Royal College of Art

Olfactory-Enabled Aesthetics of Experience Design for Human-AI Chatbot Interaction: Enhancing User Engagement

Cecilia Lee

This thesis represents partial submission for the degree of Doctor of Philosophy at the Royal College of Art. I confirm that the work presented here is my own. Where the information has been derived from other sources, I confirm that this has been indicated in the thesis.

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Authors' Declaration

During the period of registered study in which this thesis was prepared the author has not been registered for any other academic award or qualification. The material included in this thesis has not been submitted wholly or in part for any academic award or qualification other than that for which it is now submitted.

Cecilia Lee, 5th April 2022

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Acknowledgment

Time flies. I cannot believe that this time has arrived for me, too. I was wondering when I will be eventually writing the acknowledgment section and concluding my journey of Ph.D.

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Publications and Conferences

Several chapters of this doctoral research were published by the journals below.

- Lee, C. (2021). Navigating the complexity of service systems: Service design practice through a systems thinking approach. *Touchpoint(The Journal of Service Design)*, 12(2).
- Lee, C. (2020), Olfactory sense as an object of design practice: Designing for an emotional experience in the smart technology sector. *The Design Journal,* 23(3), 463-474.
- Lee, C and Leon, N. (2018). Aesthetics of Interaction between Human and AI: A Multisensory Approach. *Touchpoint (The Journal of Service Design),* 10(2).

This research was presented at the international academic conferences below.

- The Journal of Product Innovation Research Forum, PDMA Conference 2019, Florida, USA
- ARM Research Summit 2019, Cambridge, UK
- Microsoft Research AI Summer School, 2018, Cambridge, UK
- Service Design and Innovation ServDes 2018, Milan, Italy
- American Marketing Association Service Research Conference SERVSIG 2018, Paris, France

Glossary

Smart Service Product: a consumer product that is enabled by emerging technologies, such as artificial intelligence, the Internet of Things, and big data, which allow them to autonomously interact with users, based on contextual information.

Smart Service: a service that is delivered by a smart service product.

Smart Service System: the value networks of smart services in which actors, such as humans, technologies, and organisations, interact with one another to co-create value and maintain viability of the system.

Service-Dominant Logic: 'the application of specialised competences such as knowledge and skills through deeds, processes, and performances for the benefits of another entity or entity itself' (Vargo and Lusch, 2004a, p.4).

Aesthetics: value-in-use that arises through the interaction between the user and a smart service product.

Abstract

This doctoral research explores the lack of user engagement observed in human-AI chatbot interaction through the theoretical lens of service-dominant logic (SDL). A recent observation suggests that stand-alone voice assistants and chatbots enabled by artificial intelligence are experiencing a fast-growing market adoption, especially among the user group of the Millennials, but the data published by Accenture in 2017 reveals that their use is limited to very simple tasks, such as turning on music or checking weather forecast only, and a frustrating user experience with these devices has been causing an ongoing challenge of user engagement. Although there is a great number of previous studies that examined the phenomenon of lack of user engagement of wearable devices, the studies that inquired into the phenomenon of lack of user engagement of other smart service products (SSPs), such as voice assistants and chatbots, are still limited. Also, most current studies focused on user adoption and acceptance of SSPs (Bolen, 2020; Deghani et al, 2018); therefore, understanding of the post-adoption user behaviour remains limited.

In order to address this knowledge gap, this doctoral research takes a research through design approach to inquire into the phenomenon of lack of user engagement in human-AI chatbot interaction. This research is an interdisciplinary study that is situated at the intersection of design and services marketing. Many recent contributions in the human-computer interaction (HCI) discipline that examined the challenge of user engagement generated new knowledge on how sensory stimuli can be leveraged to tackle the challenge of user engagement in a smart service system. However, the focus of these studies is significantly skewed towards visual, auditory, and most recently, haptic senses. Extant literature in sensory research and most recently HCI (e.g. Obrist et al, 2017; Spence et al, 2017) addressed the lack of studies that explore the HCI phenomenon through the olfactory sense, although the olfactory sense has the most intimate linkage with the areas of the human brains that directly control human emotions. Recent studies have started to respond to this knowledge gap, and the olfactory sense is gaining research traction, but most of these studies adopted a quantitative research approach that quantifies human experience as a measurable unit. Also, they do not offer deep insights as to how a designer can use the olfactory stimulus as a design material to design for an olfactory-enabled aesthetics of experience in the context of human-SSP interaction.

In order to expand the current knowledge in the effect of the olfactory stimulus on human emotions and experience, specifically in the context of human-AI chatbot interaction, this doctoral research explores the research problem - the lack of user engagement that leads to user abandonment in human-AI chatbot interaction. Based on the review of extant literature, this

research problem was further developed into research questions as follows: 1) *How could service designers use the olfactory stimulus as a design material to design for the olfactory-enabled aesthetics of experience in human-AI chatbot interaction?* 2) *Could the olfactory-enabled aesthetics of experience emerged in human-AI chatbot interaction enable value co-creation between the user and AI chatbot that enhances user engagement?*

The contributions from this research are three-fold. First, this doctoral research is an interdisciplinary study that directly responds to the call for further research contributions from interdisciplinary studies by the service research community (Gustafsson and Bowen, 2017). Secondly, this research studied the olfactory stimulus as a design material that has been under-explored in the design and HCI disciplines. Finally, this research examined the lack of user engagement and user retention problem in a smart service system through the theoretical lens of SDL, whilst it adopted a research through design approach to explore rich details of human emotions and behaviour in the context of human-AI chatbot interaction. This study has examined the challenge of user experience qualitatively using a research through design approach, and this hybrid approach in combining the theoretical foundation from the services marketing discipline and a methodological approach from the design research discipline is original.

As a result, it expands the discipline-specific boundary of a design experiment by positioning a design experiment as a legitimate research method for exploratory research to scholars from non-design disciplines. This approach also demonstrates how service design can be used as a mid-range theory to operationalise meta-level theory - SDL - and explores an empirical observation - the lack of user engagement in human-AI interaction that is observed at a micro-level of a smart service system.

Chapter 1: Introduction

We Live in a Smart Service Experience World

1.1 Research Motivation

Extant literature in service research often describes AI chatbot as one of the product categories of smart technology (e.g. Le Dinh et al, 2022; Knote, Janson, Sollner, and Leimeister, 2020). Smart technology has started gaining tractions since the 2010s with the rapid advancement of emerging technologies and an increasing number of emerging technology-embedded smart consumer products becoming available on the market. The review of literature revealed that the majority of studies in early 2010s in smart technology focused on wearable devices, such as fitness trackers and smartwatches, which seems to be driven by a fast market growing adoption of these devices, especially during the period of 2014-2017. These studies often focused on the adoption and acceptance of wearables (Bolen, 2020; Dehghani, Kim, and Dangelico, 2018). With the recent rise of Chat GPT that has disrupted both industry and academia, academics from many different disciplines such as information systems management (Dwivedi et al., 2023), education (Rudolph et al., 2023), biomedical engineering (Biswas, 2023), and medicine (Patel and Lam, 2023) have started publishing the article about what are the implications of Chat GPT for their respective field. Again, given the nature of chatbot's recent surge in adoption, the extant literature in human-chatbot interaction observed in service research journals also focuses on the adoption and acceptance of chatbot rather than chatbot users' post-adoption behaviour (Meyer-Waarden et al., 2020).

Recently published articles in service research discipline identified the current gap in knowledge, especially in the post-adoption user behaviour; these studies addressed this gap by examining users' continued intention of using a chatbot as a customer service agent (Ashfaq, Yun, Yu, and Louereiro, 2020); users' continued intention of using fitness trackers (Windasari, Lin, Kato-Lin, 2021), the factors that determine users' continued intention of using smartwatches (Bolen, 2020), and the key drivers that determine the users' continued engagement with smart wearable technology (Dehghani et al, 2018).

Recent contributions to understanding users' continued engagement with smart technology clearly signal a growing momentum in advancing current knowledge in this area; however, most recent contributions lack deeper insights in terms of understanding from a user's standpoint what drives user engagement, satisfaction, and the users' willingness to continue to use a product.

The majority of the extant literature has examined the challenge of user engagement and the users' intention to continue to use a smart technology-embedded product through the theoretical lens of an expectation-confirmation model (ECM) (Bhattacherjee, 2001) and a technology

acceptance model(TAM) (Davis, 1986). Both ECM and TAM are well-established theoretical frameworks that have been widely used by the academic community to understand the adoption of information systems and technology-related products. Although these frameworks have helped scholars to uncover new information and develop new knowledge, they are not without any shortcomings, some of which have already been addressed by previous studies. For example, ECM, which was introduced by Bhattacherjee (2001), is based on the expectation-confirmation theory (ECT), which has been extensively used in the consumer behaviour literature to study pre- and post-consumption behaviour and customer satisfaction. ECT evaluates customer satisfaction based on the discrepancy between pre-purchase and post-purchase customer expectation. Although ECT considers emotions as cognitive evaluation of satisfaction from the consumption of products and services, the essence of ECT lies in expectation formed by perceived usefulness and ease of use (Oliver, 1980; Ashfaq et al, 2020). As a result, Bhattacherjee's ECM undermines an important role played by other dimensions, such as perceived enjoyment of use.

Similarly, one of TAM's limitations was identified as its over-simplicity, which makes it unable to capture complex human behaviour. Bagozzi (2007) articulates that TAM has been an extremely successful theoretical framework that has been widely adopted by the academic research community because of its parsimoniousness, but this parsimony has a dual side. Its simplistic approach to understanding human behaviour in terms of accepting and rejecting technology has left out many critical contextual elements that govern institutional systems in a given society. Bagozzi also points out that TAM's focus on user intention and its claim to a linear relationship between user intention and the adoption of technology neglects the benefits of use, and therefore the user's goal attainment. His critical analysis of TAM also implies that TAM is lacking explanatory power in studying the post-adoption behaviour, in which the benefits of use and the user's goal attainment play a significant role.

The body of extant literature discusses the respective shortcomings of ECM and TAM, and the recent studies have attempted to overcome these. For example, Ashfaq et al. (2020) have integrated ECM, TAM, and the Information System Success Model (ISS) to examine the post-adoption behaviour of users for those who have adopted a chatbot for e-services.

As smart technologies, especially those that are used in a consumer context, are becoming part of users' daily lives, neither the perceived functional value to users nor the perceived ease of use alone can fully explain users' pre- and post-adoption desire and behaviour. Those studies that have recognised this knowledge gap enhanced the robustness of these frameworks by integrating additional dimensions into their frameworks in order to generate a holistic understanding of user behaviour (e.g.Turhan, 2013; Choi and Kim, 2016). Although some improvements have been made, the knowledge generated from the integrated ECM and TAM

frameworks remains at a high level without being able to capture intricate details of human experience. This shortcoming cannot be resolved on their own because of the philosophical foundation of these frameworks, given that they are derived from positivism in which quantitative research is a predominant approach.

Positivists use the quantifiable unit of analysis in research, and it is demonstrated by these previous studies that depict users who are messy human-beings as a measurable unit, as the user is the unit of analysis in these studies. Examining and interpreting human behaviour entirely through a quantitative lens, which treats users as quantitatively measurable units, is unlikely to reveal user motivations that guide user behaviour. Although there could be common patterns that may explain a certain user group's motivation and behaviour, these are cultivated through the institutions of a given society (Vargo and Lusch, 2016). Institutions are rules and norms created by humans; therefore, these rules and norms are underpinned by various socio-cultural contextual elements. Scott (2008) denotes in his study that humans have a bounded rationality, and institutions often serve as easy reference for their behaviour. This institutions discourse in academic research clearly supports that it is very difficult to make generalisations about human behaviour and human experience across different groups of users.

This missing gap observed in quantitative research is often filled by qualitative research that relies on an inductive approach to uncover complex, intricate details of human behaviour. However, despite the recent emergence of interdisciplinary research, the research tradition that has firmly divided the research field into quantitative versus qualitative research still discourages a complete break free from this discipline-specific approach to research. As a result, the body of extant literature often offers a limited view on the pre- and post-adoption user behaviour in relation to smart technology, and previous studies in smart service systems that have examined the phenomena of the lack of user engagement and user abandonment are often unable to capture highly complex details of human behaviour, which is governed by institutional rules and norms of given societies.

The current literature in smart service system that specifically takes a close look at the challenge of user engagement suggests a need for further contributions from interdisciplinary research. Interdisciplinary studies that can break free from the constraints imposed by the disciplinary research tradition may make more meaningful contributions to building a holistic understanding of the challenge of user engagement in a smart service system, specifically in the context of human-AI chatbot interaction from a user-centric perspective. In response to this need, I began this journey of doctoral research in 2017. The biggest challenge I faced when I was embarking on this research journey was a highly fragmented view of existing studies on the definition of smart technology. Since academic research in smart technology has only recently started gaining

attention, there is still no widely accepted standard term for the concept of smart technology. Smart technology-embedded consumer products are often described in various terms, namely smart devices, smart wearable technology, and intelligent devices and so on (Silverio-Fernandez, Renukappa, and Suresh, 2018), not to mention the introduction of various conceptualisations of these terms.

1.2 Smart Service Product: AI Chatbot

This doctoral research focuses on the interaction between the user and an AI chatbot. As previously mentioned, the literature in service research describes AI chatbot as one of the product categories of smart technology, which is enabled by emerging technologies, such as artificial intelligence, the Internet of Things, and big data. This doctoral research conceptualises smart technology as a smart service product, according to the theoretical stance of service-dominant logic (SDL), which views the fundamental basis of economic and social exchange is a service (Vargo and Lusch, 2004). SDL was first introduced in 2004 by Vargo and Lusch who brought a paradigmatic shift in thinking to a society predominated by goods-dominant logic (GDL) in which customer (or user) value is seen as embedded in physical product itself. SDL thus offers an alternative thinking towards the concept of value. In a GDL society, value-for-exchange, in which user or customer value is realised through a transaction, was predominant. However, in an SDL world, value is not realised until it is actively co-created by all the participating actors, including both service providers and beneficiaries, and value outcome is uniquely and phenomenologically determined by the beneficiary (Vargo and Lush, 2004a; 2008b).

SDL's alternative view of the concept of user (or customer) value explains its processual perspective, which contrasts with the static view of the concept of value in GDL thinking. SDL's processual perspective on the concept of value is clearly evidenced in Vargo and Lusch's definition of SDL. They define this term as 'the application of specialised competences (knowledge and skills) through deed, processes, and performances for the benefits of another entity or entity itself' (Vargo and Lusch, 2004a, p.2). Although Lusch and Vargo (2018) claim that their introduction of SDL to the marketing discipline in 2004 was not necessarily motivated by the emerging evolution of a world economy which had been shifting towards the services sector since the twentieth century, the research streams in SDL often misrepresent SDL as a pioneering initiative that explains the phenomenon of an emerging world services economy.

SDL had a humble beginning; it was first introduced as a concept rather than a theory, which was explicitly stated by Vargo and Lusch (2008a). However, since its introduction in 2004, SDL has grown in many ways. It has introduced several related concepts, such as service logic (Gronroos, 2008), customer-dominant logic (Heinonen, Strandvik, Micklesson, Evardsson, Sundstrom, and Andersson, 2010), and service science (Maglio and Spohrer, 2008). It has also evolved towards a meta-theoretical framework that engages many other research streams from other disciplines,

such as design, engineering, and information systems (Vargo, Houtari, and Vink, 2020). In addition to bringing a paradigmatic thinking to the world of marketing that had been dominated by GDL thinking, SDL's key contribution lies in encouraging interdisciplinary research contributions and introducing a service ecosystem perspective which has expanded a dyadic view of value co-creation.

