are based on contextualism where there are no absolutes. Besides, the systems understand and respond to the environments which they are located. NUIs offers fast and minimal interactions based on the natural attributes of the object and user's expectations upon its behaviour. The invention of touchscreens also created unmediated interactions, provide users with the ability to interact with information in a direct and natural manner (Hinman, 2012).

4. Organic User Interfaces

Organic user interfaces (OUIs) use the natural morphologies as inspiration for designs. OUIs are typically operated by multi-touch and bi-manual gestures which offer flexibility to transform data on display through deformation, either manipulation or actuation (Holman and Vertegaal, 2008). In order to develop an interface that is principally organic, Vertegaal and Poupyrev (2008) introduced three principles that underlie OUI: 1) input equals output – the input and output in OUI devices are combined into one, rather than the current point-and-click planar system, where input and output devices are separated; 2) form equals function – the display can be any shape but the shape of the display should carefully match with the functionality of its graphic; and 3) form follows function – the shape of the display should be changeable by dynamically adapting its usage flow rather than remain static.

2.3 Artificial Intelligence and Virtual Assistants

2.3.1 Definition of Artificial Intelligence

Artificial Intelligence has developed immensely in the recent years, accompanying the improvement in the speed of calculation, the expansion of storage capacity and the advancement of network technology. Artificial Intelligence is a technology that uses a computer to model intelligence behaviour with minimal human interference (Hamet and Tremblay, 2017). A simple understanding from the phrase, "artificial" basically means man-made or duplication of something natural; while "intelligence" involves the knowledge of thinking, reasoning, consciousness, etc. Theoretically, Artificial Intelligence is to use computer to simulate human consciousness and thinking process so that the computer can do things that can only be done by relying on human intelligence.

With regards to Artificial Intelligence, there are two definitions. One is technological: to study how to make a computer and program it so that it can do what the human mind can do. The other is scientific: treat Artificial Intelligence as general intellectual science, or more precisely, the intellectual core of cognitive science (Boden, 2016). The development and popularisation of Artificial Intelligence systems will definitely affect the way human live.

2.3.2 Artificial Intelligence and Industry 4.0

In history, every technological advance has caused tremendous changes in the structure of human society. The explosive development of Artificial Intelligence will certainly affect the existing form of human society. As a future disruptive technology, Artificial Intelligence is gradually penetrated into various industries, which has also brought significant development opportunities for commercial Artificial Intelligence. Nevertheless, Schwab (2017) described The Fourth Industrial Revolution, also known as Industry 4.0, as the fusion of all new and current technologies interact across the three aspects: biological, digital and physical.

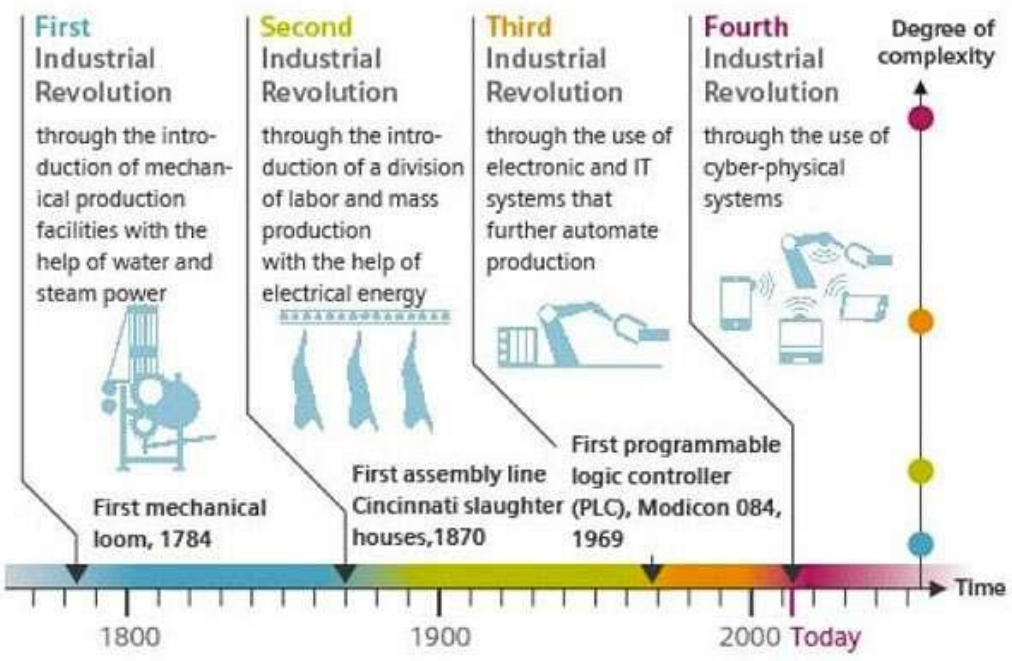

Figure 3. Timeline and roadmap rom Industry 1.0 to 4.0. Source: DFKI (2011)

Digital technology is the major driving force for The Fourth Industrial Revolution which mainly manifested in four aspect, namely digital platforms, big data and cloud computing, machine learning and Artificial Intelligence, and Internet of Things (Li, Hou and Wu, 2017). Today, Artificial Intelligence products have been widely popularized and entered millions of households as well as thousands of industrial productions. Kumar and Kumar (2013) explain that human/ user and workplace/ environment are the non-technological factors that influence Industry 4.0, as shown in figure 2 below. Therefore, understanding of the efficiency of interaction between human and machine is crucial in creating a more effective production system.

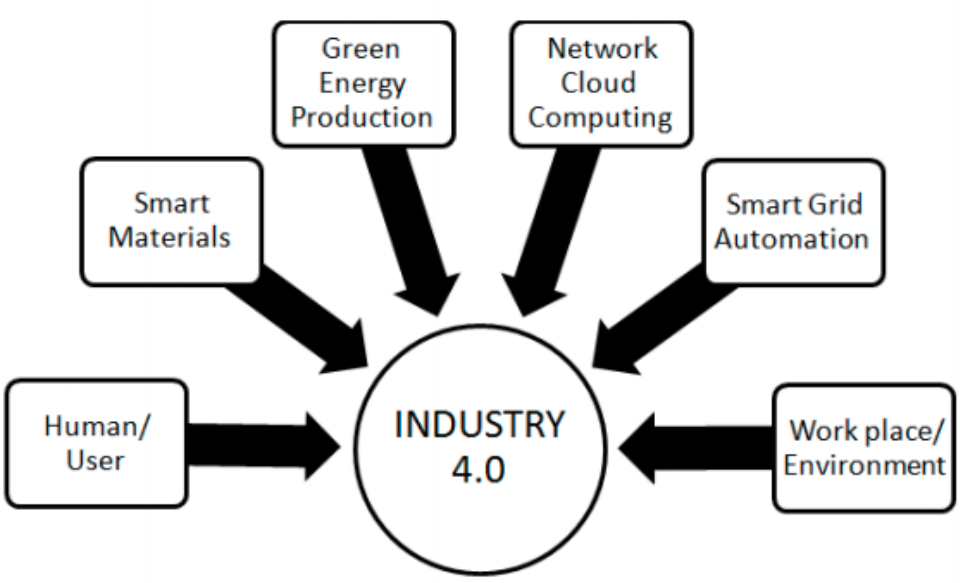

Figure 4. Influential factors in Industry 4.0.

2.3.3 Artificial Intelligence and interaction design

Today, the development of Artificial Intelligence is still in the stage of "weak AI" which is still far from the ideal. The most recognition of Artificial Intelligence product by consumers are Intelligent Voice Assistant, which is also a Virtual Assistant that interact by voice. Most people think that Artificial Intelligence is equivalent to Intelligent Voice Assistant. In fact, the gap between the two is still very large. Intelligent Voice Assistant is just one aspect of Artificial Intelligence products,

in addition to that, Artificial Intelligence also includes computer vision, machine learning, deep learning and many more. Intelligent Voice Assistant is certainly the most natural way of interaction

Based on AI technology, the interaction is moving move from graphic user interface (GUI) to conversation user interface (CUI), but the current voice interaction is one-way as there can only be one round of questions and answers between the human and the machine. This causes unsatisfaction in the overall user experience as the conversational technology has not reach the advancement to solve users' problems.

Multiple rounds of dialogue between people and machines involve technological innovations, but further design improvement is required in the GUI. The interface is designed to achieve a good user experience and enhance the engagement of the product. Communication between people and machines is not as cold as it used to be. The current user interface adds "emotion" and allows users to talk to friends while in use. However, the current AI products have not been able to achieve such an effect. The user still treated the machine as a machine while in use and does not have strong emotional communication.

2.2.4 Virtual Assistant: What do we know?

The virtual assistant (VA) is a specific software feature that originally conceived in a "desktop" computing environment to assist users in learning and operating an exclusive software package (Lugano, 2017). A typical example is the Microsoft Office Assistant, popularly known as "Clippy the Paperclip", which is an interactive animated character that proactively assist users to complete their tasks better or easier while using Microsoft Office. Lugano (2017) claimed the core purpose of virtual assistant was to increase users' productivity and efficiency with a specific product. In the past decades, much research has been done on virtual assistants for desktop computing in the context of user interfaces as well as debated over the practicality of virtual assistants. A design framework for virtual assistants investigated by Swartz (2003), has identified the major roles of virtual assistants which are provide proactive help, help query in natural language and being the "voice" of the program. The study also provides recommendations to enhance social acceptance:

- The need to obey human rules of etiquette as much as possible
- Deliberate the agent's tasks in its social context
- Consistent appearance and behaviour of the agent
- Explore ways to use agents to teach user skills
- Measure the benefits of using anthropomorphic agent or not.

2.4 Flow

By definition, flow is known as the mental state of operation, in which the engagement of a person in an activity is entirely immersed in the feelings of full attention and concentration, high degree of participation, and total enjoyment in the process of an activity (Han, 2016). In flow, emotions are not just controlled and guided, but optimistic, energetic and aligned with the performing task. Furthermore, the flow theory also explained there is no room anything else except deep focus on the on-going task of a person and not even distracted by one's emotion (Csikszentmihalyi, 1998). The preforming task brings enjoyment and pleasure to an individual who is into the flow. The feelings of enjoyment and pleasure in life are essential to create satisfaction after achieving a goal.

Csikszentmihalyi (2008) stated "the experiences that give pleasure can also give enjoyment buy the two sensations are quite different." Pleasure is a feeling of contentment when the information in consciousness indicates that the expectations of biological programs or social conditions are met. Csikszentmihalyi (2008) also emphasised pleasure is an important element for quality of life but itself solely does not bring happiness. The basic needs like sleep, rest, food and sex provide restorative homeostatic experience that return consciousness to order after the needs of the body interrupt and cause psychic entropy. For instance, when we are hungry, the taste of food is pleasant because it reduces the physiological discrepancy; the companionship of a friend is pleasant because we feel connected with another person and values friendship. However, these needs do not produce psychological growth as they do not add complexity to themselves. Therefore, pleasure helps maintain order, but itself cannot create new order in consciousness.

People tend to move beyond pleasant memories and begin to remember other events or experiences that overlap with enjoyable ones when they consider further about what makes their lives rewarding. This phenomenon can be explained with enjoyment – an enjoyable event occurs when a person not only meets certain prior expectations or fulfils a need or a desire, but also exceeds what he or she has been taught to do and achieves unexpected events or something that was previously unimaginable. Moreover, enjoyment is characterised by a sense of novelty, with accomplishment as forward movement (Csikszentmihalyi, 2008). It can be making food with new recipes or reading a book that is inspiring, as well as ending a closing a meeting with great ideas or basically any work well done, is enjoyable. These experiences are not particularly pleasant in the beginning of an activity, but when the tasks are completed, we feel a sense of accomplishment.

The eight major components in Flow experience

Csikszentmihalyi (2008) conducted an extensive research regarding the causes of enjoyable experiences based on questionnaires, interviews, review of previous studies and observations over a dozen years from thousands of respondents around the world including USA, Europe, Japan, Korea, Australia, Thailand and a Navajo reservation. In addition, the study was conducted to investigate what are the core elements that make an experience enjoyable, and the results show that human can experience enjoyment in many different ways but the way they describe enjoyment for their actions are very similar, regardless of gender, age, social class, stage of modernization or culture. In other word, the optimal experience, also known as flow, the feeling of enjoyment is similar all around the world regardless of the type activities.

A significant result of Csikszentmihalyi's work suggested there are eight major characteristics in Flow experience, includes the following:

a) A challenging activity that requires skills
b) The merging of action and awareness
c) Clear goals an feedback
d) Concentration on the task at hand
e) The paradox of control

f) The loss of self-consciousness
g) The transformation of time
h) The autotellic experience

2.5 Trust

Trust has been a subject of ongoing research for decades, and there is still no general definition for it. The characterisation of trust is often discussed in diverse fields of research, ranging from sociology, psychology, economics, philosophy and human factors or human-computer interaction tried to develop ways to conceptualise trust in respective background. (Mayer, Davis and Schoorman (1995) defined trust as a "willingness of a party to be vulnerable to the action of another party based on the expectation that the other will perform a particular action important to the trustor, in respective of the ability to monitor or control that other party" (p. 712). Their initial conceptualisation of trust was unidirectional as they did not explore the reciprocity in trusting relationships and this lead to the extended study that concluded "trust is not mutual and not necessarily reciprocal (Schoorman, Mayer and Davis, 2007). In social psychology aspect, Lee and See (2004) defined trust as "the attitude that an agent will help achieve an individual's goals in a situation characterized by uncertainty and vulnerability." (p. 51). Both definitions showed commonality in their reasoning by emphasising the willingness of an individual to participate in a context or achieving a goal of another party.

On the other hand, (Hoff and Bashir, 2015) found three common components in definition of trust across various field of research: (1) trust must be mutual with one party provide trust and another party accept trust to achieve something, (2) trustee must have reward to perform the task, (3) risk and uncertainty must be expected if the trustee fail to perform the task. These three components of trust are applicable to both interpersonal and human-computer relationships.

2.5.1 Trust in technology

In the most elementary level of communication, trust is an adhesive that connecting people as it can be explained based on our experiences from organisations, communities, governments, cultures,

societies and nations. Nonetheless, trust is not limited to the field of interpersonal relationships between humans, but it also defines how people interact with technology in a variety of ways. Building trust between human and machine can be different from trust between humans, however Hoff and Bashir (2015) affirmed that there are parallels exist between the two. Numerous studies have found more specific similarities in different dimension of science. For example, Parasuraman and Riley (cited in Hoff and Bashir, 2015) found that human's trust in machine systems is because they trust in the designer of the system and Nass and Moon (2000) studied on social responses to computers and claimed that people learned social rules when interacting with machines. In contrast, the differences between interpersonal trust and automation trust claimed by Lee and See (2004) are machines lack of emotions, loyalty, intentionality, compassion and values that are crucial to the development of trust in humans.

2.6 Summarising the literature review

In general, technology gives the impression of inorganic, mechanical, electronic, automatic, structural, inhuman, unemotional, non-thinking and asocial. Conversation with technology, especially Virtual Assistants, seem different from human-to-human conversation because human social interaction includes contrast spontaneous, intricate, active, lived, mindful, sociable and deeply interpersonal (Hutchby, 2013). Indeed, the most significant fact that distinguishes human beings from other species is our capability of extend the use of language in the form of conventional conversation – expressing ourselves, thoughts, desires and interests, while other species use comparatively complex forms of symbolic communication. Table 3 summarises the mapping of flow theory and technology acceptance model.

The technology today is mimicking the innate capability of human beings. Although these conversational technologies have not yet achieved a particularly high levels of conversational sophistication, but it is noticeable that speech-generating computers and artificial intelligence systems are gradually implemented in information search and some other basic services. Moreover,

designers of these advance technologies are aggressive to build computer systems that could 'hang' conversations with humans by focusing on the technical system rules, linguistics and usability.

The presented framework for Sustainable Virtual Assistant (SVA) considers fundamentally three background theories that draws on Flow elements from Csikszentmihalyi (2008), Trust framework from Corritore, Kracher and Wiedenbeck (2003) and Venkatesh's (2000) extended Technology Acceptance Model (TAM). The SVA framework is user-oriented, starting by define and identify the users' relatedness, autonomy and competence, based on the SDT framework. When the user achieves goals and master a particular objective, he or she will be able to maintain their interest in using the Virtual Assistants. To realise that, designers should focus on building meaningful goals to the users, by selecting fundamental elements that could help users gain interest, engage and improve their situation.

Table 3. Mapping elements of flow (Csikszentmihalyi, 2008) to elements of extended Technology Acceptance Model (Venkatesh, 2000).

Flow elements	**TAM**
Clear goals and instant feedback	Perceived usefulness
Balance between level of challenge and personal skill	Perceived ease of use
Merging of action and awareness	Behavioural intention
Sense of potential control	Perception of external control
Loss of self-consciousness	Perceived enjoyment
Time distortion	Computer anxiety
Autotelic or self-rewarding experience	Computer playfulness

3 Methodology

This section briefly presents all the methodology and methods used in this research project, supplementary information on how these methods were practically applied during the design process are explained in the next chapter.

3.1 Research model and hypothesis

Based on TAM, flow theory, trust theory and extended TAM theories, the research model examines seven variables: PEOU (Perceived Ease of Use), PU (Perceived Usefulness), PE (Perceived Enjoyment), CP (Computer Playfulness), CSE (Computer Self-Efficacy), CA (Computer Anxiety), and BI (Behavioural Intention) to use Virtual Assistants. The relationships among the variables are depicted in Figure 5.