SDL's contribution in encouraging interdisciplinary research is also clearly evident by interdisciplinary studies that have emerged from the service design discipline (e.g. Kimbell, 2011; Wetter-Edman, Vink, and Blomkvist, 2018). Also, research streams in SDL, regardless of the discipline, share the perspective that tangible goods are a vehicle for service delivery, not an end in themselves. SDL's depiction of tangible goods is in stark contrast to GDL thinking, in which the concept of value is inherent in tangible goods. SDL's view of tangible goods as a vehicle for service delivery is already well observed in a daily life these days, especially in the emerging technology sector. Amazon is the largest ecommerce retailer in the world. Their e-commerce platform, which is a tangible good, is used as a vehicle for service delivery, which is online shopping. Similarly, Facebook offers a platform, which is a tangible good, which their users use to consume services, which is a social connection. In SDL world, value is co-created by actors in a service system through the integration of resources, which refers to the concept of value-in-use in which value emerges through the consumption or the actual usage of products and services (Vargo and Lusch, 2004a, 2008a).

Building on the concept of value-in-use, this study characterises a smart service product (SSP) as 'a consumer product that is enabled by emerging technologies such as artificial intelligence, the Internet of Things or big data, which allow them to autonomously interact with users, based on contextual information'. Previous studies by Gembarski (2019) and Wunderlich, Heinonen, Ostrom, Patricio, Sousa, Voss, and Lemmink (2015) also share a similar view, as they describe smart technology in their studies as a means to an end – the delivery of smart service to the end users - rather than an end in itself.

In this doctoral research, it has narrowed down the scope of the study to the post-adoption user behaviour in human-AI chatbot interaction. There are a few reasons why this doctoral research has specifically focused on the post-adoption behaviour in human-AI chatbot interaction rather than more broadly on interaction challenges observed in human-SSP interaction. One of the reasons is that the extant literature has already conducted significant number of studies on wearables which is one of the categories of an SSP. The other reason is a fast-growing adoption of chatbot led by the Millennials (Accenture, 2017) and the recent rise of ChatGPT suggests that the use of chatbot is becoming democratised, and that means that it is quickly becoming mainstream. As chatbot is becoming mainstream, the topic of post-adoption user behaviour

rather than that of user adoption or acceptance will become more relevant for discussion in both academic and industry research. This prediction is strongly supported by the trend that emerged in research streams in wearables that have reached the user adoption maturity some years ago.

In case of wearables, many wearable makers were challenged by a higher rate of abandonment vis-à-vis a relatively lower adoption rate in 2016. Gartner's research study published in 2016 reported that 30% of fitness tracker users and 29% of smartwatch users abandon these devices, and it called for SSP makers to come up with compelling value propositions. Similar observations were also presented by academic researchers in the human-computer interaction (HCI) discipline. In the study conducted by Lazar, Koehler, Tanenbaum and Nguyen (2015), it was reported that a third of people who owned fitness trackers stopped using them within the first six months of purchase; the key driver for the challenge of user engagement and abandonment was identified as a lack of perceived user value, such as the diminishing novelty of the product, data with no meaningful information for behaviour change, and the cost of the initial efforts required for setting up wearables (Clawson, Pater, Miller, Maynatt, and Mamykina, 2015; Lazar et al, 2015). A lack of aesthetic value and users' difficulties in integrating wearables seamlessly into their daily lives were also reported as the reasons for the user abandonment in earlier studies (Arthur, 2014). Additionally, data privacy and a lack of awareness of product benefits were raised as additional reasons that explain the phenomenon of user engagement that results in user abandonment in the early stage of adoption, according to the study conducted by Ericsson in 2016. The study also stressed that a complete user abandonment does not happen overnight. This is clearly signaled by the result of Ericsson's study, which demonstrates that the amount of time users spent with fitness trackers and the frequency of their use was inversely correlated.

In the year 2021, it seems that many aspects of wearables that were causing users to abandon these devices over the past few years have been significantly resolved. As the adoption of wearables, especially fitness trackers, has reached the mainstream, product awareness among the target users has improved substantially, and it has helped to reduce users' initial concerns about personal data privacy (Lamb, Huang, Marturano, and Bashir, 2016). Also, their aesthetic appearance and feel have made great strides. In 2014, the journalist from the Daily Telegraph bluntly described fitness trackers and smartwatches as simply tech gadgets dressed up in fashion that are unlikely to be desired by users (Arthur, 2014). Over the past six years, many fitness trackers and smartwatches manufacturers have formed partnerships with fashion brands to enhance the aesthetics of their products' appearance and feel. *Haute horlogerie* brands, such as Montblanc and TAG Heuer, as well as the fashion-conscious tech brand Apple, have now joined this crowd, which has stimulated market competition further in terms of the aesthetics of wearables. In a similar vein, the functional aspects of fitness trackers and smartwatches have made an excellent progress, demonstrated by their longer battery life and their deeper and easier

integration into the smart service system which each user is part of. Tracking daily exercises has also become more discreet, as fitness trackers now offer a greater number of different modes of tracking options and the materials used for tracker straps that are tailored to each use context. For example, the Apple watch offers users multiple options of watch straps in different types of material to suit different use occasions, whether it be a leather strap for workplace or a rubber strap for gym workout.

It is clear from all the observations discussed above that wearables sector has made a significant achievement to date on the aspect of both utilitarian and emotional user value. Would the recent rise of chatbot will follow the same trajectory? Since the introduction of ChatGPT by Open AI in November 2022, the academic literature and industry reports that explore the impact and the role of ChatGPT in our lives has started flourishing, but most these studies, if not all, have focused on utilitarian user value that specifically looks at how ChatGPT can co-create utilitarian value with users to do the tasks that were done by users more easily and efficiently, such as writing a report and searching literature for research (e.g. Buholayka, Zouabi, and Tadinada, 2023; Kumar, 2023). The current state of research in ChatGPT and extant literature in human-chatbot interaction in general suggests that human-AI chatbot interaction in the context of emotional user value co-creation is under-explored.

Chatbot's utilitarian user value had been unable to meet most users' expectation until the introduction of ChatGPT very recently. But if utilitarian user value becomes the industry standard and therefore users take this for granted, what makes user-AI chatbot interaction superior will likely depend on user value that goes beyond utilitarian user value. This argument is already explicitly mentioned by marketing scholars many years ago where the scholars claimed that fulfilling user satisfaction through functional value co-creation alone is not sufficient enough to retain users in a long run (Bolton, Gustafsson, McColl=Keneedy, Sirrianni, and Tse, 2014; Pullman and Gross, 2004; Jaakkola, Helkkula, and Arikka-Stenroos, 2015; Zorfas and Leemon, 2016; Magids, Zorfas, and Leemon, 2015).

Like design researchers, marketing researchers have, early on, recognised the importance of understanding user value through a holistic lens. More recently, the researchers in other disciplines, such as HCI and cognitive psychology have also demonstrated a keen interest in understanding user behaviour from an experiential perspective (e.g. Saunderreger and Sauer, 2010; McColl-Kennedy, Gustafsson, Jaakkola, Klaus, Radnor, Perks, and Friman, 2015), and it suggests that understanding the challenge of user engagement in human-AI chatbot interaction through the lens of SDL may generate new knowledge that can be relevant not only to the design research community, but to a broader audience from academic research community.

1.3 Aesthetics & Utility

In response to this growing need for understanding user behaviour through an experiential lens, contemporary scholars who were following the work of Kurosu and Kashimura (1995) and Tractinsky (2004) started investigating the relationship between aesthetics and usability, and the effect of these variables on how a user perceives the performance of product or service offerings in pre- and post-usage stages. The results from these studies, however, are convoluted. Some studies demonstrated additional empirical evidence that supports Tractinsky's claim that 'beautiful is usable' (e.g. Norman, 2004; Lee and Koubeck, 2012; Sonderegger and Sauer, 2010), while others generated a result that contradicts Tractinsky's claim and put forward a reversed proposition, 'usable gets beautiful' (e.g. Lindagaard and Dudek, 2003; Tuch, Roth, Hornbaek, Opwis, and Bargas-Avila, 2012). These studies are mostly based on web interfaces in which visual aesthetics plays a dominant role; therefore, its findings offer a limited view on the relationship between aesthetics and utility from an experiential perspective. Most recently, several artists who have collaborated with museums to explore the effect of sensory stimuli on museum visitors' emotions and the quality of their experience inquired about the effect of other sensory stimuli, such as auditory, haptic, and olfactory stimuli. In one specific example, Tate Modern – a contemporary art museum in London, UK – demonstrated how a multi-sensory approach can be adopted in a museum context to design for an engaging visitor experience (Obrist, Gatti, Maggioni, Chi, and Velasco, 2017).

These studies that examined the relationship between the aesthetics and utility emphasise an increasing trend observed in research streams in smart technology where a shift of the research paradigm from 'efficiency-focused' towards 'experiential-focused' is taking a foothold. In a similar vein, the extant literature in the services marketing discipline highlights the importance of both cognitive and affective aspects to create an optimal customer experience (Verhoef, Lemon, Parasuraman, Roggeveen, Tisros and Schlesigner, 2009). These studies further claim that the ability to establish an emotional connection with customer is essential to building customer loyalty and thus maintaining an organisation's competitive advantage in the long run (Pullman and Gross, 2004; McColl-Kennedy et al, 2015). Commentators in the smart technology industry shared a similar view. They argue that SSPs should be able to connect with users on an emotional level if they want to go beyond merely being 'stuff' (Chaturvedi, 2016; Robbins, 2015).

This observation suggests the evolution of the concept of aesthetics. Aesthetics is no longer discussed as a static term that refers, in most cases, to the physical appearance of objects. Instead, aesthetics refers to value-in-use that arises through the interaction between a user and an SSP. The evolution of the concept of aesthetics in the research stream in the design research community is already clearly manifested. Since the 00s, design researchers (e.g. Petersen, Iversen, Krogh, Ludigsen, 2004; Locher, Overbeeke, and Wensveen, 2010; Xenakis and Arnellos, 2013; Ross and Wensveen, 2010; Lenz, Diefenbach and Hassenzahl, 2014) started

examining the concept of aesthetics from an experiential perspective and introduced derivative concepts such as aesthetic experience and aesthetics of interaction. Hummels and Overbeeke (2000) describe the aesthetics of interaction as 'the sense of beauty that arises during the interplay between a user and a product in their context.' (p.9). Thuring and Malhke (2007) define aesthetics as 'the sensual experience a product entails, and to the extent to which this experience fits individual goals and preferences' (p.257). In both definitions, it is clear that the sense of beauty, the sensory aspect of the interaction between a user and a product, and user value that arises through this interaction are emphasised. Xenakis and Arnellos (2015) conceptualise aesthetic experience as 'the adaptive processes of choosing the right action possibilities' (p.3), and they characterise the concept of aesthetics as a 'valuative emotional process' that reduces the interactive uncertainty. The trend observed in the conceptualisation of aesthetics by the design research community clearly conveys that any designers aiming to design for an interactive experience that engages users should consider how to help users to experience the aesthetics that emerges through the interaction. The conceptualisation of aesthetics from an experiential perspective further reinforces the importance of building an emotional connection with users. It also implicitly shows the positive consequence of an aesthetic experience, which suggests that an aesthetic experience can elicit an authentic emotional response in end user that helps to reduce interactive uncertainty and that enhances the affordance of interaction.

More details of the evolutionary trajectory of the concept of aesthetics are discussed in Chapter 2. Building on the aesthetics as an experience rather than beauty as a static form, this doctoral research conceptualises aesthetics as '*value-in-use that arises through the interaction between a user and an AI chatbot'*. Following the argument put forward by Xenakis and Arnellos, if aesthetics can elicit an emotional process that can reduce interactive uncertainties, users are more likely to co-create value with a chatbot because the aesthetics that emerges through the interaction works as a value co-creation enabler by enhancing information processing fluency of users and thus reducing interactive uncertainties.

Many observations in research streams in experiential-focused aesthetics also suggest the importance of human emotions and their intricate relationship with the human senses that give rise to the aesthetics of experience. Despite an implicit connection between human emotions and aesthetics of experience suggested throughout the body of the extant literature, previous studies in the design and the services marketing disciplines have yet to examine the intricate relationship between human emotions and the aesthetics of experience and how it affects user satisfaction, engagement, and users' continued intention. Previous studies in marketing, especially research streams in retailing (e.g. Hulten, 2011) and tourism (e.g.Agapito, Oom do Valle, and Mendes, 2012) have presented empirical findings on how sensory marketing approaches influence

customer emotions that could translate into a positive brand awareness and a favourable brand attitude. However, to my best knowledge, most studies that have looked at the interaction between customers and technology were conducted in the context in which the nature of interaction is uni-dimensional rather than bi-directional. One specific example is the interaction between the customer and a self-assistive technology in a retailing environment. The interaction between user and a self-assistive technology in retailing is uni-dimensional, as the self-check-out kiosk is not enabled by smart technology, and as a result, it reacts to the user rather than proactively and autonomously interacting with the user. The current research gap in this space is that new knowledge generated from the studies that have examined the uni-dimensional interaction between user and a self-assistive technology in a retailing environment offers a little opportunity for the result of these studies to be replicated in a smart service system context. In smart service system, users interact with a chatbot, which can autonomously interact with its users, and its interactive behaviour becomes smarter as it learns more about the users. This pattern of interaction is difficult to be explained by previous studies that have examined the interaction between user and a self-assistive technology.

1.4 Why Olfactory Stimulus?

Recent contributions, especially in the HCI discipline, have generated novel insights on how sensory stimuli can be used to tackle the user experience challenges, such as the lack of user engagement and user abandonment in a smart service system context, in which the nature of interaction is bi-directional. However, to my best knowledge, existing studies in the design research and services marketing disciplines have not yet addressed how users' emotions and the aesthetics of experience are intertwined and how it affects user satisfaction, engagement, and continued intention in human-chatbot interaction. In response to this knowledge gap, this doctoral research aims to explore the human's olfactory sense as a potential source of design material which designers can leverage to design for the olfactory-enabled aesthetics of an interactive experience for human-AI chatbot interaction.

There are specific reasons why this research is particularly interested in exploring the olfactory sense as a design material. The human's olfactory sense is closely linked to the areas of the human brain that directly control human emotions (Hirsch, 1995). This close linkage between the human's olfactory nerve system and the amygdala and hippocampus in the human brain that control the human emotions suggests that the olfactory stimulus can potentially make a great design material if the design objective is to elicit aesthetic emotions in user which can serve as a valuative process that can help users to seamlessly enable value-in-use. Olfactory or scent marketing has already been widely used in the marketing discipline, especially by marketing practitioners in experiential-centric services such as hospitality and retail. In a meta-analysis of the atmospheric effects of scent conducted by Roschk, Loureiro and Breitsohl (2017), the studies

that they have reviewed suggest that scent improves the in-store experience and positive shopping outcomes (citing Bone and Ellen, 1999).

Despite this benefit, olfactory stimulus remains under-explored (Davies, Kooijman, and Ward, 2003), especially in human-AI chatbot interaction (Obrist, Tuch, and Hornbaek, 2014). Although recent contributions in HCI discipline (e.g. Maggioni, Cobden, Dmitrenko, Hornbaek, and Obrist, 2019) have explored the olfactory stimulus in design context, specifically for studying HCI, these studies have often focused on understanding how the olfactory stimulus can be used for interface design. As a result, there is still a gap in knowledge, especially in the area in which the olfactory sense is explored from an aesthetics of experiential perspective. In order to understand aesthetics as an enabler for value co-creation in human-AI chatbot interaction, designers will need to have a better understanding of the nature of the relationship between the olfactory stimulus, user emotions, the aesthetics of experience, and value co-creation. Understanding this relationship will further help designers to make good judgment on how the relationship between user emotions and the aesthetics of experience is likely to affect the value co-creation process between the user and AI chatbot and the outcome of value co-creation in terms of user satisfaction, engagement, and the continued intention for a chatbot.