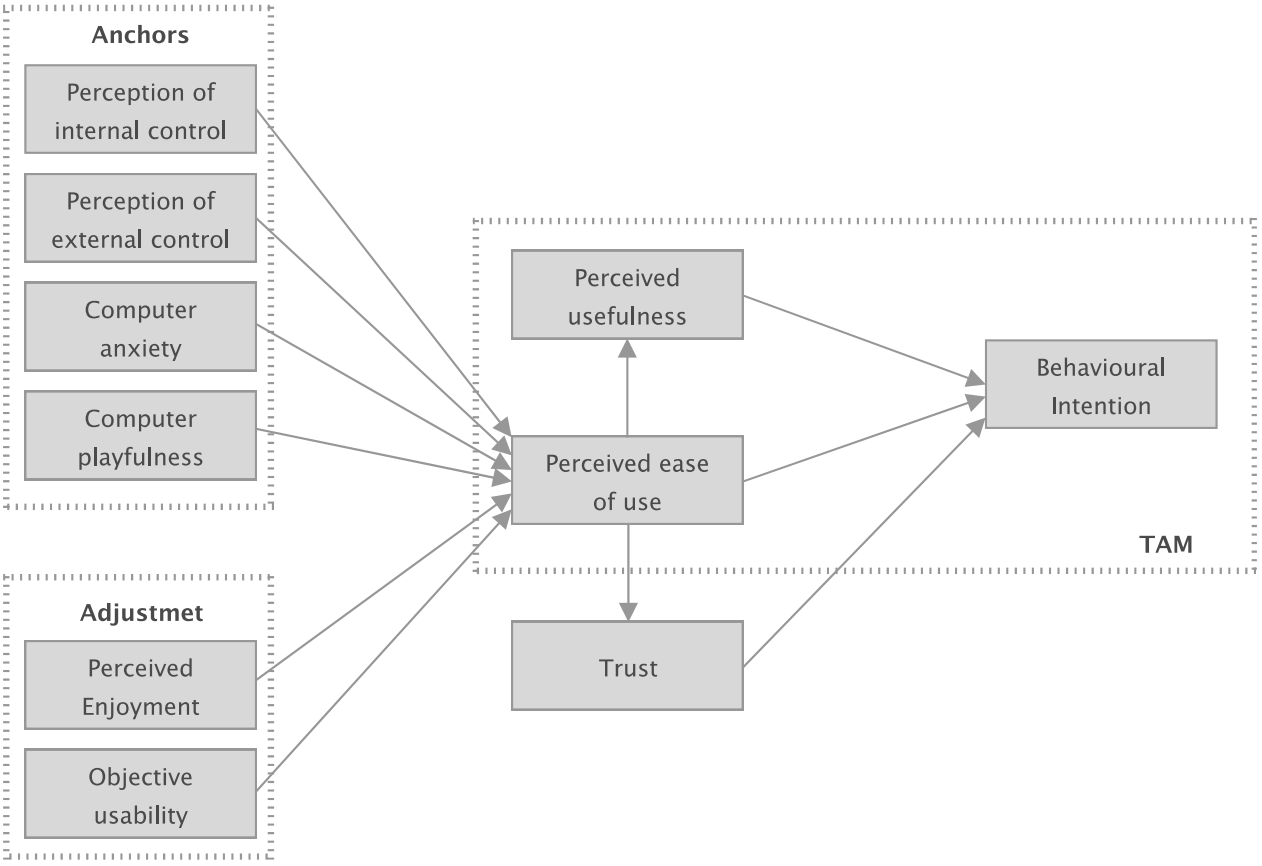

Figure 5: Research Model

Since numerous research have studied on TAM (Davis, 1986) and extended TAM (Venkatesh, 2000), this thesis will only focus on the addition of new element of trust, as the following hypotheses:

H1. Perceived ease of use will positively affect trust of Virtual Assistants.

H2. Trust will positively affect behavioural intention of Virtual Assistants.

3.2 Research design

The research design of this thesis was based on mixed-methods research which involves both quantitative and qualitative research strategies in order to consolidate the conclusions of these data into a cohesive whole (Leedy and Ormrod, 2015). In order to develop a sustainable Virtual Assistant, it is essential to learn the features and functions of the Virtual Assistants that available in the market as well as the user experience. As Baxter, Courage and Caine (2015) claimed that the product information gathered in competitor analysis not only beneficial to understand the existing products in terms of features, users and competitors, but also helps to avoid time wasted on duplication of work.

A descriptive research design was carried out in two parts. The first part involved quantitative data collection was implemented via an online survey to identify the current user experience of Virtual Assistant, the identified factors were investigated and measured through the respondents' responses to the questionnaire. The second part which is the exploratory part, involved a data collection from the questionnaire, where participants are requested to describe their feelings and thoughts based on their experience interacting with the Virtual Assistants.

3.3 Competitive analysis

Competitive analysis was carried out to understand the latest trends of Virtual Assistants in current market by listing "the features, strengths, weaknesses, user base, and price point for your

competitors" (Baxter, Courage and Caine, 2015). Table 4 summarises the analysis of Google's Assistant, Amazon's Alexa and Apple's Siri based on respective official websites and technology review websites.

Table 4. Competitive analysis.

	Google Assistant	**Amazon Alexa**	**Apple Siri**
Specialisation	- Entertainment - Productivity - Communication - Personalisation - Smart home	- Productivity - Smart home - Shopping - Entertainment - Communication - Personalisation	- Entertainment - Communication - Productivity
Interaction	- Voice - Text	- Voice	- Voice
Strengths	- Intelligence and accuracy - Advancing quickly - Google compatibility - Voice recognition	- Engagement - High competence - Voice recognition	- Language support - Large music library
Weaknesses	- Feeling of being monitored - System unstable	- Weaker natural language processing - Low availability	- Limited functionality - Weak voice recognition - Weak natural language processing

Skills	- Customisation of information and actions - Perform task upon user request.	- Can create custom skills and respond - Third-party-created skills available in skills library	- Basic command for operation from smartphones
Users	- Support single to multiusers	- Support multiuser and recognise individual voices and offer personalised information to respective accounts	- Support single to multiusers

3.4 Designing a Sustainable Virtual Assistants

In order to develop a new framework for sustainable interaction design between human and virtual assistants, understanding the design of the technology and its relationship with human as the user are essential. This chapter establishes on the previous three chapters to present and validate the framework. Chapter two formed the foundation for the theory based on the literatures and existing theories across multiple disciplines that supports human cognition and behaviour.

3.4.1 Technology Acceptance Model

The Technology Acceptance Model (TAM), formulated by Davis (1986) to predict user acceptance of computer-based information system. The TAM consists of six diverse yet causally related

conformation, including external variables, perceived ease of use, perceived usefulness, attitude towards using, behavioural intention to use and actual system use. TAM has been successfully tested in numerous studies across a wide range of applications, and it is now commonly recognised as a valuable tool for predicting intentions to use an information system. In order to design a user-centric system, the model is essential for designers "to improve our understanding of user acceptance processes, providing new theoretical insights into the successful design and implementation of information system." (Davis, 1986).

Furthermore, Davis, Bagozzi and Warshaw (1989) stated the main purpose of TAM is to provide a basis for tracing the influence of external factors on internal beliefs, attitudes and intentions. External factors include system characteristics, user engagement in design, training and the nature of implementation process (Venkatesh and Davis, 1996). Figure 6 shows the model, external variables influencing two specific beliefs, *perceived usefulness* and *perceived ease of use* are the main correlations of computer acceptance behaviour. Perceived ease of use is the extent to which potential users expect the target system to be effortless. Perceived usefulness is defined as the subjective probability of the prospective user that using a specific application system will increase his or her job performance in an organizational environment (Davis, Bagozzi and Warshaw, 1989). As stated by Davis (1986), both perceived of usefulness and perceived ease of use are predictors of user attitude toward using based on user's evaluation of desirability in using a system. Additionally, he also explained attitude towards using and perceived usefulness potentially influence user's behavioural intention to use the system. Finally, the actual use of system is predicted by behavioural intention to use.