1.5 Research Aim & Research Questions

In response to the current void in the extant literature, this doctoral research aims to explore the olfactory stimulus as a design material in the human-AI chatbot interaction context and whether the use of olfactory stimulus can enable the aesthetics of experience that promotes value co-creation between the user and a chatbot. It specifically takes a look at whether the aesthetics experienced by users during the interaction with an AI chatbot positively affects user satisfaction and engagement with an SSP and thus their decision to continue to use it. In doing so, it intends to delve deeper into the relationship between olfactory-enabled aesthetics of experience and value co-creation.

Based on this research aim, this research puts forward research questions as follow: 1) How could service designers use the olfactory stimulus as a design material to design for the olfactory-enabled aesthetics of experience in human-AI chatbot interaction? 2) Could the olfactory-enabled aesthetics of experience emerged in human-AI chatbot interaction enable value co-creation between the user and AI chatbot that enhances user engagement?

1.6 Methodological Approach

In exploring the research questions stated above, this doctoral research adopted ‘a research through design approach’. The term, research through design was introduced by Bruce Archer in the 70s (Pedgely and Wormald, 2007). In the 90s, Frayling has further popularised the term by using it in his working paper, *Research in Art and Design* published by the Royal College of Art.

In his paper, Frayling (1993) describes a research through design approach as the type of research that resembles materials research, development work, and action research.

Research through Design (RtD) is also known as a research methodological approach that embraces design practices as a legitimate research method. Design was considered ill-legitimate academic discipline for many decades, just because its epistemological origin does not allow it to fit into what makes academic research defined by positivism (Glanville, 2012). A historical background of design and its relationship with science is discussed in more detail in Chapter 3.

Taking a research through design approach, this research developed three AI chatbots with varying degrees of visual aesthetics to control the potential effect of visual aesthetics on user emotions during the user's interaction with the chatbot. It then deployed a design experiment as a research method to explore users' emotions and behaviour throughout the user journey that spans the three stages of pre-, during- and post-interaction with an AI chatbot. It also took a close look at how a change in users' emotions affects the level of user satisfaction, engagement, and continued intention for an AI chatbot. Design experiment is new to most scholars from non-design disciplines. Since this doctoral research is an interdisciplinary study aimed at readers from several disciplines – service design, services marketing, and HCI, the epistemological origin of design experiment and how its historical background makes it distinct from scientific experiment is also discussed in Chapter 3.

1.7 Thesis Structure

This thesis is structured as follows. In Chapter 2, it reviews the theoretical foundation of this research and discusses relevant previous studies in the design and marketing disciplines. It then re-articulates the current knowledge gap identified in the extant literature, which this doctoral research aims to fill with new knowledge contributions. Chapter 3 discusses the methodological approach of this research. It also takes a look at the historical background of the relationship between art/design vis-à-vis science and de-mystifies design experiment, which is relatively unknown to the scholars from non-design disciplines.

The odour category development exercise and two-rounds of design experiments were conducted in this research to seek for answers for the research questions posed above. Chapter 4 discusses the odour category development exercise. Chapter 5 builds on the result from the odour category development exercise in Chapter 4 and introduces the first-round design experiment and presents its result and discussion. It also discusses how this experimental approach will be refined in the second-round design experiment to achieve a desirable result from the experiment. In Chapter 6, the second-round design experiment and the result are presented and discussed. Chapter 7 puts forward a general discussion, based on the results from the odour category development exercise and two-rounds of experiments that were

conducted for this research and introduces the Olfactory-Enabled Aesthetics of Experience Design Framework for Human-AI Chatbot Interaction, an empirical research output. This framework is intended, not only to fill the current knowledge gap in the extant literature, but also to provide pragmatic guidelines for designers who wish to adopt this framework in their design practice and leverage the olfactory stimulus as a design material to design for the olfactory-enabled aesthetics of experience specifically for human-AI chatbot interaction. In concluding section of Chapter 7 discusses the new knowledge contributions and the implications for design practice that were discovered throughout this research. It also shares the limitations of the research and introduces the future direction of the research for those who may want to expand the findings from this research.

Living in a smart service experience world has definitely changed the way we interact with a technology, which has brought a profound transformation in how we live, work and interact with one another. Let us take on a journey to the world of a smart service experience.

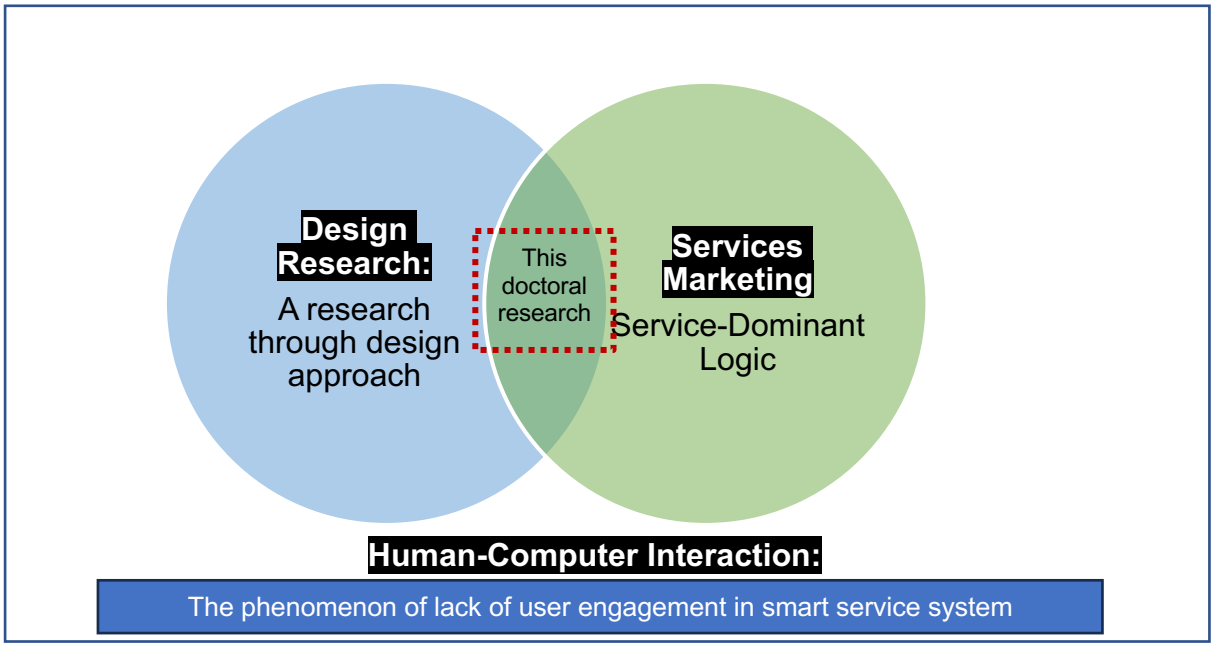
Chapter 2: Literature Review

The Review of Literature in Service Research and Design Research

2.1 Introduction

This doctoral research is an interdisciplinary study that is situated at the intersection of the service design and services marketing disciplines and examines a human-computer interaction (HCI) research problem – the lack of user engagement in human-AI chatbot interaction. This phenomenon is studied through the theoretical lens of SDL derived from services marketing, whilst it adopts a research through design approach with a boundary object to explore answers to the research questions studied.

FIGURE 2. 1:INTERDISCIPLINARY RESEARCH AT THE INTERSECTION OF DESIGN, SERVICES MARKETING, AND HCI



Research through design is a design research methodology introduced by Bruce Archer in the 1970s (Pedgley and Wormald, 2007) and was further disseminated by Christopher Frayling (1993) within the design research community. It has also been adopted by disciplines other than design research, notably the HCI research community. For the readers who are not familiar with this methodological approach, research through design refers to the methodological approach that embraces design practice as a legitimate research method. In the design research community, the term is often used interchangeably with 'practice-based PhD in design', but the meaning of the latter term is not clearly established within the design research discipline itself, which often becomes a source of confusion (Pedgely and Wormald, 2007). Chapter 3 takes a close look at the background of research through design and discusses why the approach is often understood as a practice-based PhD in design. But it is imperative to note here that this doctoral research is not a practice-based PhD in design. Research through design is used in this doctoral research, but with a boundary object, which is an AI chatbot in this research context. Research through design with a boundary object has a slightly different approach to generating new knowledge. Specifically, the contribution to knowledge of this doctoral research lies in novel findings that emerge through the data collected from a series of design experiments conducted with a boundary object, which may become a new theoretical framework for the service design research community. At the Royal College of Art (RCA) a PhD in design that does not present design outcomes, such as design artefacts, or practice itself, as a contribution to knowledge is considered a thesis-based PhD in design. Following the norms of the institution in which this doctoral research was carried out, this research is a thesis-based PhD in design. A more detailed discussion of research through design with a boundary object can be found in Chapter 3, which is devoted to the discussion of the methodology of this doctoral research.

The service research community has been calling for contributions from interdisciplinary studies for over two decades, but the contributions to date have been modest, according to Gustafsson and Bowen (2017) who studied the underlying reasons for the lack of interdisciplinary studies in service research. They attribute the lack of contributions from interdisciplinary studies within the service research community to the growing complexity of services and the inherent challenge of bringing different disciplinary perspectives to study this complexity. In their view, interdisciplinary research will be encouraged within the service research community once service researchers master paradoxical thinking. For example, they stress that it is important for service researchers to frequently exercise their ability to think according to two opposing perspectives, such as academic rigour and practical relevance, simultaneously.

Gustafsson and Bowen's (2017) study offers relevant facts about the challenges involved in bringing interdisciplinary perspectives to the study of services that are becoming complex service systems. However, there has been a growing research focus on service design by the service

research community. Although this is a recent trend, the *Journal of Service Research* and the *Journal of Service Management* have actively published service research that has embraced the concept of design (e.g. Yu and Sangiorgi, 2018; Kurtmollaieve, Fjuk, Pedersen, Clatworthy, and Kvale, 2018; Beltagui, Candi, and Riedel, 2016; Teixeira, Patricio, Huang, Fisk, Nobrega, and Constantine, 2016). That said, it is not fair to say that the service research community has not been relatively receptive to the idea of integrating other disciplines into service research. The literature in service research reveals instead that more contributions from the service design community are needed.

Although some service design researchers have published their work in the service research journals, their contributions need to be further encouraged, which will benefit the advancement of interdisciplinary studies within the service research community. This doctoral research is a direct response to the call for interdisciplinary studies in service research, but from a design research perspective. This chapter reviews the key constructs in both service research and design research that underpin the research questions of this doctoral research. Since the intended audience for this research is from diverse disciplines, this chapter organises the review of key constructs into two sections, Services and Design, to help readers navigate the key constructs and cross-reference each construct with its relevant discipline of origin.

The purpose of this chapter is to provide an overview of how each key construct of this research is depicted in the current literature and articulate the current gaps in knowledge. It then introduces the research questions, which are distilled from the gaps identified in the review of the literature. The next section first introduces a review of the literature in service research.

2.2 Services

***'A service is a fundamental basis of all economic exchanges.'* (Vargo and Lusch, 2004a).**

2.2.1 Service-Dominant Logic

This doctoral research explores the lack of user engagement in human-AI chatbot interaction through the theoretical lens of service-dominant logic (SDL). SDL is a concept introduced by Vargo and Lusch in 2004. Their article - 'Evolving to a new dominant logic for marketing' - published in 2004, has been cited more than 18000 times by June 2021. SDL has brought about a paradigmatic shift in marketing thinking, which had been dominated by goods-dominant logic (GDL) thinking for many decades. The thinking in GDL is derived from neoclassical economics in which value, in principle, is embedded in goods. In a GDL-oriented society, value-for-transaction is considered the norm, as value is derived from the exchange of goods or units of firms' outputs (Smith, 1736/2010; Vargo, Maglio and Akaka, 2008).

It is imperative to note that Vargo and Lusch's introduction of SDL was not necessarily motivated by the emergence of the services sector in the world economy. Lusch and Vargo (2018) explicitly mention this in their book chapter 'An overview of service-dominant logic'. For many decades, services were considered offerings that were ancillary to physical goods. The literature often makes a clear distinction between goods and services by characterising services by four distinct features – *intangibility, inseparability, heterogeneity,* and *perishability* (Vargo and Lusch, 2004b, 2008b; Cova and Salle, 2008).

Vargo and Lusch (2004a) take a processual approach to conceptualise the idea of service. Their conceptual approach clearly articulates that their conceptualisation of SDL is not based on a conventional view of services. Based on their processual perspective, Vargo and Lusch define SDL as 'the application of specialised competences (knowledge and skills) through deeds, processes, and performances for the benefits of another entity or entity itself' (Vargo and Lusch, 2004a, p.2). Furthermore, their conceptual definition also highlights SDL's emphasis on operant resources. Vargo and Lusch (2008a) classify resources into two distinct categories: operant and operand. Operant resources refer to the resources which humans can use to act upon other resources, such as knowledge and skills, whilst operand resources are the resources that are acted upon, such as material. SDL's conceptual definition explicitly places an emphasis on operant resources.

Although Lusch and Vargo (2018) claim that their work on SDL was not motivated by the evolution of the world economy towards services and a knowledge-intensive economy, SDL's processual perspective and its emphasis on operant resources is a timely description of how the world economy has evolved over recent decades. In their early discourse on SDL, Vargo and Lusch maintain that SDL has three key theoretical underpinnings – *intangibility, exchange process*, and *relationship* (Vargo and Lusch, 2008a). Intangibility is a term associated with GDL, which is also acknowledged by Vargo and Lusch (2008a), while an exchange process reflects SDL's emphasis on process rather than the transaction itself. Relationship describes the interaction between actors, as a major part of the latest work in SDL focuses on the resource integration of actors through the interaction between them within a service system.

Many scholars have pointed out that a shift from a goods-dominant view towards a service-dominant view is a much-anticipated phenomenon, given the growing reliance of the total production outputs of the world's leading economies on the services sector (Rust, 2004, cited by Achrol and Kotler, 2006). One of the greatest weaknesses of GDL thinking is its limited conceptual boundary, which means it does not offer a broader perspective to understand the evolution of the world economy towards the services sector, especially in the marketing discipline. As a result, it has ended up creating many sub-disciplines to study this evolution

(Vargo and Lusch, 2008b). Consequently, the core idea of business-to-business and services marketing has become an initial stepping-stone for a service-dominant economy, which laid out the conceptual ideas that structure the notion of SDL thinking, namely *network*, *interactivity*, and *relationship* (Vargo and Lusch, 2008b).

When SDL was first introduced in 2004, it was underpinned by eight foundational premises (FPs) below.

TABLE 2. 1: FOUNDATIONAL PREMISES OF SERVICE-DOMINANT LOGIC (VARGO AND LUSCH, 2004A)

FP1	The application of specialised skills and knowledge is the fundamental unit of exchange.
FP2	Indirect exchange masks the fundamental unit of exchange.
FP3	Goods are distribution mechanisms for service provision.
FP4	Knowledge is the fundamental source of competitive advantage.
FP5	All economies are services economies.
FP6	The customer is always a co-producer.
FP7	The enterprise can only make value propositions.
FP8	A service-centered view is customer-oriented and relational.