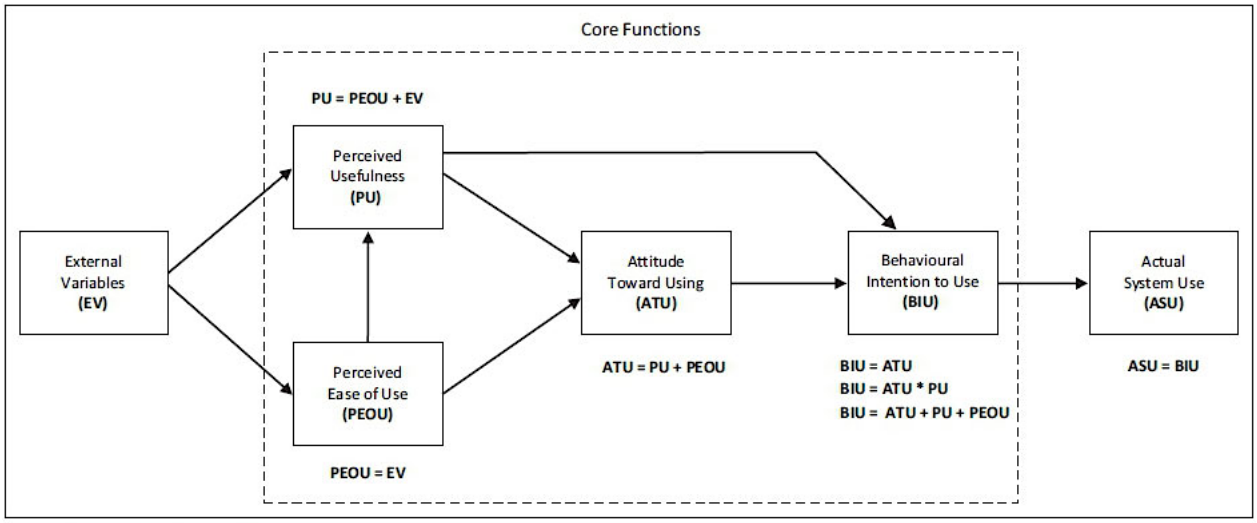

Figure 6: Technology Acceptance Model. Adapted from Davis (1986).

3.4.2 Determinants of Perceived of Use

Previous research has determined that perceived ease of use as an essential factor affecting the acceptance and usage behaviour in information technology users. In fact, the decision-making process is absent from the TAM, in order to explain whether a user is to accept, to adapt and to use the designed system. Venkatesh (2000) discovered that very few studies have been able to understand how this perception develops and changes over time. His research proposes and tests a theoretical model of the determinants of system-specific ease of use based on anchoring and adjustment from behavioural decision theory.

In the absence of specific knowledge, heuristics indicate that individuals tend to rely on general information as an "anchor". However, Venkatesh (2000) claimed that users often fail to ignore this anchoring information in the decision-making process. He also stated that users are expected to anchor their system-specific ease of use of a new system to their general beliefs in computers and computer usage before directly experiencing the target system. Users are expected to adjust their system-specific perceived ease of use to reflect their interaction with the system as the system experience increases. On the other hand, based on previous experience with other systems, it is

expected that the initial anchor points for perceived ease of use are individual difference variables and general beliefs about computer systems (Venkatesh, 2000).

Figure 7 presents the theoretical model of the determinants of perceived ease of use, constructed in relation to control, intrinsic motivation and emotion as general anchors that identify perceptions about the ease of use of a new system. Control is a structure that reflects contextual factors or behavioural constraints (Ajzen, 1985, as cited in Venkatesh, 2000). Venkatesh (2000) claims that control relates to an individual's perception of the availability of knowledge, resources and opportunities required from the specific behaviour. Control is divided into perceptions of internal control which conceptualised as computer self-efficacy and perceptions of external control which conceptualised as facilitating conditions.

Moreover, there are two main classes of motivation: intrinsic motivation and extrinsic motivation. As stated by Gagné and Deci (2005), intrinsic motivation, also known as autonomous motivation, endorsing one's action with sense of volition and at the highest level of reflection. Extrinsic motivation relates to execution behaviour towards achieving specific goals or rewards (Deci and Ryan, 1987). Conforming with Venkatesh (2000), extrinsic motivation is represented by the perceived of usefulness construct in TAM but intrinsic motivation was not considered in the model. Therefore, he proposes the role of intrinsic motivation in relating to computer playfulness in general system usage context. The emotional aspects of technology use is expected to be captured through computer anxiety, defined as "an individual's apprehension, or even fear, when she or he is faced with the possibility of using computers" (Simonson et al., 1987, as cited in Venkatesh, 2000).

Computer self-efficacy, facilitation conditions, computer entertainment, and computer anxiety are system-independent anchoring constructs that play a key role in shaping the perceived ease of use of new systems, especially in the early stages of the user experience system. As experience increases, system-specific perceived ease of use is expected, while still anchored on general beliefs about computer and computer use, will be adjusted to reflect objective usability, perceptions of external control exclusively to the new system environment, and system-specific perceived enjoyment.

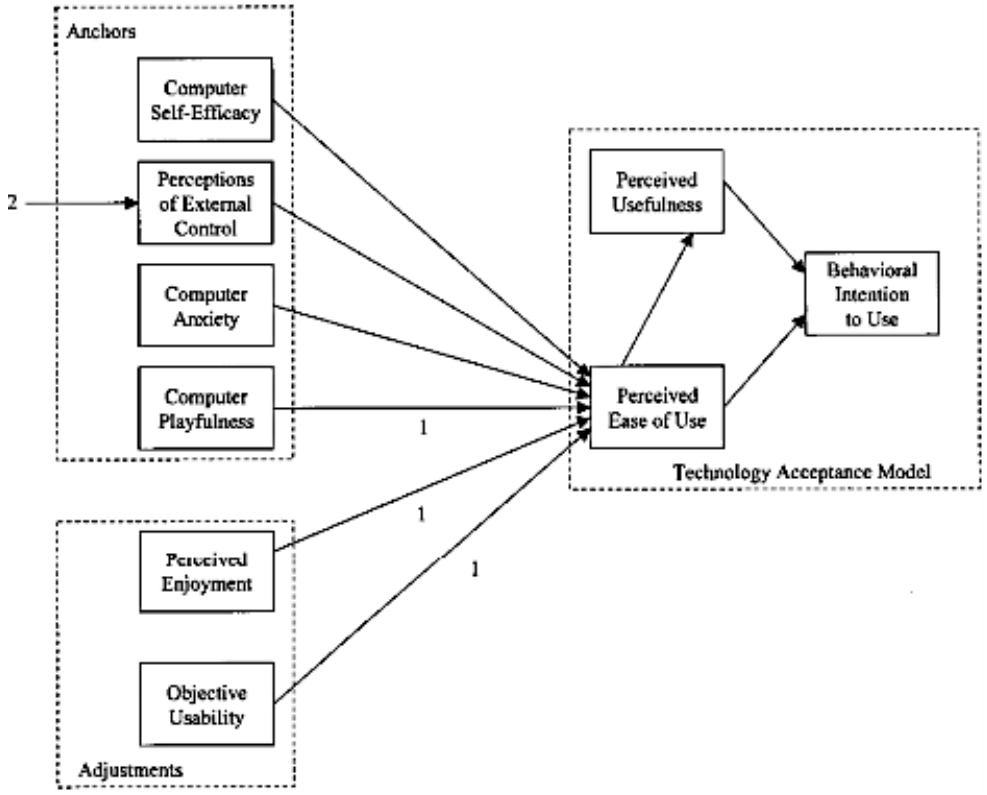

Figure 7. Theoretical model of the determinants of perceived of use. Adapted from Venkatesh (2000)

3.4.4 Flow at conversation

The eight elements of the Flow theory by Csikszentmihalyi are essential to create optimal experiences for the users. In human-computer interaction design for Virtual Assistant, the concept of flow can be associated to positive affect that the Virtual Assistants create to the users. Major components such as clear goals, feedback, concentration on the task, accomplishment of tasks, disappearance of sense of self whilst in the flow, effortless involvement, and amendment of the notion of time. In addition, the flow theory has been studied in many researches related to games, virtual world as well as educational and social context, which primarily focused on user engagement and motivation.

The interaction or communication between human and Virtual Assistant is conversational. Social interaction with human is least predictable, whereas the conversation will be exciting or boring, we would not know unless we keep the flow going. Flow tends to occur when people feel that they are fully involved in one activity, that includes four components: control, interest, attention and curiosity (Csikszentmihalyi, 2008). Firstly, control is enhanced by providing goal-oriented activity and delivering feedback to the user. An optimal conversation happens in two-way, as it "involves finding some compatibility between our goals and those of the other person or persons, and becoming willing to invest attention in the other person's goals." (Csikszentmihalyi, 1998). These aspects result in allowing users to develop concentration and attention into a specific activity, as Csikszentmihalyi (1998) explains "each of the flow-producing activities requires an initial investment of attention before it begins to be enjoyable." In terms of social flow, our attention become structured by external demands and foster the growth in level of both challenges and skills when we interact with another person or stranger. Furthermore, interest is forthrightly related to the user's ability to avoid external influences, improving one's concentration and attention. Additionally, curiosity is supported by the ability to promote discovery and creativity, bringing new realities to individuals. AlMarshedi, Wanick Vieira and Ranchhod (2015) stated these four aspects placed autonomy, feedback, motivation, meaningful goals, novelty and concentration as important elements in implementing a flow experience.