SDL's FPs have been further refined, with additional premises, after repeated revisions of the terminology and further contributions from other scholars (see Vargo and Akaka, 2009, p.35 for a complete list of FPs). There have been some contentious debates on the heavily GDL-oriented lexicon and terms used in FPs. A notable example is a change of the term 'services' to 'service', as the former connotes the meaning of intangible goods that characterise 'services' in GDL (Lusch and Vargo, 2006; Vargo and Lusch, 2008a, 2008b; Vargo and Akaka, 2009; Cova and Salle, 2008).

Although SDL is now recognised as a meta-theoretical framework (Vargo, Huotari, and Vink, 2020), its earlier discourse shows a rather pedantic approach, which is pointed out by Achrol and Kotler (2006) who believed that the SDL research community should focus its efforts on understanding the concept from an ontological, epistemological, and pragmatic standpoint rather than debating the language of the conceptual thinking to advance the concept towards the development of metatheory.

With their continuous efforts to refine the thinking derived from SDL, Vargo and Lusch (2016) have recently condensed the eleven FPs into the five core axioms, which capture concisely the core theoretical constituents of SDL. The five core axioms of SDL are parsimonious, and therefore offer more robustness for the operationalisation of the concept. The five core axioms are illustrated in Table 2.2 on the next page.

TABLE 2. 2: SERVICE-DOMINANT LOGIC'S FIVE AXIOMS (VARGO AND LUSCH 2016)

Axiom 1 (FP 1)	Service is the fundamental basis of exchange.
Axiom 2 (FP 6)	Value is co-created by multiple actors, always including the beneficiary.
Axiom 3 (FP 9)	All social and economic actors are resource integrators.
Axiom 4 (FP 10)	Value is always uniquely and phenomenologically determined by the beneficiary.
Axiom 5 (FP 11)	Value co-creation is coordinated through actor-generated institutions and institutional arrangements.

SDL's core axioms clearly communicate a shift in how value is created and determined, as the world economy has shifted from a goods-dominant world towards a service-dominant world. In GDL, because the value is inherent in physical goods, value-in-exchange was the central tenet of thinking in GDL. However, value-in-exchange is no longer relevant in the context of SDL, in which users or customers actively participate in value creation, and value is determined by the beneficiary uniquely and phenomenologically. The disappearance of a clear distinction between the roles of producer and customer in the value creation process is one of the key conceptual characteristics of SDL. In an economy in which SDL is dominant, customers are no longer passive recipients of goods or services. Instead, they actively participate in the value creation process in collaboration with service providers (Prahalad and Ramaswamy, 2004; Vargo and Lusch, 2004a, 2008a, 2008b). This is explicitly conveyed by SDL's FP6 – 'Customers are always the co-creators of value'.

The concept of value is unique, cumulative, and temporal (Woodruff and Gardial, 1996; Woodruff, 1997; Woodall, 2003). It is also known to be situation- and context-specific, as it is perceived differently depending on the context (Bolton and Drew, 1991, cited by Khalifa, 2004; Woodruff, 1997). However, value-in-use does not reflect this salient feature sufficiently. Vargo (2008) admits that because the concept of value-in-use still carries the conceptual baggage from a goods-dominant approach, it tends to undermine the importance of the context-specific dimension of value.

Chandler and Vargo (2011) argue that the cumulative and temporal nature of value inherent in context enables the market to transcend time and space and to evolve continuously. Furthermore, in response to a neglected view of value-in-use towards the context, they proposed the concept of value-in-context. They critique value-in-use for its failure to recognise the significance of context in service provision and the co-creation of the market. According to their definition, context is 'a unique set of actors and the unique reciprocal links among them' (Chandler and Vargo, 2011, p.41). Their definition suggests that they hypothesise that the influence of social networks and social forces is inherent in each context.

Although the concept of value-in-context has not attracted a wide attention from the scholarly community, it has anticipated the increase in attention towards the role of institutions in SDL

narratives. As explicitly stated in SDL's core axioms (Axiom 5: Value co-creation is coordinated through actor-generated institutions and institutional arrangements), the role of institutions is discussed extensively in the latest SDL discourse, especially with the introduction of a service ecosystem perspective (Vargo and Lusch, 2016; Vargo et al., 2020; Vink, Koskela-Huotari, Tronvoll, Edvardsson, and Wetter-Edman, 2020).

The most recent narratives of SDL confirm that the conceptual boundary of SDL has expanded, including the role of institutions in value-in-use. In the current narrative of SDL, with its expanded conceptual boundary, the concept of value-in-context is implicitly recognised. For example, value-in-use is realised through the interaction between actors within a service system, through the integration of resources for value co-creation. The actors' integration of resources in a service system is described as actor-generated institutions and institutional arrangements in Axiom 5. The outcome of value co-creation is then the value that is uniquely and phenomenologically determined by the beneficiary. Although value-in-use does not explicitly articulate the context-specific nature of value, this aspect is already implied through SDL's fourth axiom – value is always uniquely and phenomenologically determined – which highlights the context- and individual-specific nature of value.

A shift in thinking from value-in-exchange towards value-in-use is also strongly pronounced in the phenomenon of lack of user engagement observed in smart service system. For example, the market adoption of SSPs, in particular fitness trackers, has reached the mainstream (Ericsson, 2016). A continuous growth in the market and the reaching of mainstream user groups indicate that value-in-exchange has already been fulfilled. Users saw the potential value of an SSP and have purchased it. But the concept of value-in-exchange cannot explain why people stop using SSPs, and neither does it help to understand the underlying problem and explore potential solutions that could reverse this trend.

From a value-in-use perspective, the phenomenon of lack of user engagement can be simply explained as the lack of value-in-use for users. The underlying reason will need to be investigated further, but empirical studies (e.g. Lazar, Koehler, Tanenbaum, and Nguyen, 2015; Clawson, Pater, Miller, Mynatt, and Mamykina, 2015) demonstrate that users have tried SSPs, and SSPs were unable to meet their expectations, which resulted in a reduced frequency of use and a complete abandonment in the worst scenario. This trend is already well reported in an example of human-AI chatbot interaction. Many disappointed users have stopped interacting with the chatbot and looking for a human agent instead. But whether the recent rise of ChatGPT, with its powerful intelligence, could reverse this trend remains a question.

Similarly, the concept of value-in-use argues that there is no longer a clear distinction between the roles of producer and customer in value creation because customers are no longer passive recipients of goods or services, but are active participants in the value creation process, in collaboration with suppliers (Prahalad & Ramaswamy, 2004; Vargo & Lusch, 2004, 2008a). This trend is already well observed in current industry practice in which users' and customers' active participation in new product and service developments are strongly encouraged in order to maximise the opportunity to build new product and service offerings that create value for users and customers. A typical example can be an open innovation platform, where customers participate in new product and service idea generation.

Yu and Sangiorgi (2018) have also introduced a new service development framework that emphasises an experiential aspect of value co-creation between a producer and a consumer. They explicitly state that a changing view of the concept of service in the literature to date has also initiated a shift in how the concept of value is understood. In their study, they view the concept of value as follows: 'Value is uniquely constructed in the individual customer's life, influenced by his or her functional, emotional, socio-cultural, and relational experiences, sometimes over an extended period' (citing Grönroos & Voima, 2013; Heinonen, Strandvik & Voima, 2013; Sandstrom, Edvardsson, Kristensson, and Magnusson, 2008). However, an experiential aspect of the concept of value was already recognised much earlier on, in Schmitt's (1999) experiential marketing and Pine II and Gilmore's (1999) experience economy. In their words, superior customer value is materialised by enabling a superior customer experience, because the value is no longer embedded in physical goods exchanged, and only materialises during the consumption or use of products or services.

A shift in the concept of value towards an experience-focused perspective is already well manifested in SSPs. Fitness tracker makers these days sell their products bundled with service offerings to engage with their users more deeply. For example, Apple's Fitness +, Amazon's new Halo View, and Fitbit's Fitbit Premium, are well-known examples that aim to provide personalised health and fitness services that complement SSPs (IDC, 2020). Industry commentators from IDC predict that wearables and services will evolve together in the near future. These observations anticipate that user value will be significantly co-created with SSPs through the use of personalised service content generated from collected user data via SSPs.

The empirical observations in the SSP sector illustrated above suggest that there is a need for academic research that explores how to design for a user experience that enables value co-creation between users and SSPs. Despite the need for further research, to the best of my current knowledge, the literature to date has yet to explore how to enable value co-creation in human-SSP interaction. However, there are some studies in the HCI discipline (e.g. Lazar et al,

2015; Clawson et al, 2015; Deghani, Kim, and Dangelico, 2018; Bolen, 2020; Trajkova and Marin-Hammond, 2020) that have examined the factors that drive user abandonment and the factors that determine user engagement and retention. These empirical studies offer interesting insights that contribute to an understanding of user motivation and what aspects of SSPs and the interaction between users and SSPs contribute to either user frustration and abandonment or user satisfaction and engagement. They also discuss these factors not only from a product-centric view that is embedded in GDL but also from the perspective of SDL in which user value emerges through the interaction. For example, users who shared their experience in studies by Lazar et al. (2015) and Clawson et al. (2015) pointed out that their frustration was mainly caused by the conscious effort required to integrate their SSP into their daily life, as it created extra effort for them.

But because these studies only offer the reasons that explain the phenomenon, there is a limitation to how much they can contribute to an understanding of how a user experience that enables value co-creation within a human-SSP interaction can become a reality. Also, there are no earlier findings which design researchers can build upon to expand further how designers can approach designing an interactive experience that co-creates value in the context of human-SSP interaction. The absence of research contributions in this area presents a knowledge gap in the current literature. At the same time, this gap in knowledge invites further contributions, such as theoretical frameworks that help design researchers to re-imagine how to approach designing an interactive experience that results in value co-creation within a human-SSP interaction, leading to user satisfaction, enhanced user engagement, and continued intention to use SSPs that ultimately reduces user abandonment.

2.2.2 AI Chatbot in a Smart Service System

As the services sector continues to play a dominant role in advancing the world economy, services have expanded their conceptual boundaries and formed a service system. A service system configures multiple resources and actors and facilitates interaction between actors for value co-creation. For example, business platforms such as Amazon and Facebook are typical examples which demonstrate how a service business builds its service system around its business model.

In academia, the concept of the service system has started to gain research traction in the service science discipline. Research streams in this discipline have introduced a number of different conceptual definitions of the service system. Maglio and Spohrer (2008) conceptualise the service system as ‘value configurations of people, technologies, organisations, and value propositions connecting internal and external service systems and shared information (e.g. language, laws, measures, and methods)’ (p.18). Medina-Borja (2015) defines the service system as ‘socio-technical configurations of people, technologies, organisations, and information

designed to deliver services that create and produce value' (p.2). Despite some variations in their wording, both definitions emphasise the aspects of *interaction* and *value co-creation.* In Maglio and Spohrer's definition, they describe the interaction between actors – people, technologies, and organisations – within a system as value configurations which allude to the activity of value co-creation by actors in the service system. Similarly, Medina-Borja also explicitly characterises the interaction between actors in the service system as value co-creation. The existing literature on service systems often emphasises the importance of understanding the interaction between actors in a service system which contributes to sustaining the viability of the system (Barile and Polese, 2010). The interaction between actors in the service system has become increasingly more complex, with the advent of emerging technologies that are given material agency (Leonardi, 2011). Technology is no longer an object that is acted upon by human actors in a service system. It has acquired material agency that allows it to take over a dual role as both an operant and an operand resource.

As technology has become an actor that can directly interact with users for the activity of value co-creation, the service system has transformed into a smart service system, with more complex interaction between multiple actors in the system. The concept of a smart service system is a fairly new term to services research, and therefore there is no conceptual definition that is widely accepted by the service research community. Building on the definition by the National Science Foundation, Beverungen, Muller, Matzner, Mendling, and Brocke (2017) conceptualise smart service systems as 'value co-creating configurations of people, technologies, organisations and information that are capable of independent learning, adapting, and decision-making' (p.5). Most recently, Gembarski (2019) defines the concept of a smart service system as the 'assembly of smart products and digital services that represent holistic solutions which are not limited to fulfill[*sic*] a predefined set of customer needs but to [*sic*] adapt to changing requirements over time' (p.28).

A noticeable difference between the conceptual understanding of a smart service system and that of a service system can be found in the smart service system's ability to adapt autonomously. Also, the concept of value co-creation is explicitly stated, while it is merely implied in the definition of the service system. On the other hand, there are also dissenting voices pointing out that what makes the service system smart still remains unclear, as the current literature does not offer a cohesive view on what it means by a smart service system and how one can be created (Beverungen, Matzner, and Janiesch, 2017). The conceptual definition of a smart service system by the National Science Foundation cited above highlights technology's newly acquired material agency that allows it to augment human capability and interact with humans autonomously. The conceptual understanding of the smart service system by the German National Academy of Science and Engineering (ACATECH) instead holds an outcome-

driven view of services. Beverungen et al. (2017) introduce their definition as 'individually configured bundles of products and services' (citing the Smart Service Welt Working Group and ACATECH, 2015, p.782). Similarly, Allmendinger and Lombreglia's (2005) study on smart services, published nearly two decades ago, characterise smart services as the 'kinds of upkeep and upgrades you may be bundling with your product, both in their value to customers and in their cost efficiency to you' (p.1). The depiction of smart services in these studies suggests that they are boundary objects within a smart service system.

A common topic of debate in research streams on the smart service system is the need for a thorough understanding of the complex nature of the interaction between human and technology actors in a smart service system. Without this understanding, the research streams in smart services and smart service systems are unlikely to build a cohesive and holistic view on how to transform a service system into a smart service system from both a theoretical and a practical point of view.

Although technologies with material agency are now smarter than before, and thus they can autonomously interact with users based on the contextual data they can read, the level of their intelligence is still a long way away from enabling them to fully serve the needs and expectations of today's highly demanding users. As a result, it becomes more important for makers of SSPs to gain better insight into the enablers of, and deterrents to, value co-creation between actors in smart service systems (Wieland, Polese, Vargo and Lusch, 2012). Recent contributions in the HCI discipline have presented some interesting and novel insights into the drivers that help retain user engagement and the factors that drive it down – resulting in user abandonment. But in order to sustain the viability of a smart service system, all the actors who are part of a specific smart service system will need to have a deep understanding of users' needs, desires and behaviour through the lens of value-in-use. The notion of value-in-use in the smart service system further reinforces the importance of the outcome of value co-creation. A service system can remain viable only when the actors in a service system can seamlessly facilitate value co-creation for mutual benefit, and the users of smart services who are the beneficiaries of value co-creation uniquely and phenomenologically determine value-in-use. It highlights the importance of putting a user or human actor at the centre of a smart service system operation (Maglio 2015; Medina-Borja, 2015). Following on from this observation, Medina-Borja (2015) proposes that the current conceptual boundary of a smart service system needs to be expanded by integrating soft elements, such as human actors' behaviour, cultural beliefs and desires. In her view, the concept of the smart service system that articulates an elevated role of technology alone cannot explain emerging phenomena. Instead, she asserts the need to establish a human-centred smart service system that articulates both the human actors' complex needs and desires and the newly gained

material agency of the technology actors that allows them to directly interact with human actors in a service system.