In the context of using Virtual Assists, flow has been studies and identified as a possible measure for virtual contexts, such as virtual world and online context. It is undeniable fact that human interaction with technology, no matter in games or conversations, are unique experience for users. Flow experience was concluded by Hsu and Lu (2004) plays an important role in user intentions and engagement in playing entertainment technology where usability is enhanced through dialogue, social interaction, accessibility and system navigation.

3.4.5 Trust in Virtual Assistants

The framework of Corritore, Kracher and Wiedenbeck (2003) is a regularly cited framework addressing trust in interaction within online or virtual context. Virtual Assistants represent an interactive system that depending on online user interfaces and voice commands which are

intangible for the users. The online trust model introduced by Corritore, Kracher and Wiedenbeck, 2003) consist of two categories of factors that impact the level of trust of an online user: external factors and perceived factors (Figure 8). the external factors are claimed to be in the facet of environment, physically or psychologically, connecting a specific online trust condition. Possible external factors associated to a trust condition include the level of risk, level of control for user interactions, and characteristics of the user interface such as navigational architecture, structure of information and interface design elements (Corritore, Kracher and Wiedenbeck, 2003).

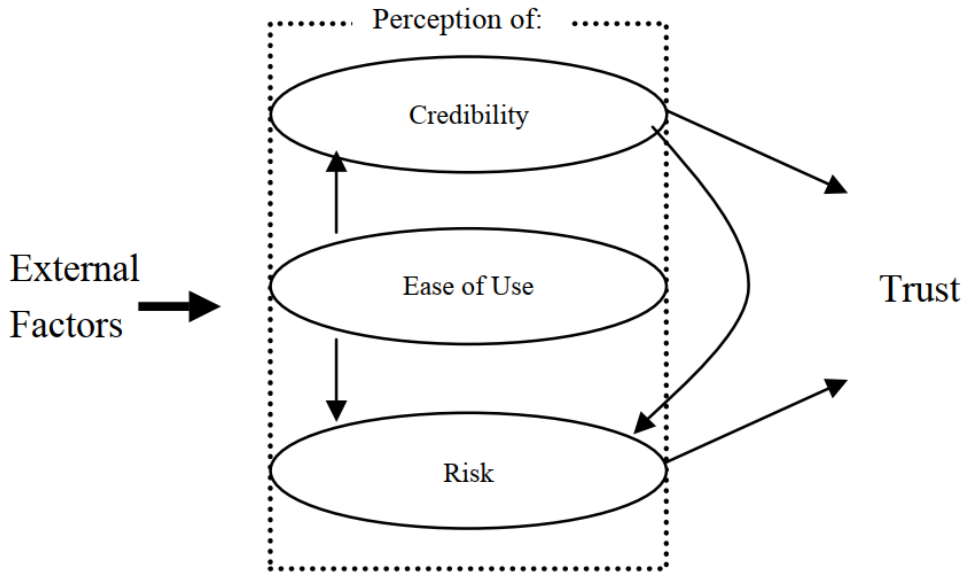

Figure 8. Model of online trust

The model has proposed three perception external factors, specifically ease of use, credibility and risk can influence the user's decision to trust in an online context. Firstly, ease of use from the framework by Corritore, Kracher and Wiedenbeck (2003) is incorporated from Technology Acceptance Model (TAM), which is a model that describes factors required for human to use technology. Venkatesh and Davis, (2000) believe that ease of use is based on a person's general computer self-efficacy and is adjusted by using direct behavioural experience of the target system to consider the objective availability of the system. A study conducted by Gefen, Karahanna and

Straub (2003) in e-commerce proved that perceived ease of use to be associated with increased trust of the consumers.

Secondly, risk is considered a key factor in trust because users' perception of risk is closely related to their trust as well as the intention of use. In the context of sharing personal information on a website or to a Virtual Assistant, perceived risk can be low, even though issues related to being hacked, waste of time, or getting wrong answers may occur. But, when Virtual Assistants become more advance and involve higher level of user engagement, the risk is undoubtedly higher when the users started to feel insecure. In this case, many researchers believe that trust is an important consideration in developing or designing virtual service platform like e-commerce, banking services and Virtual Assistant.

Thirdly, Corritore, Kracher and Wiedenbeck (2003) claimed that credibility is one of the three perceived factors that influence users' trust in an online context. Credibility gives a reason for trust and function as a positive signal of the reliability in the object. The perceived factor credibility is further divided into four dimensions: honesty, expertise, predictability and reputation.

Majority of the research use expertise and trustworthiness and expertise to define credibility. On the other hand, honesty is a synonym of trustworthiness (Fogg and Tseng, 1999). The term is explained as an aspect of credibility that captures the perceived good or morality of the source. Expertise is another dimension of credibility captures the perceived knowledge and skills of source. In relation to Virtual Assistant, expertise refer as will be the perceived knowledge or competence that plays a plausible factor to impact users' trust in using the service of Virtual Assistants. In the perspective of human-computer interaction, Fogg and Tseng (1999) concluded "highly credible computer products will be perceived to have high levels of both trustworthiness and expertise."

Moreover, predictability mentioned by Corritore, Kracher and Wiedenbeck (2003) as a factor that involves in credibility that affect users' decision to trust, which based on past experience and trustor's expectation. In application on Virtual Assistant, consistency of the output and being predictable are claimed as facts that directly impact the user trust. Lastly, reputation of a Virtual Assistant defines the quality of recognised past performance. Hoff and Bashir (2015) described an

operator's trust could be biased with the established reputation of an automated system before they interact with it. Numerous studies have shown that people tend to trust automation when they described it as a reputable or "expert" system. However, although reputable automation gains more initial trust from the users, but this trust may be reduced rapidly when there is a significant error in the system. Past experience with automated systems or similar technologies can dramatically change the process of trust formation (Hoff and Bashir, 2015). Realistically, it is rational to believe the reputation of a Virtual Assistant's reputation can impact users' trust.

4 Data collection

4.1 Questionnaire

A questionnaire or a survey refers to a data collection technique used to gather users' opinions on specific defined topics, similar to a structured interview but the interviewer is absent in the answering process and completely self-administered by the respondents (Lazar, Feng and Hochheiser, 2017, p.126). The advantage of conducting an online-based questionnaire are cost efficient, high accessibility, and commonly used as a convenient sampling method. Therefore, in order to motivate the respondents to answer the questions, the structure of the questionnaire need to be carefully designed, especially with clear instructions, wordings, typography and good ordering (Preece, Rogers and Sharp, 2015).

4.2 Respondent recruitment

In terms of dissemination, great efforts have been made to obtain a wide and representative sample of information. In this process, participants have been primarily recruited through snowball sampling with the use of social networks and professional networks. A link to the online questionnaire was shared broadly on various social platforms with the intention to approach different types of users around the world.

4.3 Material and measures

There are no established measurement instruments designed to investigate trust, motivation, engagement and related factors for this research. Therefore, the measurement instruments for this study were carried out by adopting different measurement instruments from related literatures. Table 5 lists the main elements measured in the questionnaire. All questionnaire items, including PEU, PU, PE, CA, CP, PEC and BI were adapted from (Venkatesh, 2000). Next, all items were measured on a seven-point scale ranging from strongly disagree (1) to strongly agree (7).

Table 5: Items in the questionnaire.

Elements	**Questionnaire**
Perceived Ease of Use (PEU)	I found it was easy to get Virtual Assistant to do what I want it to do.
	My intention with Virtual Assistant was clear and understandable.
	It was easy for me to become skilful at using Virtual Assistant.
Perceived Usefulness (PU)	Using Virtual Assistant in my work would enable me to accomplish task more quickly.
	Using Virtual Assistant in my job would increase my productivity.
	Using Virtual Assistant would enhance my effectiveness in my work.
Perceived Enjoyment (PE)	I had fun using Virtual Assistant.
	I found using Virtual Assistant to be enjoyable.
	The actual process of using Virtual Assistant was pleasant.
Computer Anxiety (CA)	Virtual Assistants do not scare me at all.
	I feel ease in using Virtual Assistant.

	I feel comfortable working with a Virtual Assistant.
Computer Playfulness (CP)	How would you characterise yourself when you use a Virtual Assistant?
Perception of External Control (PEC)	I have control over using the Virtual Assistant.
	I have the resources necessary to use the Virtual Assistant.
	I have the knowledge necessary to use the Virtual Assistant
	Given the resources, knowledge and opportunities, it would be easy for me to use the Virtual Assistant.
Behavioural Intention to use VA (BI)	Assuming the business functions would be available in Virtual Assistants, I predict that I will use it on regular basis.
	I intend to use it.

4.4 Ethical approval and study procedure

All respondents were given an informed consent that had to be approved before starting the questionnaire. The purpose about the study was presented, clearly informed the respondents the construction of the questionnaire and their participatory in the survey was completely voluntary. The respondents understand their right to excluded from the survey anytime, without expressing their reason to do so. No personal data was collected from the survey and their identity remain anonymous for the entire research process.