Having recognised the need to understand the operation of a smart service system from a human-centred perspective, recent studies have taken a human-centred approach to understand how to design an adaptive manufacturing system (Peruzzini and Pellicciari, 2017) and how to design smart housing (Agee, Gao, Paige, McCoy and Kleiner, 2021). Similarly, Sangiorgi, Lima, Patricio, Joly, and Favini (2018) raised the question of the challenge of the increasing complexity and human-centredness of service systems. In response to this challenge, they proposed service design as an innovative approach that allows actors in a service system to navigate its complexity to enable the value co-creation process within a system through a human-centred design process. These studies offer great insight into the evolution of smart service systems towards human-centredness; however, there is a lack of knowledge about the complex nature of the interaction that takes place between human and technology actors within a smart service system. In order for the smart service system to remain viable, all the actors within a smart service system need to have a good understanding of the evolving dynamics of their interaction that may enable or constrain the value co-creation process.

The study by Storbacka, Roderick, Bohmann, Maglio, and Nenonen (2016) used actor engagement as a micro-level concept to explore value co-creation in a service system. This allows actors involved in a system to understand how the micro-level interaction in a service system interacts with meso- and macro-level interaction between actors to enable value co-creation at a system level. It also allows those who design a service system to instill human-centredness during the system design process, as system designers gain a good understanding of the enablers that help the beneficiary to realise value-in-use.

A similar study is much needed for a smart service system that involves many SSPs, which includes not only the interaction between humans and SSPs at the micro-level but also the interaction between SSPs. This gap in knowledge manifested in the literature presents an opportunity for future research that could shed light on what it means to establish and sustain a human-centred smart service system.

It is also imperative to mention that the review of the existing literature on smart service systems and human-centred service systems has revealed that there is a need for further research on how to take into consideration the influence of socio-cultural factors that underpin institutional norms and rules in the current discourse of smart service systems. Institutional norms and rules shape organisational and individual beliefs and values which underpin user needs and desires within a smart service system of a particular society; therefore, designing and operationalising a

human-centred smart service system requires an understanding of both the interpersonal and the technical elements of a system and how these can be integrated into a given system to enable value co-creation between human and non-human actors.

The significance of institutional norms and beliefs has already been discussed extensively in recent research contributions to SDL discourse (e.g. Vargo et al., 2020; Vargo and Lusch, 2016, Vink et al., 2020). Similarly, the role of institutions needs to be carefully explored within the context of a smart service system to advance the current understanding of the enablers of, and deterrents to, the value co-creation process within smart service systems. In doing so, the actors within a given smart service system will be able to build a preemptive capability that will help sustain the viability of the system. However, this discussion is beyond the scope of this doctoral research, and it will not be explored in depth here. Nonetheless, the influence of socio-cultural factors that are shaped by institutional norms and beliefs is examined when the results of design experiments are discussed in detail in chapters 5 and 6. This study specifically looks at how socio-cultural factors influence the way that users make sense of the emotions elicited by the olfactory stimulus during their interaction with an AI chatbot.

2.2.3 Value Co-Creation

With a shift from a goods-dominant economy towards a service-dominant economy, the concept of value co-creation emerges as a fundamental process that facilitates a superior customer experience (Pine II and Gilmore, 1999; Prahalad and Ramaswamy, 2003). Research streams in services research, especially those that emerge from within the circle of services marketing scholars, have studied the concept of value co-creation extensively. Despite the proliferation of research contributions on value co-creation, these studies barely reach a consensus on how they conceptually understand what is meant by value co-creation. Many conceptual approaches to defining the concept of value co-creation are derived from service management disciplines, such as services marketing, strategic management, and relationship marketing. Each discipline holds its own conceptual view on value co-creation, which has made it difficult for the service research community to reach a consensus on what it means by value co-creation (Grönroos and Voima, 2013; Neghina, Caniels, Bolemar and Birgelen, 2015).

To take an example, research streams in SDL conceptualise value co-creation as ‘a joint collaboration between firms and customers who integrate resources to create value for themselves or others (Vargo and Lusch, 2004a, 2008b). Several SDL FPs, specifically FP6, FP9, and FP10 (See Table 2.3), explicitly highlight that value is co-created. SDL’s FP6 underlines the disappearance of the role that categorises producer versus customer in the process of value creation (Vargo and Lusch, 2004a; Prahalad and Ramaswamy, 2004), because customers are no longer passive recipients of services but active participants of the value creation process as

co-producers (Prahalad and Ramaswamy, 2004; Payne and Frow, 2008; McKoll-Kennedy, Vargo, Dagger, Sweeney, and van Kasteren, 2012; Pinho, Beirao & Patricio, 2014)

TABLE 2. 3: TEN FOUNDATIONAL PREMISES OF SDL (VARGO AND LUSCH, 2008A)

FP1	Service is the fundamental basis of exchange.
FP2	Indirect exchange masks the fundamental basis of exchange.
FP3	Goods are a distribution mechanism for service provision.
FP4	Operant resources are the fundamental source of competitive advantage.
FP5	All economies are service economies.
FP6	The customer is always a co-creator of value.
FP7	The enterprise cannot deliver value, but only offer value propositions.
FP8	A service-centered view is inherently customer-oriented and relational.
FP9	All social and economic actors are resource integrators.
FP10	Value is always uniquely and phenomenologically determined by the beneficiary.

Grönroos (2011), however, argues that S-D logic's view of 'the customer as a co-creator of value on all occasions' is misleading. In his view, value creation cannot be an all-encompassing process that includes all the value chain activities. As stated in SDL's FP7, the enterprise can only offer value propositions: firms are value facilitators, while customers are value creators by enabling value-in-use through the consumption of product or service offerings (Gronroos, 2008; Grönroos and Ravald, 2011; Grönroos and Voima, 2013). However, Grönroos's view is challenged by previous studies that look at how value is co-created with customers from upstream value chain activities, such as new product ideation (e.g. Kristensson, Matthing, and Johansson, 2008; Filieri, 2013; Roberts and Darler, 2017). These studies often involve customers or users as co-creators of products and services during the early stages of the development of new products and services through participatory design practice. Involving customers as co-creators at an early stage of new product development contradicts Grönroos's claim, which limits the customer's role as a co-creator of value through value-in-use to downstream value chain activity, when the consumption of products and service offerings takes place.

As value networks that constitute service systems rapidly expand and become more complex, it becomes more challenging to understand the roles of companies and customers in the value co-creation process. Achrol and Kotler (2006) also share this view by elucidating that in a complex service system that consists of many value networks, it becomes increasingly trickier to understand the role of companies and customers in the value co-creation process, and to what extent customers are involved in this process.

In SDL narratives, the existing literature suggests that the customer assumes a dual role as a co-creator of value and the beneficiary of value-in-use, who determines the outcome of value co-creation. As such, Gummerus (2013) points out that the value co-creation process can be divided into two distinct concepts: value creation and value outcome. But how each actor perceives value

is idiosyncratic in nature, and it is guided by individual-specific goals, beliefs, and values (Pinho et al, 2014). As a result, the research stream that supports this view argues that SDL's axiom 4, which states that value is determined phenomenologically, has lower explanatory power for understanding the value outcome of the co-creation process. Furthermore, Grönroos and Voima (2013) assert that phenomenology represents multiple different ways of interpretation which causes confusion and inconsistency in understanding the value outcome; therefore, they suggest that the SDL's axiom 4 needs to be revised, as 'value is always uniquely and both experientially and contextually perceived and determined by the customer' (p.145). In their view, doing this will help the community of SDL researchers operationalise the concept of value co-creation, which is a higher-order construct that has a higher level of abstraction. In Grönroos and Voima's (2013) definition of value, they imply that the outcome of value is largely shaped by the temporal, spatial, social, and contextual dimensions of the value co-creation process. Their view is further supported by a group of value researchers (e.g. Woodruff, 1997; Woodall, 2003) who concur that value is cumulative and temporal.

Research streams in strategic management conceptualise value co-creation from an organisational perspective and describe the concept as a company's ability to co-create a unique personalised experience with customers. Prahalad and Ramaswamy (2003, 2004) describe the co-creation of a personalised experience as the way in which an individual customer chooses to interact with the experiential environment facilitated by companies. In their work, Prahalad and Ramaswamy (2003) argue that delivering superior customer value is no longer a source of competitive advantage for organisations. Instead, the source of competitive advantage lies in companies' ability to co-create an experience with customers that translates into value (Ramaswamy, 2008).

Understanding the concept of value co-creation through an experiential perspective is also witnessed in the existing literature on consumer culture theory (Arnould and Thomson, 2005) which describes the co-creative role of customers as working consumers (Cova and Dalli, 2009). In consumer culture theory, cultural and symbolic meanings become the foundation of the consumption experience. It is further explained by the idiosyncratic nature of this experience, as individuals evaluate their experience of consumption based on their previously learned experience (Woodruff and Gardial, 1996; Woodruff, 1997; Woodall, 2003) that is shaped by a socially constructed process. Cova and Dalli (2009) introduce the concept of working consumers, which they characterise as 'consumers who co-produce marketing offerings through immaterial labour'. They elucidate immaterial labour as customers' contribution to marketing offerings by offering their idiosyncratic views represented by cultural, affective, and symbolic meanings of their own. It suggests that prior to the introduction of SDL, the existing literature on consumer culture theory had already recognised a shift in the role of customers from that of a passive

recipient of product and service offerings to that of a co-creator and active participant in value co-creation. It is also easily observed in an emerging trend in innovation spaces, such as open innovation platforms that crowdsource innovative ideas from groups of target customers as co-creators of product and service development and bring out innovative new products and services that create value for customers. Penaloza and Venkatesh (2006) argue that immaterial labour also contributes to creating new social structures. Customers rely on their own idiosyncratic views, cultivated by the influence of cultural, affective, and symbolic meanings they have been exposed to when they evaluate their consumption experience. Following this logic, their individual-specific view influences the value co-creation process with a service provider, which either breaks down the existing social structure or creates a new one. The common themes gleaned from the existing literature on consumer culture theory and strategic management in relation to the concept of value co-creation can be summarised as follows: customers do participate in value creation in form of immaterial labour; their role in the value co-creation process is significantly influenced by their own idiosyncratic views, which are shaped by the cultural and symbolic meanings they are familiar with; therefore, the value outcome may represent a personalised unique consumption experience that results in value-in-use.

A conceptual understanding of value co-creation in the existing literature on relationship marketing focuses on the customer co-creation of value. Grönroos (2008, 2011) categorises the role of actors in the value co-creation process: firms as value facilitators and customers as value creators. His interpretation contradicts SDL's FP6 – the customer is always a co-creator of value. It also implies that value-in-use, which refers to value created *by* the user *for* the user, is not identified as one of the key theoretical underpinnings in SDL narratives. In Grönroos's analysis, customers take a role as a creator of value through value-in-use, whilst companies do so as value facilitators that support customers to create value. The essence of the conceptualisation of value co-creation in Grönroos's (2008, 2011) study is that the process of value co-creation is established only when companies have an opportunity to co-create value with customers through direct interaction. Gummerus (2013) concurs with Grönroos by classifying the value co-creation process into three specific procedures: company value creation, value co-creation, and customer value creation. Furthermore, he sub-categorises customer value co-creation into two different levels: processes (value created by customers' goal-oriented activities) and practices (value emerged from unconscious customer activities, as value itself is inherent in a social context).

Gummerus offers a proposition that takes a more systematic approach to evaluating the customer value creation process. Customer value creation is often considered a black box: how their customers realise the value in the context of their daily use is invisible to most companies. Researchers have already recognised this gap and claimed that a holistic and a complete view of how the value co-creation process takes place and how customer value is materialised in the

context of customers' daily use will become possible only when the customer value creation process can be fully captured (Elg, Engstrom, Witell, Pkisinka, 2012; Pfisterer & Roth, 2015). In order to tackle this gap in knowledge, previous empirical research tried to uncover the customer value creation process in the sphere of customers' private lives. Elg et al. (2012) used a diary method to investigate the patient value creation process in order to develop service offerings in healthcare settings. Their study was conducted with a fairly small sample; therefore, the generalisability of their study findings may be limited, but it can still serve as preliminary insight, which other researchers can build on to expand the current knowledge in the customer value creation process. In a similar vein, in response to Payne and Frow's (2008) call for further research into understanding how customers engage with the value co-creation process, McColl-Kennedy et al. (2012) conducted empirical research in a healthcare setting to gain a deeper understanding of how customers co-create value with a service provider and other stakeholders in healthcare customer value networks. They examine the customer co-creation process in the healthcare service setting in this empirical study through the theoretical lens of SDL, consumer culture theory, and social practice theory. The results of their study present the typology of customer co-creation practice style: *team management*; *passive compliance*; *insular controlling*; and *partnering*. In their discussion, they also reinforce an individual-specific perception of value which supports the view that individuals see the world through their own mental map, which forges their personal beliefs that shape the way they interact with others and make sense of the value co-creation process.

When a service system transforms into a smart service system, it introduces additional complexity to the interaction between actors within a system, because the machine-to-machine interaction and communication is realised and accelerated in a smart service system. In other words, SSPs will interact with both humans and other SSPs in a smart service system to co-create value, and as a result, the process of value co-creation among actors in a smart service system is more complex than that of a service system.

This growing complexity observed in smart service systems uncovers a gap in current knowledge in the existing literature. This gap in knowledge suggests a need for a systematic approach to exploring and understanding how the value co-creation process takes place at micro-, meso-, and macro levels of smart service system, and how value itself is realised at each level of the system to sustain the system's viability. Doing so will allow the community of value co-creation researchers to build more solid empirical evidence that further strengthens the claims made by previous studies as well as to validate theoretical assumptions, which may have not been sufficiently proven.

As SDL is adopted by design research, the concept of value co-creation is being explored by design researchers, too. The existing literature in service design describes value co-creation as one of the key theoretical underpinnings of service design. In Kimbell and Blomberg's (2017) study - 'The object of service design', they describe the concept of value co-creation as one of the fundamental elements that constitute service design. Also, they define a value co-creation system as 'a focus on the dynamic exchange of resources and processes that achieve outcomes for the actors involved, typically organisations but possibly individuals' (p.84). Similarly, service researchers who have studied service design in the context of service innovation have often explored a service design approach from a value co-creation perspective. Yu and Sangiorgi (2018) introduced a new service development framework using service design as a human-centred approach to implement value co-creation for new service innovation. Patricio, Pinho, Teixeira, and Fisk (2018) examined how service design can be used as an enabler for value co-creating interaction among actors within a healthcare service system. Wetter-Edman, Sangiorgi, Edvardsson, Holmlid, Grönroos, and Mattelmaki (2014) explored how value co-creation in a service system can be realised through a service design approach in the SDL logic context.

The existing literature on design research, particularly in the service design discipline, examines the concept of value co-creation through a processual approach. Because value is materialised through the consumption experience in a service-dominant economy, design researchers use service design as a human-centred approach that helps actors within the service system to enable value co-creation. Despite the growing research traction of value co-creation within the design research community, the research contributions from the design research community to the value co-creation research stream remain relatively limited in comparison with contributions from the services marketing and management disciplines, which have a history of studying the concept of value co-creation for several decades. But the research contributions on value co-creation by the services marketing and management disciplines lean heavily towards the way users (or customers) engage in value co-creation with service providers and make sense of value (e.g. Ramaswamy, 2008; Payne and Frow, 2008; McColl-Kennedy et al, 2012).

A divergent conceptual approach observed in the existing literature in the services marketing and design research disciplines reveals an opportunity for further research contributions from interdisciplinary studies, which can make a significant contribution to advancing the current state of knowledge in value co-creation. Because smart service systems present unprecedentedly complex challenges, which researchers have never encountered before, a fresh perspective that combines thinking from both the services marketing and the management and design research disciplines may reveal novel and original knowledge that may challenge the current thinking and assumptions that are yet to be uncovered. By doing so, research streams in value co-creation can establish a common foundation of knowledge whilst advancing current knowledge of the

process of value co-creation and how it is enacted through the interaction between actors in a smart service system.