5 Data Analysis and Results

The following chapter describes the results from the analysis, organized in three parts. First, the

sample will be presented. Second, the results from the online survey, including presentation of the quantitative data are outlined. Last, the results from the exploratory part, containing the qualitative data which user description of their feelings and thoughts based on their previous experience with Virtual Assistants will be presented. the data was analysed using IMS SPSS Statistic software.

5.1 Background of the respondents

Demographics of the respondents were not collected in the survey as these are not part of a considerations for this research. This research focuses on the respondents' experiences with Virtual Assistants, purpose of usage, frequency of use, devices used, favourite features and least favourite features of Virtual Assistants. A total of 76 respondents around the world has responded to the online survey, 67 respondents in the study reported to have experience in using a Virtual Assistant and 8 responded do not have experience.

The respondents' frequency of usage. As illustrated in Figure 9, it is clear that majority of the respondents do not use Virtual Assistant frequently on daily basis. In total, most of the respondents reported to have use Virtual Assistant when they are reminded (30.3%), followed by respondents who claimed to use it few times a month (25.0%) and few times a week (22.4%). Only 11.8% of the respondents admitted they use Virtual Assistant on daily basis while 10.5% of the respondents identified themselves as never use it.

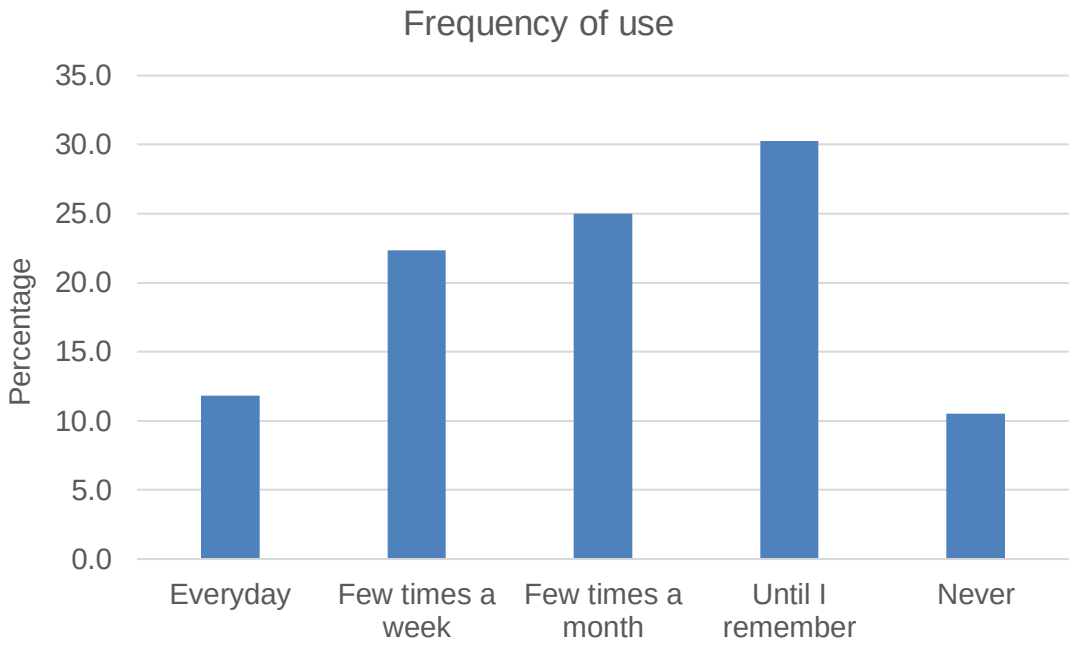

Figure 9. Bar chart of respondents' frequency of use of a Virtual Assistant.

Device used to access Virtual Assistant. Virtual Assistant adoption is burgeoning across devices. Figure 10 provides information about the types of devices used for Virtual Assistant. Overall, it can be observed that the smartphones are the most device used to connect with Virtual Assistants (77.6%) while wearables are the least device used along with Virtual Assistants (1.3%).

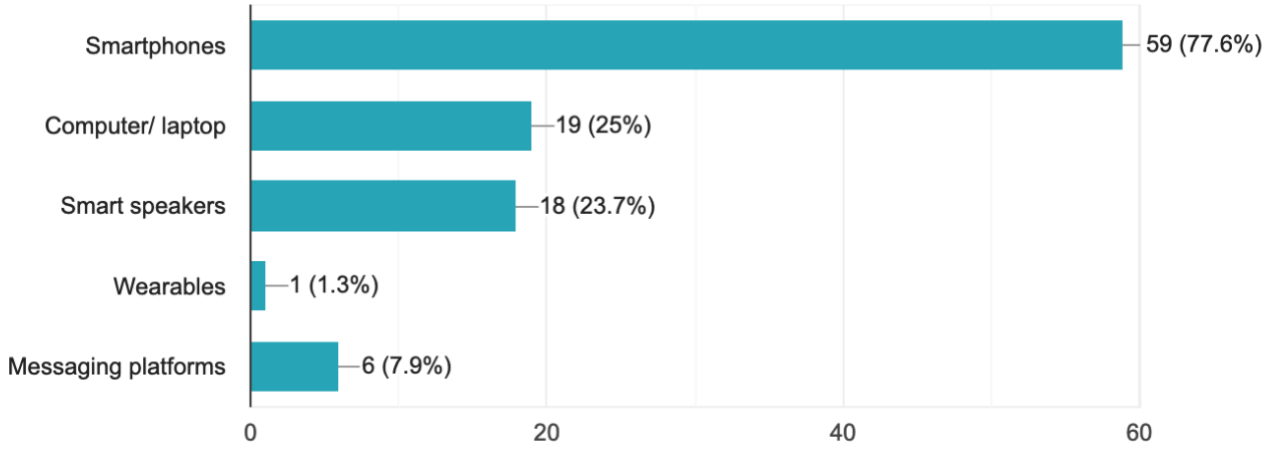

Figure 10. Bar graph of devices used to connect with Virtual Assistant.

Respondents' purpose of using a Virtual Assistant. Figure 11 below showed that most of the respondents strongly indicated that the main purpose they used Virtual Assistants is to search for information followed by control of home applicants and as a companion to chat.

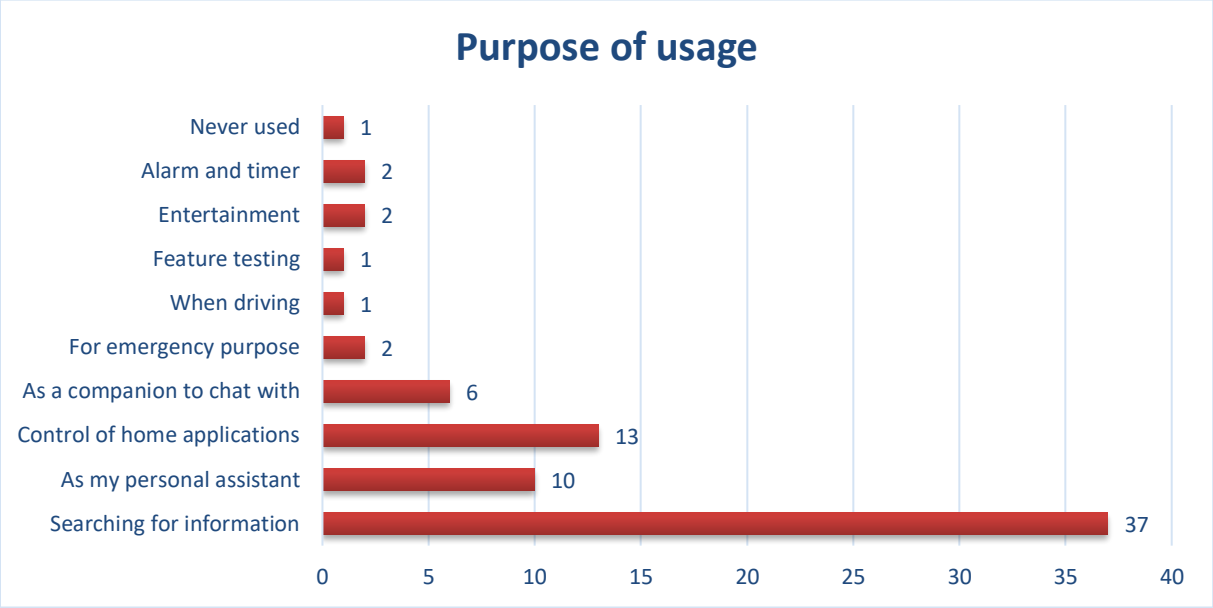

Figure 11. Purpose of usage.

Perceived playfulness of the respondents with Virtual Assistants. Majority of the respondents (33%) claimed themselves as "playful" users, followed by 22% of the respondents identified themselves as "spontaneous" users. Based on the terms described by the respondents, we can assume that Virtual Assistant are not a frequent solution for users to handle serious and formal procedure, such as loan applications and bank transfers that involves detailed personal information that could risk one's safety. See figure 12.

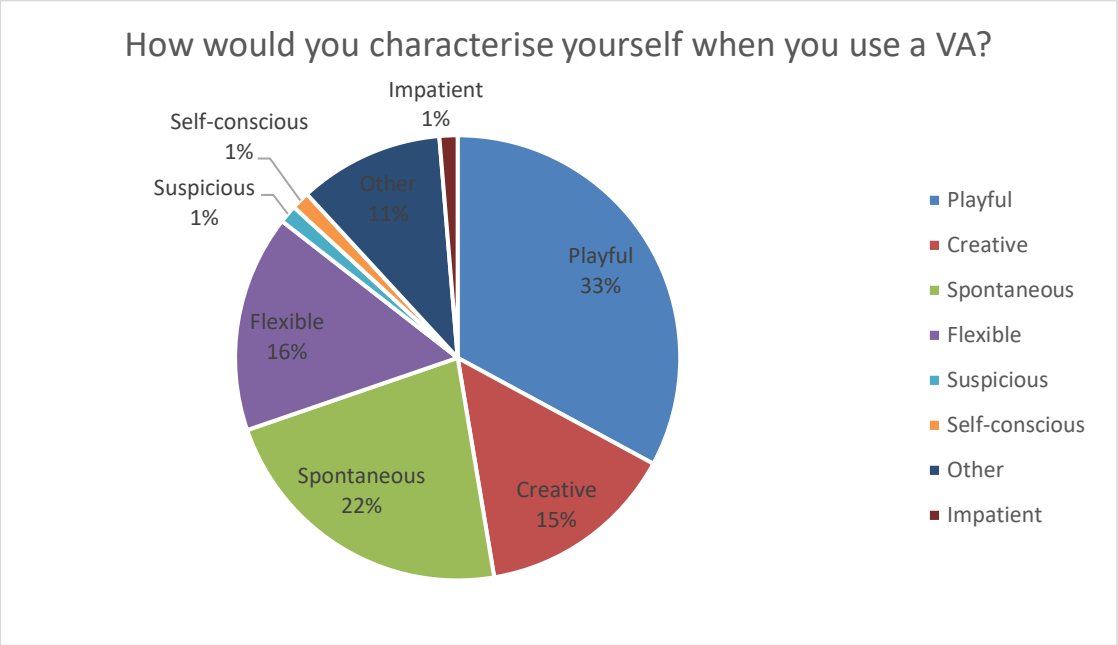

Figure 12. *Perceived playfulness*

5.2 Results from explanatory research

This section presents the results from the explanatory part of the questionnaire, where the respondents answered different measurement instruments of factors standing out as promising from the previous chapters.

An overview of the studied variables. Table 6 presents a descriptive overview of the dependent variable for sustainable Virtual Assistant, five factors assumed to affect trust and intention to use. The two highest mean was reported in *perceived of external control* with 5.04 of 7 (*SD* = 1.00) and *perceived enjoyment* (*M* = 4.91, *SD* = 1.16). This finding indicated that respondents experienced the Virtual Assistants as controllable and enjoyed using them. In contrast, the lowest mean was found in *perceived usefulness*, this result revealed that respondents do not perceived Virtual Assistants as a useful tool. All variables have a normal distribution, with respective skewness close to 0.

Table 6**.**

Sample size (N), mean (M), standard deviation (SD) and Skewness for the seven variables

Variables	N	M	SD	Skewness
Perceived Ease of Use	76	4.84	1.01	-0.35
Perceived Usefulness	76	3.95	1.51	0.02
Perceived Enjoyment	76	4.91	1.16	-0.45
Computer Anxiety	76	4.87	1.23	-0.40
Trust	76	4.17	0.94	-0.15
Perception of External Control	76	5.04	1.00	0.10
Behavioural Intention	76	4.43	1.32	-0.07

Correlation between variables. A correlation analysis was conducted to explore the relationship between the measured variables. There were consistently high and significant inter-correlation between the variables as illustrated in table 7. The highest correlation was found between *perceived ease of use (PEU)* and *perceived of external context (PEC)*, r (76) = 0.660, $p < 0.001$, which means these two variables are highly related and affect each other. The correlation analysis also revealed a high positive relationship between *perceived of enjoyment* and *perceived ease of use*, r (76) = 0.651, $p < 0.001$, and *perceived of external context* and *computer anxiety*, r (76) = 0.629, $p < 0.001$.

Table 7. *Correlations between the variables*

		PEU	PE	PU	CA	T	PEC	BI
PEU	Pearson Correlation							
	Sig. (2-tailed)							
PE	Pearson Correlation	.651**						
	Sig. (2-tailed)	.000						
PU	Pearson Correlation	.345**	.319**					

	Sig. (2-tailed)	.002	.005				
CA	Pearson Correlation	.588**	.527**	.484**			
	Sig. (2-tailed)	.000	.000	.000			
T	Pearson Correlation	.416**	.372**	.364**	.522**		
	Sig. (2-tailed)	.000	.001	.001	.000		
PEC	Pearson Correlation	.660**	.482**	.293*	.629**	.453**	
	Sig. (2-tailed)	.000	.000	.010	.000	.000	
BI	Pearson Correlation	.294**	.347**	.467**	.506**	.371**	.409**
	Sig. (2-tailed)	.010	.002	.000	.000	.001	.000

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Multiple regression analysis to explain the respective variation in behavioural intention. The regression analysis describes the relationship between the variables and determine whether they are significant or not. Multiple regression analysis was used to test whether the six technology-, user-, and context- related factors significantly predicted respondents' ratings of intention of using the Virtual Assistant and trust respectively.

A multiple linear regression was calculated to predict *behavioural intention (BI)* based on *perceived ease of use (PEU), perceived enjoyment (PE), perceived usefulness (PU), computer anxiety (CA), trust (T) and perceived of external control (PEC)*. A significant regression equation was found (F (6, 69) = 6.41, p < 0.001, R^2 = 0.36. Of the six variables, the analysis revealed two to be particularly important to explain the variation in behavioural intention: *perceived usefulness* (β = 0.29, $p < 0.05$) and *computer anxiety* (β = 0.37, $p < 0.01$). *Computer anxiety* had the highest standardised regression coefficient, see table 8.

Table 8: Results for variables predicting behavioural intention with standardised regression coefficients (β) and t-values (t) and p-value (Sig.)

Model		Beta	t	Sig.
1	(Constant)		3.300	.001

	Computer Anxiety	.506	5.049	.000
2	(Constant)		2.852	.006
	Computer Anxiety	.366	3.321	.001
	Perceived of Usefulness	.290	2.627	.010

a. Dependent Variable: Behavioural Intention

The regression analysis also used to test if *trust (T)* significantly predicted by the *perceived ease of use (PEU), perceived enjoyment (PE), perceived usefulness (PU), computer anxiety (CA), behavioural intention (BI) and perceived of external control (PEC)*. A significant regression equation was found (F (6, 69) = 5.54, p < 0.001, R^2 = 0.33. Of the six variables, the analysis revealed *computer anxiety* (β = 0.37, p < 0.01) to be particularly important to explain the variation in trust, see table 9.

Table 9: Results for variables predicting behavioural intention with standardised regression coefficients (β) and t-values (t) and p-value (Sig.)

		Standardized Coefficients	t	Sig.
Model		Beta		
1	(Constant)		3.103	.003
	Computer Anxiety	.522	5.262	.000

a. Dependent Variable: Trust

Simple linear regression between perceived ease of use and trust. A simple liner regression analysis was used to test if perceived ease of use predicts trust. Shown from table 10, the result of the regression indicated that perceived of use explained 16% of the variance in trust (adjusted R^2 = 0.16, F (1, 76) = 15.5, p < 0.001). perceived ease of use is significantly affecting trust (β = 0.42, p < 0.001).

Table 10: *Standardized regression and t-value for perceived ease of use predicting trust.*

Independent variable	Trust

Perceived ease of use	β	t
	.42	3.935 ***

*Note. *** $p < .001$.*

Simple linear regression between trust and behavioural intention. A simple liner regression analysis was used to test if perceived trust predicts behavioural intention. The result of the regression indicated that perceived of use explained 13% of the variance in trust (adjusted R^2 = 0.13, F (1, 76) = 11.8, p = 0.001). therefore, the trust has a significant effect on behavioural intention ($\beta = 0.37$, $p = 0.001$). See table 11.

Table 11. *Standardized regression and t-value for trust predicting behavioural intention to use.*

Independent variable	Behavioural intention	
Trust	β	t
	.37	3.441

Note. p = .001.