2.3 Design

***'Design is the process by which we devise a course of action aimed at changing situations into preferred ones'* (Simon, 1982, p.129).**

2.3.1 Service Design

Service design is a fairly new discipline within the design research community, although the concept of designing services was introduced to the marketing discipline by Shostack in 1982. As the world economy has shifted from a GDL economy towards an SDL economy, the perspective on innovation has also shifted from an output-based view, such as incremental innovation versus radical innovation, towards value co-creation (Sudbury-Riley, Hunter-Jones, Al-Abdin, Lewin, and Naraine, 2020). A heightened emphasis on the outcome of value co-creation as an emergent approach to innovating has further elevated the role of design in business world. Several years ago, McKinsey & Company (2018) commissioned a research study which assessed the business value of design. Their research data reveals that design-led organisations that have embraced design as part of their strategic capability tend to perform as twice as better in terms of revenue growth and shareholder return. This is well illustrated by the success of an organisation like Apple. Apple has revolutionised the consumer electronics market with its design that takes the emotional value of a product and service experience into account. Apple products boast millions of fanatical followers. The long queues in front of Apple stores whenever a new iPhone is launched on the market explains clearly why many organisations today are focusing on creating an experience that connects their brand with their users (and customers) on an emotional level. The growing recognition of design as part of the strategic capability of organisations is also increasingly observed in a sector where design had been part of neither a product nor a service delivery business model for a long time, such as software products aimed at developers. Leading market players in the B2B sector, such as Microsoft, IBM, and VMware, nowadays have a strong design team that embraces human-centred design principles to build tools and frameworks that are used by the developer community. This trend is a clear sign that the positive impact of design on business outcome is significantly recognised by many businesses.

With the growing traction in design thinking practice by corporate executives in an SDL economy, service design has emerged as a human-centred approach that explores opportunities to reconfigure resources and enhance innovation through the value co-creation process (Sun and Runcie, 2017; Andreassen, Kristensson, Lervik-Olsen, Parasuraman, McColl-Kennedy, Edvardsson, and Colurcio, 2016). The existing literature that has examined service design operationalises it as a problem-solving process that can explore wicked problems in a messy world and that allows actors within the service system to collaboratively identify potential

solutions (e.g. Salgado, Wendland, Rodriguez, Bohren, Oladapo, Ojelade, Olaere, Luwangula, Mugerwa, and Fawole, 2017; Griffione, Melles, Stiggelbout, and Snelders, 2017). The service design process is iterative and incorporates a reflection-in-action approach (Schön, 1983), and this iterative and adaptive process offers superior explanatory power for the study of emerging phenomena in an SDL economy in which value-in-use continuously evolves with the use context. Also, more importantly, service design helps service providers to understand the problems from a user's (or customer's) perspective rather than from a company perspective. Consequently, service design further reinforces the notion of value-in-use.

The review of the existing literature in service design reveals two specific patterns. One of these is the proliferation of empirical studies in experience-centric settings, such as healthcare services, tourism, and financial services. Since service design, in its literal meaning, means designing for a service, it may be obvious that this pattern is well observed in the literature. However, in an SDL economy, a service is considered to be the fundamental basis of all economic and social exchange (Vargo and Lusch, 2004a), which results in a product as part of service offerings. Nonetheless, the lack of previous studies in service design for product service systems suggests that earlier studies underestimated the fact that the product is part of service offerings. For example, to the best of my current knowledge, the literature on service design has yet to study SSPs, such as fitness trackers and AI chatbots, from a service experiential perspective. An SSP is a boundary object of smart services. It means that user value, co-created between the user and an SSP, is materialised through the user experience, which is the consumption experience of an SSP's services. But most previous studies in service design are heavily skewed towards pure services. Salgado et al. (2017) adopted service design as a human-centred problem-solving approach to assess the barriers which prevent local women in Nigeria and Uganda from using local healthcare facilities to give birth safely in order to reduce pre- and postnatal related mortality and morbidity in these countries. Griffione et al. (2017) also used service design as a collaborative problem-solving process to explore how a more effective shared decision-making model can be developed in a healthcare services setting. Vink, Evardsson, Wetter-Edman and Tronvoll (2019) adopted service design as a human-centred approach to reshape the mental models of actors in the healthcare service system to enable service innovation. Similarly, Patricio, Fisk, Cunha, and Constantine (2011) introduced a new service design approach and illustrated how this can be used to redesign financial services.

Another pattern observed in the existing literature in service design is the introduction of a service design methodology that helps to operationalise the concept of SDL and its key theoretical underpinning – value co-creation – in design practice to encourage service innovation. Sudbury-Riley et al. (2020) have introduced a service design methodology called the Trajectory Touchpoint Technique, which helps organisations to build a more robust understanding of value

co-creation. In doing so, service design can shed light on how a theoretical perspective of SDL and value co-creation can be empirically examined through design practice in a real-life context. They illustrate the application of the Trajectory Touchpoint Technique in the context of palliative care. In a similar vein, Yu and Sangiorgi (2018) have introduced a new integrated service development framework that helps service designers to approach the development of new service concepts that encourage value co-creation.

One of the biggest challenges SDL has faced in the past ten years has been its higher level of abstraction that makes it difficult to be operationalised in an empirical context. As a result, the concept of value co-creation which constitutes SDL is equally a higher-order construct that is also difficult to be operationalised for an empirical observation in research studies. Brodie, Saren, and Pels (2011) recognised this challenge early on and identified a need for mid-range theory for SDL to be developed.

In response to this call for the development of mid-range theory, Storbacka et al. (2016) introduced a micro-level concept called actor engagement to enable the operationalisation of the concept of value co-creation in SDL discourse. Again, they characterise SDL's theoretical underpinnings, such as value co-creation, as a high-level macro construct that is better suited to the development of meta-level theory. Storbacka et al. (2016) argue that because actor engagement is a micro-level concept that offers a level of analysis that is lower than the phenomenon that takes place at a macro-level, it allows researchers to empirically observe a high-level construct, value co-creation.

In the existing literature in design, service design is implicitly depicted as a mid-range theory that can enable the operationalisation of the concept of value co-creation and close the gap between SDL at a meta-theory level and empirical observation that takes place at a micro level. It is uncertain whether researchers intended service design to be used for this purpose, but this approach is clearly manifested in previous studies by Sudbury-Riley et al. (2020) and Yu and Sangiorgi (2018).

The two patterns in the existing literature in service design illustrated above reveal an opportunity for further research in smart service system. It is clear from recent contributions to service design research (e.g. Sun and Runcie, 2016; Andreassen et al., 2016) that in both academia and practice, there is a growing enthusiasm for and interest in service design. As the world enters the Fourth Industrial Revolution, the advancement in technology has transformed a service system into a smart service system in which technologies can autonomously interact with both humans and other technologies within a system. Giving added complexity to a service system by technologies enabled by material agency (Leonardi, 2001), smart service systems represent

complex patterns of interactions among actors of the system at the micro, meso, and macro level and across all three levels. This emerging complexity means that design researchers will need to untangle it at each level as a starting point for building a robust understanding of the value co-creation process among actors in a smart service system. The need to expand the analytical lens from a dyadic relationship to a 'many-to-many' relationship in the value network had already been pointed out by Achrol and Kotler (2006) and Gummesson (2006). Their earlier observation and critique were later reflected in a service ecosystems perspective which stresses the nature of the complex interaction between multi-actors in a service system at the micro, meso, and macro levels (Akaka, Vargo, and Lusch, 2013; Akaka and Vargo, 2015).

This historical trend suggests that studying the interaction between the human and technology actors in smart service system should not be carried out with a siloed approach. Instead, design researchers will need to take a zoom-out approach to build a robust understanding of how the interaction between actors across all three levels – micro, meso, and macro – sustain the viability of a system. Nevertheless, a smart service system represents a highly complex and complicated system that is hyper-connected by multiple actors and institutions, and it will take considerably longer than three years of PhD to complete this research, especially using design as a research method, which is grounded in the qualitative research tradition. But, as observed in the existing literature in SDL discourse, the findings from previous studies that have examined the dyadic relationship between actors within a service system have informed the development of a service ecosystem perspective.

Although research that enquires into the interaction between human and technology actors at the micro level will not be able to fully flesh out the pattern of the value co-creation process across different levels of the system, it is still a good starting point. This research inquiry will help the design research community to start building the common foundation of knowledge required to design a value co-creating interaction in a smart service system. Also, more importantly, the research phenomenon that manifests at the micro level of the smart service system often directly touches upon the user problem. An example is the lack of user engagement, specifically with an AI chatbot, in this research is a recent phenomenon observed at the micro level of a smart service system. According to previous studies, the reason for the emerging phenomenon of the lack of user engagement is attributed to the lack of perceived user value (Clawson et al, 2015; Lazar et al, 2015). Most contributions on the phenomenon of the lack of user engagement observed in human-technology interaction are predominantly from the HCI discipline, and they have focused primarily on generating new knowledge on the reason for the lack of user engagement. Hence, both the design research and the HCI disciplines are exposed to a significant amount of knowledge about what the driving factors or causes of the lack of user engagement are. However, these studies often lack a processual perspective. For example, what

enables the value co-creation process and what intervenes or breaks down the value co-creation process between the user and an AI chatbot remains unknown. Similarly, how the value co-creation process affects the level of user engagement and user satisfaction, and the user's continued intention is unknown, too.

Although this gap in knowledge suggests that contributions to knowledge from design research can fill this void, there is still a paucity of studies that have adopted design research to examine the concept of value co-creation, especially in the context of the smart service system. Previous studies (e.g. Sudbury-Riley et al, 2020) demonstrate that service design can function as a mid-range theory and help the operationalisation of the concept of value co-creation by bridging the gap between the theoretical perspective of SDL on value co-creation and an empirical observation – the lack of user engagement taking place at the micro level of the smart service system.

This knowledge gap observed in the existing literature motivates further research on how service design could help to empirically observe the concept of value co-creation in the context of human-AI chatbot interaction in smart service system. Doing so will allow design researchers to build a holistic view of how value co-creation that takes place between the user and an AI chatbot at the micro level of the system may influence the value co-creation process at the meso and macro level of the smart service system.

Also, more importantly, currently there is a significant lack of in-depth understanding of what makes users engage and connect deeply with an AI chabtot on an emotional level. Industry commentators have already stressed the importance of instilling emotional connection into the interaction between the user and the SSPs in general (Chaturvedi, 2016) to enhance user engagement. Many SSP makers have focused on making SSPs smarter than yesterday to make sure that they can co-create utilitarian value with their users; but previous studies have already validated that utilitarian value alone cannot retain users in the long term.

The value co-creation process between the user and the SSP becomes seamless, as SSPs become more deeply integrated into users' lives, and deep interaction will only become possible when SSPs can offer a human-centred experience that connects with users on an emotional level (Robbins, 2015).

A number of previous studies (e.g. Spadafora, Chahuneau, Marelaro, Sirkin, and Ju, 2016; Wright, Wallace and McCarthy, 2008) have explored how to enable an emotional experience between the user and an object. These studies, however, focused only on a dyadic relationship – the interaction between the user and an object – in which a service system perspective is absent.

Thus, these studies do not offer a holistic picture of how the value co-creation process that takes place between the user and an object at the micro level may have a ripple effect on meso and macro levels of the system. Also, smart service systems remain largely missing from previous empirical studies that have explored emotional experience design. This gap in knowledge suggests that further research needs to be done to understand how the value co-creating interaction that results in both utilitarian and emotional value-in-use can be designed in the context of the smart service system.

2.3.2 Aesthetics

'Aesthetics is the sensual experience a product entails, and the extent to which this experience fits individual goals and preferences' Thuring and Malhke (2007, p.257).

Aesthetics is a discipline that has been studied for many centuries (e.g. Aristotle 384-322BC; Bell, 1914). Earlier studies in aesthetics describe the discipline as a static relationship with the physical properties of an object. Their description implies that aesthetics is a static concept of beauty that emerges through forms. Aligned with this, Clive Bell introduced the term 'significant form', which refers to the beauty of a work of art that gives rise to aesthetic emotions. Significant form, in Bell's words, is defined as certain dimensions, colours, and textures in visual art that provoke aesthetic emotions in a viewer. Bell characterises significant form as an object of aesthetic emotions and makes a distinction between aesthetic emotions and everyday human emotions (Bell, 1914; Carroll, 1989). According to Bell's description of significant form as an object of aesthetic emotions, everyday human emotions caused by a cognitive response are excluded from what is considered 'aesthetic emotions'. Bell explicitly states that emotions elicited in viewers when they look at descriptive painting that illustrates historical values and topographical work should be seen as suggested emotions rather than aesthetic emotions. Aesthetics emotions are one of key constructs in this doctoral research, and it is closely discussed in the following section of this chapter.

Bell's concept of significant form is an approach which generalises the common patterns observed in works of art, specifically visual art, that evokes the viewer's emotions. Although Bell's approach was not without criticism from other philosophers, he, like Kant, has had a significant influence on the theorisation of art and aesthetics itself. As already suggested by Bell's conceptualisation of significant form, early studies in aesthetics defined the term as the physical appearance of an object that arouses emotions in a viewer, and 'aesthetics' was often used interchangeably with 'beauty'. Although Bell argued that his conceptual meaning for aesthetics did not refer to beauty, he himself also acknowledged that the concept of aesthetics was often interchangeably used with beauty or carried the connotation of beauty, as in phrases

such as ‘a beautiful young woman’. Bell was cautious about using the concept of aesthetics interchangeably with beauty, because the use of beauty in early studies tended to refer to desirability, in his view (Bell, 1914).

Regardless of whether aesthetics is seen as beauty, or beauty as desirability, the common characteristics observed in early studies in aesthetics (e.g. Aristotle, Bell, Kant, and Collingwood) suggest that these studies held a static perspective on the concept of aesthetics. This perspective viewed aesthetics as describing the physical appearance of an object; therefore, it is one of properties of an object. But this static perspective has gradually evolved towards an experiential perspective, which describes aesthetics as an experience.

An experiential perspective on the concept of aesthetics was first explored through the concept of aestheticisation introduced by the Bauhaus school in the early twentieth century. Also, the contributions by both John Dewey (1934/1980) and Shusterman (2000) on pragmatism were catalysts that have furthered the conceptual status of aesthetics as experience rather than as a static form of beauty. Dewey (1934/1980) claimed that the conceptual boundary of aesthetics needs to be expanded further, as the aesthetic experience is not necessarily tied solely to works of art; instead, he argues that the aesthetic experience can take place in any ordinary type of activity which anyone could experience on a daily basis. A shift in the conceptual view of aesthetics as a static concept towards aesthetics as an experience has introduced many new concepts with an experiential view towards aesthetics, such as the aesthetics of interaction and aesthetic experience. This evolution observed in research streams in aesthetics also reflects how aesthetics is understood and interpreted in SDL context. Aesthetics as the physical appearance of an object conveys GDL thinking, in which the value of aesthetics is embedded in works of art or in objects. On the other hand, aesthetics as experience implies that the value of aesthetics arises from the interaction between humans and the work of art, which reflects the fundamental thinking of SDL, which claims that value is co-created by multiple actors, including the beneficiary.

A shift in the conceptual thinking on aesthetics has also brought a change in the way aesthetics is studied in the HCI discipline. Earlier studies in HCI that examine aesthetics has often explored the interaction between humans and computers through the lens of a relationship between utility and aesthetics; thus, the view of aesthetics as the physical appearance of an object, as defined by G-D logic, remained paramount. For example, the research streams (e.g. Tractinsky, 2004; Norman, 2004) that support the view that ‘what is beautiful is usable’, demonstrated by the study conducted by Kurosu and Kashimura in 1995, argue that users tend to find an object with a superior aesthetic appearance more usable and efficient than an object with a less appealing appearance. The notion that what is beautiful is usable is, however, challenged by later studies

(e.g. Tuch, Roth, Horbaek, Opwis, and Bargas-Wvila, 2012; Hamborg, Hulsmann and Kaspar, 2014) which claims that 'what is usable becomes beautiful'. The results of these studies demonstrate that the impact of an aesthetically appealing appearance of an object on its usability, as perceived by its users, gradually weakens as the user uses a product for some time and becomes familiar with it.

The contributions from recent scholarship at the nexus of utility and aesthetics indicate that how users make sense of aesthetics reflects an SDL perspective on value-in-use. As users experience value-in-use, the importance of the physical attractiveness of an object gradually wanes, but value-in-use itself emerges as the aesthetics of the object for users. This is articulated by the recent study by Xenakis and Arnellos (2015) who define aesthetics as 'a valuative emotional process that reduces the interactive uncertainty'; in their view, aesthetics is the value that arises through the embodied interaction.

Scholars in the HCI discipline have started making active contributions to the debate on aesthetics as experience since the 2000s. Many of them have realised that in order to understand the concept of aesthetics, they need to understand aesthetics as the interactive behaviour between the user and an object (Locher, Overbeeke, and Wensveen, 2010; Lenz, Diefenbach, and Hassenzahal, 2014). This view still prevails among contemporary HCI researchers, as recent studies often characterise aesthetics as the user value that arises through the interaction between the user and a technology, as technology is seamlessly integrated into the user's daily life (Hur, Sturdee, Alonso, Markopoulos, and Alexander, 2017).

The concept of aesthetics is a complex and nebulous one that shares diverse perspectives that derive from many different epistemological origins. Classical thinkers and philosophers in aesthetics agreed very little on the conceptual definition of aesthetics. A similar pattern continues in contemporary scholarship. A shift in thinking towards aesthetics as experience has introduced multiple competing definitions and frameworks that conceptualise aesthetics as experience. Hummels and Overbeeke (2000) define the aesthetics of interaction as 'the sense of beauty that arises through the interplay between a user and a product in their context.' (p.9). Building on Shusterman's pragmatist aesthetics, Petersen, Iversen, Krogh, and Ludvigsen (2004) describe aesthetics as 'appropriated in use through meaning-making activities rather than a static relationship with the beauty of artefacts' (p.271). They also emphasise the participation of users in creating meaning and sense in a given context, which enables aesthetic experience. In their view, users' sense-making and meaning-making processes entail not only the sensory embodied experience but also socio-cultural influence and users' prior experiences that inform the way they make sense of their experiences. Lenz et al. (2014) also articulate that in order for designers to

create an engaging and positive experience with a technology, designers will need to take into account meanings that emerge through the interaction.

Djajadinningrat, Gaver, and Frens (2000) characterise the 'aesthetics of interaction as the consequence of a shift of focus from aesthetically controlled appearance to aesthetically controlled interaction, which results in a transition from ease of use to enjoyment of experience' (p.66). Thuring and Malhke (2007) define aesthetics as 'the sensual experience a product entails, and to the extent to which this experience fits individual goals and preferences (p. 257). Similarly, Hekkert (2006) conceptualises aesthetic experience as 'an experience that is restricted to (dis)pleasure that results from sensory perception' (p.157). In their definitions of aesthetics, it is explicitly stated that aesthetics as experience refers to a sensory experience that generates value – pleasure and joy in use – for users. A similar argument is made by Nam and Kim (2011) who claim that it is imperative that designers should be able to create a product that is pleasurable and that offers an emotional experience to users. Jordan (2000) furthermore emphasises that because products are living objects, those products which users can relate to can be perceived as pleasant to use, which translates into emotional value for users.

Table 2.4. below shows the evolutionary trajectory of the concept of aesthetics from a design and an HCI disciplinary point of view.

TABLE 2. 4: THE EVOLUTION OF AESTHETICS

CONCEPTS	THEORETICAL PERSPECTIVE	RELEVANT WORK
Aesthetics	A static concept of beauty; the physical appearance of an object	Aristotle (384-322BC); Bell(1914); Tractinsky (2004); Kurosu and Kashimura (1995).
Aesthetic Experience	Aesthetics as the sense of beauty that emerges in the user's experience of product or services.	The Bauhaus School (1991-1933); Xenakis and Arnellos (2013).
Aesthetics of Interaction	Aesthetics emerges in recurring interaction between actors. A recurring interaction between actors is also known as an adaptive process that allows actors to adapt their behaviour to help them achieve their goals.	Hummels and Overbeeke (2000); Petersen, Iversen, Krogh, and Ludvigsen (2004); Lenz, Diefenbach, and Hassenzhal (2014); Moen (2015).

The evolutionary trajectory of aesthetics presents an interesting pattern. Although there are divergent views and perspectives on aesthetics as an experience or interaction, general commonalities can be drawn. First, it is noticeable that contemporary scholarship's conceptualisation of aesthetics as experience often emphasises the sensory aspect of an experience. Also, the individual- and context-specific aspect of an experience, in which aesthetics is 'appropriated in use', is mentioned repeatedly in earlier studies. The general commonalities observed in contemporary scholarship makes a clear distinction between aesthetics as experience and aesthetics as an appearance. For example, although Bell, equally, stressed the sensory aspect of an experience through the introduction of a hypothetical

relationship between significant form and aesthetic emotions, he made a clear distinction between aesthetic emotions and any other emotional state experienced by a viewer. Carroll (1989) critiques Bell's approach as a reflection of his own prejudice, which tended to encourage a distorted world view in theorists. In her view, art is closely intertwined with cultural practice; thus, if the significant form of art is an object of aesthetic emotion, aesthetic emotions experienced by a viewer cannot be completely independent from socio-cultural influence.

Her critique is clearly supported by the contemporary scholarship in HCI that examines aesthetics as experience and interaction. Aesthetics as 'beautiful in use' or 'appropriated in use' is highly contextualised in each use scenario by the users, who bring their knowledge and prior experiences that are deeply influenced by existing socio-cultural elements. The users' meaning- and sense-making processes mentioned above can be the course of action users take to appropriate the use of an object in a given use scenario.

In addition to the general commonalities observed in the conceptual understanding of aesthetics, the existing literature in HCI that examines aesthetics from an experiential perspective also reveals areas for future research. Building on their conceptual definition of aesthetics as experience, earlier studies have discussed what enables an aesthetic experience in the context of user-object interaction. The common approach adopted by industrial designers has been to influence the feeling of interaction by visual or haptic effects (Djajadiningrat, Wensveen, Frens, and Overbeeke, 2004). The literature highlights the significant role played by sensory triggers in the narratives of the aesthetics of experience. Despite this explicit acknowledgement, the research contributions that explore how designers could use sensory modalities as a medium of design to help users experience the aesthetics in their interaction with an object remain limited. Nam and Kim (2011) point out that the gap in current knowledge in the existing literature is the lack of relevance to real life design problems and the implications for design practice.

Similarly, previous studies (e.g. Petersen et al, 2004; Lenz et al, 2014) make a strong claim that users will be able to experience the aesthetics of a product only when it is appropriated by their use of it. But most these studies do not offer practical design guidelines for designers to design the aesthetics of experience or orchestrating the aesthetics of experience for users to realise it. This missing knowledge suggests that more studies are required to understand how to bridge the gap between aesthetics as experience from a theoretical standpoint and from a design practice standpoint. Without filling this gap in knowledge in the current literature, it will be difficult for the research streams in aesthetics as experience to build empirical evidence of their theorisation. Further research that examines the potential design methods that can bridge this gap and help users to experience the aesthetics of experience could advance the current knowledge in aesthetics. Similarly, future research that explores how existing design methods can be used to

bridge the gap and help users to experience the aesthetics of experience that emerges in a wide range of use scenarios could also contribute to the research streams in aesthetics as experience within the design research and HCI disciplines.

2.3.3 The Olfactory Stimulus as a Design Material

The human olfactory sense is known to be the most primitive sense that has an intimate relationship with the areas of the human brain, the amygdala and the hippocampus, that directly control human emotions (Hirsch, 1995). Despite this close link between the human olfactory nerve system and human emotions, the olfactory sense remains under-explored, especially in the HCI discipline (Obrist, Tuch, and Hornbaek, 2014; Davis, Kooijman, and Ward, 2003).

In the services marketing discipline, the research streams in retailing have examined the effect of an olfactory stimulus on customers' perception of a service and customer behaviour. With the rise in emerging technologies and the wide adoption of digital technologies by mainstream users (and customers), recent scholarship in marketing and psychology have also examined how to integrate human senses other than the visual into an online environment in order to influence user (and customer) judgement and decision-making process.

Petit, Velasco, and Spence (2019) examined the use of sensory-enabling technologies to create an engaging online customer experience. Spence (2020) also inquired into the use of an olfactory stimulus in a museum environment and explored the integration of the olfactory stimulus into visual effects in this environment to augment an immersive visitor experience. But he acknowledges the counterintuitive research outputs, which illustrate that an olfactory-rich environment in a museum does not necessarily evoke a positive emotional response in visitors. In a similar vein, Cirrincione, Estes and Caru (2014) elucidate that in their experimental work that examined the effect of odour on visitors' perception and memory of art in a gallery, a pleasant ambient odour reduced the positive evaluation of the works of art and hindered visitors' memories of the art they experienced. Their study results support those of an earlier study conducted by Eskine, Kacinik, and Prinz (2012) who demonstrated that a pleasant ambient odour does not have a positive linear relationship with the perception of art in a viewer. With the emergence of the experience economy (Pine II and Gilmore, 1999), experiential marketing has effectively used olfactory cues as one of the tactics to influence consumer behaviour and decision-making process, but the result of empirical studies in an art context confirms that a pleasant ambient odour does not always positively influence art gallery and museum visitors.

In marketing practice, sensory marketing has been widely accepted and used for many years, even prior to the introduction of the notion of the experience economy by Pine II and Gilmore in 1999. In retail and tourism settings, marketers have been using odour as a marketing strategy to build a favourable customer attitude and brand image. Also, marketers have often used odour as a lever to differentiate their product and service offerings, especially if their offerings are difficult

to be differentiated from competitors' offerings, based on technical specifications that serve the functional needs of customers and users (Spangenberg, Crowley, and Henderson, 1996; Minsky, Fahey, and Fabrigas, 2018). Minsky et al. (2018) claim that one of the reasons why marketers use odour for products and service offerings that are difficult to be differentiated is because of the ability of odour to evoke memories of earlier experiences in customers, which, as a result, helps customers to build an association between the odour and the brand. By doing so, marketers were trying to enhance customers' brand recall, as well as encouraging them to build an emotional connection with the brand, given that odour touches human emotions deeply (Hirsch, 1995).

An empirical relationship between odour and human memory is well reported in the existing literature in psychology and marketing; however, Cirrincione et al.'s study (2014) proves that the use of odour does not necessarily improve the human memory, specifically in the context of experiencing art. Their study tested participants' ability to recall the paintings they had seen. The participants viewed 15 paintings by each of two different artists in an environment impregnated with odour. They were later presented with 60 paintings in a random order, that included 30 paintings they had seen before. The study result confirmed that a pleasant ambient odour did not have a strong relationship with participants' ability to recall the paintings. Cirrincione et al. (2014) explain this result as external distraction to viewers of paintings. Building on Isen's (1984) mood maintenance model, they argue that participants were distracted by the pleasant ambient odour because they were trying to maintain a positive mood and focused their attention on the odour rather than on the paintings. Their study result brings a different perspective to the notion of an empirical relationship between odour and the human memory that had rarely been challenged for decades. It also denotes that further research may be needed in this space in order to accurately determine the external validity of an empirical relationship between odour and human memory.

Returning to an example of experiential marketing, Minsky et al. (2018) discuss in their study several empirical studies in which the olfactory stimulus has had a positive effect on human experience. One of these studies demonstrates that office workers working in an environment where ambient odour was used made fewer typing errors, while another study confirms that the odour used in a retail store helped increase the purchasing intentions of customers and the average units of sales. The latter instance has already been repeatedly proven in the existing literature in marketing. For example, the most recent meta-analysis by Roschk and Hosseinpour (2020) projects that the use of positive ambient odour would be likely to increase the average customer expenditure by up to 23%. The authors warn, however, that this outcome relied on several situational contingencies, such as the congruency of the odour with a product, a unidimensional aroma structure, odour familiarity, the types of service exchanged, and the

proportion of female participants in the study; however, the projected amount of increase in average expenditure is not insignificant.

On the other hand, the reduction in the number of typing errors made by office workers raises some questions. Minsky et al. (2018)'s study does not provide details of this example. Also, the types of odour used in this example are unknown, and therefore it could be explained in many different ways, based on the arguments in the existing literature. Odour is closely linked to the areas of the human brain that directly control human emotions. A pleasant ambient odour that elicits pleasant emotions in office workers could have improved the processing fluency in their brains, which might have contributed to the reduced number of errors (Kuchinke, Trapp, Jacobs, and Leder, 2009). Alternatively, if the odour used were *incongruent* with an office environment, this incongruency between the odour used and the office environment might have helped office workers stay alerted, and as a result, they might have made fewer typing errors than usual (Cirrincione et al, 2014).

The examples introduced in the study by Minsky et al. (2018) are based on real-life situations in which odour was used to achieve intended business outcomes. As shown by many earlier empirical studies conducted in the marketing discipline, Rimkute, Moraes, and Ferreira (2016) claim that the effectiveness of ambient odour is also well supported by scientific empirical evidence, demonstrated by academic research. For example, a positive relationship between an ambient odour and its spillover effect on customer experience is repeatedly found in the existing literature. The majority of earlier studies have examined the effect of odour on customers' ability to retrieve memories and build a connection with a brand. Although the use of a pleasant ambient odour demonstrates that it could evoke memories of earlier experiences in customers, Krishna's (2012) work discovered that product odour rather than ambient odour is more effective at evoking memories in customers, which helps customers to quickly access relevant information and forge an association that influences their judgement and decision-making process.

A systematic review of the effect of odour on consumer behaviour conducted by Rimkute et al. (2016) reveals that the effect of odour on memory retrieval becomes significant in a condition in which the odour is congruent with the class of product and the customers are not aware of the odour. Their study result supports the view that when customers are aware of the presence of odour, its positive effect on customers' perception of services is minimised, because they consciously adjust their ratings of the quality of the services. Similarly, when customers are aware of ambient odour, their likeability rating of human faces tends to diminish. This finding suggests that marketers who adopt the ambient odour in order to build positive customer perception of products and services will need to ensure that they use an odour that is congruent with product and service offerings and use it discreetly.

This finding also presents a complex implication for SSPs. An SSP is an everyday consumer product that is used in various use scenarios in the daily lives of its users. As a result, SSP makers and SSP-enabled smart service providers who are planning to adopt odour to build a positive perception in users may face a challenge in identifying an odour that is congruent with multiple use scenarios. Imbuing the product with the odour is another challenge. Despite the fact that sense-enabling technology has made great strides to date, the chemical senses, smell and taste, are still far behind the haptic sense, which has been rapidly catching up with visual and auditory senses in terms of the discussion in academic research.