5.3 Results from the exploratory part of the study

This section presents the results from the exploratory part in the questionnaire where respondents freely could write their thoughts in response to an open-ended question: "*What do you like the most about a Virtual Assistant?"* and *"What do you dislike the most about a Virtual Assistant?"*. Table 12 and table 13 present the final set of keywords identified in the thematic analysis. The table also shows which of the three high-level dimensions each category belongs to, as well as a short description and frequency for each keyword.

Table 12. Results from open-ended questions: *What do you like the most about a Virtual Assistant?*

Keywords	**Explanations**	**Frequency**
Type	Respondents reporting that using voice assistants are able to eliminate typing actions, allowing them to multitask.	8

Easy	Respondents reporting that the Virtual Assistants are not complicated and easy to use to solve their issues.	12
Fast and quick	Respondents reporting that the processing time for Virtual Assistants are quick and instant response.	12
Informative	Respondents reporting that thy used Virtual Assistants to organise and perform search of information.	16
Convenience	Respondents reporting that using Virtual Assistants are a convenient way to get information, controllable, automatic and responsive.	8
Productivity	Respondents reporting that Virtual Assistants helps them to be productive and increase efficiency.	4
Intelligence	Respondents reporting that Virtual Assistants are intelligent and smart.	2
Availability	Respondents reporting that Virtual Assistants are accessible and available 24/7.	3
Fun	Respondents reporting that Virtual Assistants are fun to use for entertainment at leisure time.	5
Time	Respondents reporting that using a Virtual Assistant is time efficient.	5
Ability	Respondents reporting that Virtual Assistants are competence in their expertise area.	5
Reliable	Respondents reporting that Virtual Assistants are reliable for conversations.	1

Interactive	Respondents reporting that Virtual Assistants provide smart feedback, easy to navigate and	6
Miscellaneous	Non relevance answers like “I don’t use”, “I don’t like”, “nothing” and other non-relative terms.	3

Based on the results, most of the respondents use Virtual Assistant to seek for information. They assume that is the fastest way of getting an answer because Virtual Assistants are always available for service. Moreover, the respondents also strongly indicated that the operation of Virtual Assistants are easy and convenient, they can quickly adapt the method of interaction. Additionally, the respondents like the impression of Virtual Assistants being fun and interactive.

Table 13. Results from open-ended questions: *What do you dislike the most about a Virtual Assistant?*

Keywords	**Explanations**	**Frequency**
Not understand	Respondents reporting that Voice Assistants do not understand them.	18
Wrong, mistakes	Respondents reporting that the Virtual Assistants often do mistakes by interpreting user request wrongly.	16
Immature	Respondents reporting that the technology of Virtual Assistants are still immature.	2
Irrelevant	Respondents reporting to the sentence structure and feedback of the Virtual Assistants.	5

Slow	Respondents reporting that the duration for information processing in Virtual Assistants could be slow.	5
Miscellaneous	Non relevance answers like “I don’t use”, “I don’t like”, “nothing” and other non-relative terms.	8

However, the results showed that most of the respondents claimed dislike the Virtual Assistant being hardly understand them during a conversation. This situation can be interpreted into two aspects: 1) the advancement of natural language processing technology requires further improvement; 2) the system does not understand the user needs and ignorance of certain key information as one of the respondents claimed that “it will not understand the words or ignores it.”

6 Discussion

The descriptive study examines the factors associated with the intention associated with one's intention to use Virtual Assistant in daily context. With survey data from 76 respondents, the research model with seven factors was proposed and analysed to identify which factors are affecting the trust and behavioural intention of the users. The results supported the elements of PEU, PE, PU, CA, T, PEC and BI from the framework are highly related to each other, proven that these elements are important design considerations in developing a Virtual Assistant.

The result revealed that computer anxiety and perceived usefulness are strong antecedent to behavioural intention. This suggests that providing an engaging experience is crucial to the adoption of Virtual Assistants. In responding to the open-ended questions, people mentioned that they felt fun and entertaining while interacting with Virtual Assistants, as described in the flow theory, when people are fully immersive in the they felt time pass slower than usual, especially the optimal experience of having fun and enjoyment. Besides that, most of them also found it is useful to seek for information, which can be explained by "clear goals and immediate feedback" from flow theory (Csikszentmihalyi, 2008). In other word, the information that a user is searching for represents the goal, while the Virtual Assistants will perform the task of search and report the result immediately to the user.

On the other hand, a regression analysis of trust has revealed computer anxiety is an important factor to explain the variation in trust. In conjunction with flow theory, emotions are important for optimal experience because it is "the state in which people are so involved in an activity that nothing else seems to matter; the experience itself is so enjoyable that people will do it even at great cost, for the sheer sake of doing it." (Csikszentmihalyi, 2008). This situation can be supported by (Skinner's (1985) behavioural theory of operant conditioning, a behaviour no longer followed by the reinforcing stimulus results in a decreased probability of that behaviour occurring in the future. When a user continuously does not feel enjoyment in using a Virtual Assistant, or constantly feel disappointment and stress while in the conversation, they will decided to distrust the technology, probably as well as all the similar ones.

Furthermore, the role of a Virtual Assistant is to assisting human in diverse context. Even though the Virtual Assistant are built based on the innate characteristics of human but there are limitations. The framework could assist designers in several ways. First, it can be used as a reference that could assist designers to create engaging service design that draws upon intrinsic motivation. Second, the framework can provide elements that relatable to users over user's skills and expectations.

Conversation between human and Virtual Assistants are defined into five stages: pre-conversation, initiate conversation, during conversation, end conversation and post-conversation (see table 14). These five stages are important framework to design contextual conversation. Pre-conversation is a stage where before the user wants to begin a conversation with a Virtual Assistant. By mimicking the way of human communicates, we often start with greetings or refer to the name of the targeted person. Possible actions such as voice command and selecting the chat window are essential to "wake" the system. Then, to initiate a conversation, human tends to start with a question. To interact with a computer system, input of personal information are necessary references for the Virtual Assistant to call out the right profile and measure its competence in the system background. Furthermore, many unexpected occasions or distractions will happen in a conversation. So, to inform both human and Virtual Assistant about respective status, the transparency of the action is important to avoid unnecessarily waste of time. Conversation is two-way, meaning both parties have to reach a mutual agreement in ending a conversation. For example, human typically used the term "goodbye" to end a conversation of a phone call. Inheriting this behaviour would increase the naturalness and brings emotion in the interaction with a virtual system. Lastly, post-conversation refers to the actions done separately by human and Virtual Assistant, which transparent system status is not required in this context.

Table 14. Stages of conversation between human and Virtual Assistant.

Stages of conversation	**Human**	**Virtual Assistant**

Pre-conversation	User would activate the system because they need assistance, information or feedback.	The system would inform user about its equipped knowledge or expertise and process user's background and information before started.
Initiate conversation	User would interact with the system by first sending out a question or request.	The system should notify its existence and always available for service.
During conversation	User would expect the usual flow of conversation as happens with another human. User would also expect the system navigation is transparent, which they are always update about the background action of a Virtual Assistant.	The system should repeat user's question when it is uncertain and reduce errors as minimal as possible. The system also should inform users about the background action such as typing or loading time.
End conversation	User would verify the answers from the system, expecting to end with "goodbye". Sometimes user would remain idle.	The system should confirm the completion of previous task and no new task assignment before ending. The system should prompt user when idle is detected, and automatically end the conversation if user remains idle for a while.

Post-conversation	User would provide feedback, follow-up of a task or a greeting to end.	Execute users' request and recorded in history.

7 Limitations and Future research

This study discusses and presents a sustainable framework that combines with multiple theoretical framework. However, the findings and conclusions are subject to a number of restrictions in the study. Firstly, due to time constraint, the sample size (n = 76), although it is sufficient for the exploratory research in this master thesis but may have limited the generalizability of the findings. Second, a questionnaire study could be lack of accuracy and possibility of potential source occurs. In regard with Svartdal (2009), when users answer questions based on what they think they should say, there may be source errors in the questionnaire, not how they actually think about it. Moreover, the use of questionnaires is also limited because users tend to be almost general in terms of agreement or disagreement. Au contrary, a correlational design, as illustrated in explanatory research study, only implies the interpretation and prediction of the possible variation of the dependent variable rather than the assertion of causality (Svartdal, 2009). Future research is recommended for qualitative research and experimentation to observe user's behaviour and emotion while interacting with Virtual Assistants under different contexts.

This section described some of the potential limitations of this study. Future research to encouraged to replicate this study to determine whether the same factors are equally important when Virtual Assistants are more advanced, and users have gained more experience.

8 Conclusion

This master thesis proposed a framework with the aim to increase the sustainability of a Virtual Assistant in early stage of development. The study provided a contribution in response to gaps in

previous research literature on user perceptions of factors affecting the intention of use of a new technology. Through explanatory analysis, new factors that are critical to users' behavioural intention of use have emerged. The main finding is that user's trust in Virtual Assistants maybe affected users' perception of ease of use and this factor also directly affecting user's behavioural intention of use.

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