Although Krishna's (2012) study demonstrates that product odour can more easily evoke memories in customers than ambient odour, it is problematic to imbue SSPs that are used in a wide range of use scenarios with a single odour, as it may trigger negative emotions in the user if the odour is not congruent with a specific use context. The use of SSPs in diverse scenarios in users' daily lives raises a question about whether the olfactory stimulus can be effectively integrated into the user experience and ultimately help users and SSPs co-create value. The technical complexity concerning the integration of the olfactory sense into the HCI context has already been acknowledged by the HCI research community (Obrist et al., 2014; Petit et al., 2019). However, with the advancement of the olfactory sense-enabling technologies, the contributions by the HCI research community that closely examine odour have ensured that gradual progress has been made.

For example, most recently, Maggioni, Cobden, and Obrist (2019a) introduced smell-based interaction design toolkits called OWidgets for olfactory-enabled experience design in HCI. Companies such as AromaJoin offer a targeted scent delivery through technology, in this case AromaShooter (Spence, 2020), to businesses and allow the consumers to try the scent of a new perfume they are interested in purchasing. A shift towards a multi-sensory experiential approach from an ocular-centric world that focuses on the visual is not only pronounced in academic research but also in museums and art galleries that have previously held a conservative approach towards experimenting with other senses.

Spence's (2020) recent article reviewed numerous initiatives in multisensory experiences that took place in various major museums and art galleries globally to help visitors to have a more engaging and immersive experience. One of the examples Spence introduced in his article is the pairing of eight masterpieces from the Louvre Museum with perfumes that were specially designed by top perfumers, commissioned by the museum in 2019. The integration of the olfactory stimulus in an art context presents a similar technical challenge to that of the HCI context. Ambient perfume that is used across an open gallery and museum space can potentially

elicit a negative emotional response in viewers when the perfume is not congruent with specific paintings the viewers are seeing. In order to mitigate this technical challenge, the Louvre Museum sold scent in their museum shop to visitors who wanted to use their olfactory sense to augment their experience of eight masterpieces in the museum's permanent collection.

Also, there is a growing research call for emotional experience design in the HCI context (e.g. the Call for Papers for the Special Edition 'AI Service and Emotion' of the *Journal of Service Research,* 2021), as an increasing number of SSPs have been integrated into users' daily lives and users are becoming more demanding than ever, taking functional value for granted. But earlier studies in HCI affirm that studying the nexus of the olfactory sense and user emotions in the context of HCI has been a challenge for the research community. Kaye (2004) explains that the human olfactory sense is inherently more complicated than the visual sense, because the visual sense has only four receptors, whilst humans have thousands of olfactory receptors in their noses, which can process different types of chemical molecules in the environment. Kaye's explanation alludes to the inherent complexity of the human olfactory sense as the very reason for the paucity of literature examining the olfactory sense in the HCI discipline.

Since the 2000s, the olfactory sense has started to gain more research traction in the HCI research community. Earlier studies in the HCI discipline that have examined the olfactory sense reveal two distinct research streams. One of these examines the olfactory sense as a medium for designing a user interface (e.g. Maggioni et al, 2019; Olofsson, Niedenthal, and Zarkzewska, 2017; Dmitrenko, Maggioni, and Obrist, 2017). Olofsson et al. (2017) explored odour as a medium of design for the development of odour-based educational games. Similarly, Dmitrenko et al. (2017) introduced the OSpace, which is a design approach for olfactory interaction design.

Another research stream instead focuses on the effect of the olfactory sense on human experience, judgement, and decision-making process (e.g. Miyasato, 2017; Wintersberger, Dmitrenko, Schartmuller, Frison, Maggioni, 2019; Rainer and Timmerer, 2014; Brewster, McGookin, and Miller, 2006). Miysasto's (2017) study examined the effect of olfactory stimulus on human emotions to encourage energy-saving behaviour. In a similar vein, Wintersberger et al. (2019) explored the effect of an olfactory-based driver display on safe driving behaviour. Rainer and Timmerer (2014) assessed the quality of consumers' experience with multimedia content from a multisensory perspective, whilst the study by Brewster et al. (2006) investigated the effect of the olfactory sense on participants' ability to recall photographic images.

Despite some novel insights that have advanced the current thinking, the findings from the research stream that inquire about the olfactory sense as the medium of design for olfactory-enabled user interface design have also brought to the fore the limitation of these studies. The

analytical focus of these studies is ingrained in a GDL thinking. These studies explored how HCI researchers and designers can use the odour to create a novel form of interaction, such as an olfactory-enabled interface for users. The research problem of these studies indicates that the authors assumed that user value is embedded in olfactory-based interfaces, and they were trying to validate this assumption through their studies. However, in an SDL context, the use of olfactory stimulus is explored through the lens of value co-creation and value-in-use; thus, the studies that explore the effect of odour on human experience, emotions, and decision-making will ensure more up-to-date contributions to the current research context.

Building on the foundation of an SDL thinking, Obrist et al. (2014) offered experience design opportunities in an olfactory space, specifically focusing on the HCI context. Also, Maggioni et al. (2019b) presented Smell Space, with four distinct experience design features – chemical, emotional, temporal, and spatial – for olfactory experience design, based on a review of the literature in neuroscience, sensory science, and experimental psychology. In addition, they further validated their design features in two specific empirical contexts, desktop and VR implementations.

The contributions from these studies advance the current knowledge in olfactory-enabled experience design. However, they also have shortcomings, which need to be addressed by future research. These studies have predominantly adopted a positivist approach. Although Maggioni et al. (2019b) have demonstrated their design process through the lens of a design space analysis approach (MacLean, Young, Bellotti, and Moran, 1991) for three empirical studies discussed in their study, they conducted their empirical observation through a scientific experiment. The tension between design and scientific experiments is a historical debate (Steffen, 2014), which is discussed extensively in Chapter 3. Designers are not accustomed to operating within the context of a carefully defined scientific experiment. Also, a design space analysis approach, which relies heavily on design rationale articulated through the documentation of the design process, is also not necessarily an approach that is widely adopted by designers, as many designers often rely on their tacit knowledge during their design process (Schön, 1983).

In essence, the fundamental aim in conducting an experiment is different between the scientific and design research communities. Designers and design researchers conduct an experiment to learn from trials and errors and move closer to their intended outcome (Steffen, 2014). Despite the differences that are observed between these two research communities, the current research streams that explore olfactory stimulus as the medium of design in the HCI context has not explored the design process from the perspective of how designers think and work. This gap suggests that there is a need for further research that takes into consideration how designers

think and work, and how their approach is both similar to, and different from, that of scientific researchers.

In design research, studying the olfactory stimulus poses an additional challenge. The distinction between smell and perfume is often considered an oxymoron. In sensory research, some research streams argue for the differences between smell and perfume (Van Toller and Dodd, 2012). Despite this fact, this study does not differentiate between these two. Smell may carry a superordinate meaning, given its broader scope, while perfume is restricted to the meaning of producing fragrances to serve a designated purpose, mostly a commercial one. In this study, perfume is described as a subset of smell, which is produced for serving an aesthetic purpose. In the contemporary art world, many artists have used both smell and perfume in their artistic practices. The olfactory artist Sissel Toolas collaborated with the jewellery maker Georg Hornemann to create a functional ring which emits three specific functional smells – attraction, distraction, and attention. The artistic goal for this project was to use scent as a subconscious message to influence human behaviour (https://www.georghornemann.com/en.html). Another example of the exploration of the olfactory stimulus in artistic practice is the olfactory installation created by Qatari artist Aisha Naser Al Sowaidi, which was exhibited at the Qatari Pavilion for the Emotional State exhibition sponsored by the London Design Biennale 2018. She created seven units, domes that emit specific odour whenever a visitor stands behind them. Her motivation for this installation was to use the odour to evoke memories that help people to reflect on and interact with their past experiences. In her installation, a close relationship between odour and memory is further reinforced. The integration of smell for artistic purposes may be an indication that the distinction between smell and perfume is becoming more blurred.

This tendency is also pronounced in industry, which has leveraged perfume as a strategic tool to strengthen business personality and brand identity. This business tactic prevails specifically in the tourism and retail sectors. For example, Abercrombie & Fitch sprays its signature fragrance, Fierce, around the store to bolster its brand image of masculinity and sex appeal among the target customer groups. Similarly, the Westbury hotel group created its signature candle for their use to build a strong brand recall and brand awareness among its target customers. How these businesses use the olfactory stimulus as part of their business strategy also suggests that they tend to use it as a design material to orchestrate their touchpoints to enable their intended customer experience.

These empirical examples are evidence that designers who may be interested in experimenting with an olfactory stimulus to design for the aesthetics of experience in HCI need to build a good knowledge of how the olfactory stimulus can be integrated into the orchestration of all touchpoints. A seamless touchpoint orchestration is crucial for enabling an engaging user

experience, which is often the outcome of value co-creation. The existing literature in design research, however, has yet to explore the olfactory stimulus as a potential design material to orchestrate all the touchpoints within the user journey to enable the aesthetics of experience in HCI.

This section has reviewed the literature in olfactory sense from design, services marketing, and HCI from both a theoretical and an empirical standpoint. The section that follows takes a close look at the literature in aesthetics emotions and articulates the current knowledge gap in the existing studies.

2.3.4 (Aesthetic) Emotions

In the existing literature that examines the olfactory stimulus for customer experience design (e.g. Calvi, Quassolo, Massaia, Scandurra, D'Aniello, and D'Amelio, 2020; Bao and Yamanaka, 2015; Braun and Cheok, 2015), a close link between the human olfactory sense and human emotions is highlighted. Because of this intimate relationship between the olfactory sense and emotions, the olfactory stimulus has been actively studied by scholars in the marketing discipline to understand its effect on customer emotions and customer behaviour (e.g. Teller and Dennis, 2012; Chebat and Michon, 2003).

However, the research contributions that examine the link between human emotions and the olfactory sense are a fairly recent phenomenon (Van Toller, 1991). In the book *Perfumery: The psychology and biology of fragrance*, published in 1991, Van Toller laments that despite the presence of a significant relationship between human emotions and the olfactory sense, this link has been largely ignored by theorists (e.g. Bull, 1951; Solomon, 1977). He attributes the ignorance of the research community to the lack, or absence, of an educational context for emotions and the olfactory sense. For example, he refers to Descartes, who held a rationalist view and degraded emotions as a lower-order biological process exhibited by animals. In Descartes' view, human emotions are not as important as human's cognitive ability, which meant that he did not give enough attention to the concept of emotions. Similarly, Van Toller describes that the olfactory sense had not received the attention it deserved from the research community, because of the absence of a language of smell that is widely adopted by the international academic community. Humans learn how to differentiate colours by their names, but there are no standardised semantic descriptors for odours that are widely accepted and adopted by the international academic research community.

Despite the discouraging view offered by Van Toller on the lack of research interest in the link between emotions and the olfactory sense, the existing literature on emotions during the 1990s and the 2000s depicts a stark contrast to Van Toller's description. As illustrated earlier, researchers in the marketing discipline have actively pursued their inquiry into the effect of the olfactory stimulus on human memory, emotions, and experience. A similar phenomenon is

observed in the HCI discipline, as recent contributions to the HCI discipline that examine the effect of sensory modalities on HCI have tried to integrate sensory modalities other than vision and sound, which had predominated in earlier studies (Obrist et al, 2014; Maggioni et al, 2019a; Spence, 2020).

Going back to Van Toller's view, although he critiques the academic research community's lack of interest in the significance of the relationship between human emotions and the olfactory sense, he does not deny that the concept of emotions boasts a rich history of research, with contributions from numerous disciplines, namely neuroscience, psychology, sociology, and marketing, to name a few. But scientists have been struggling for a long time to find the common foundation of knowledge to conceptualise and operationalise the concept of emotions. Scherer (2005) explicitly describes this gloomy situation as follows, 'Defining "emotions" is a notorious problem. Without consensual conceptualisation and operationalisation of exactly what phenomenon is to be studied, progress in theory and research is difficult to achieve and fruitless debates are likely to proliferate' (p.695).

Despite the continuing debate on the conceptualisation and the operationalisation of the concept of emotions, one commonality can still be found in the conceptual definitions of emotions derived from various disciplines. Most researchers in the field of emotions, whether they have recognised it or not, view the concept of emotions as a multi-faceted phenomenon that consists of complex sets of dimensions. For example, Desmet (2005), from the design discipline, suggests that the concept of emotions consists of the following five dimensions: behavioural reactions; expressive reactions; physiological reactions; and subjective feelings. In a similar vein, Kim and Fesenmaier (2015), who have explored emotions for tourism experience design, conceptualise emotions as a complex set of interactions between subjective and objective factors mediated by neural system which performs four specific processes as follows: 1) Giving rise to affective experiences such as feelings of arousal; 2) Generating cognitive processes such as relevant perceptual effects, appraisals, labelling processes; and 3) Activating widespread behaviour that is often, but not always, expressive, goal-directed, and adaptive. An earlier study in the marketing discipline by Bagozzi, Gopinath, and Nyer (1999) interprets emotion as follows: 'By emotion, we mean a mental state of readiness that arises from cognitive appraisals of events or thoughts; has a phenomenological tone; is accompanied by physiological processes; and is often expressed physically (e.g. in gesture, posture, facial features); and may result in specific actions to affirm or cope with the emotion, depending on its nature and meaning for the person having it' (p.184).

The selective examples of conceptual definitions of emotions introduced above are derived from different disciplines, such as design, tourism, and marketing. However, regardless of the disciplinary differences, all these examples clearly demonstrate that emotion involves multiple

dimensions, which touch upon cognition, affect, and behaviour. Also, although it is not explicitly stated in all three definitions, the idiosyncratic nature of emotions is implicitly highlighted. Desmet (2005) mentions 'subjective feelings', while Kim and Fesenmaier (2015) articulate the presence of subjective factors that determine emotions. Bagozzi et al. (1999) stress the phenomenological aspect of emotions. Supported by this observation, this study contends that emotion is a subjective experience, which is difficult to understand by means of a simplified basic emotions categorisation.

Ekman (1992) introduced categories of basic emotions, which comprise the following six discrete emotions – excitement, surprise, anger, fear, sadness, and disgust. But emotions elicited by the olfactory stimulus are rich in detail that cannot be easily categorised into a single unit of emotion, such as fear. Chrea, Grandjean, Delplanque, Cayeux, Le Calve, Aymard, Velazco, Sander, and Schere (2009) claim that earlier empirical studies demonstrate that olfactory-induced emotions rarely match the categories of basic emotions. Also, the basic emotions underestimate the significance of the idiosyncratic nature of emotions that are determined by contextual-driven meanings, which forge a subjective emotional experience.

Addressing the drawback of basic emotions derived from categorical theory, Wundt introduced dimensional theory, which classifies emotions according to certain dimensions (Reisenzein, 1992). There are many debates on what dimensions and how many dimensions should be used to classify emotions within dimensional theory, but Russell's (1980) Circumplex Model of Affect, which uses valence and arousal as dimensions to classify emotions, has been widely used in the literature to date. But the Circumplex Model of Affect is not also without its drawbacks. Russell himself acknowledged the limitation of the dimensional theoretical approach, which lacks the ability to holistically capture rich accounts of emotions. Chrea et al. (2009) also point out that the scale of pleasantness and arousal rating defined by dimensional theory excludes many important contextual details that can be explored through rich verbal descriptions of an emotional experience. They also argue that the concept of emotions derived from both categorical theory and dimensional theory use a self-report questionnaire to measure emotions. This approach imposes pre-determined prescriptive choices on the participants, which often results in a biased understanding of an emotional experience.

The emotion research community recognised this challenge early on. For example, Desmet (2003) introduced the Product Emotional Measurement instrument, known as PrEmo. PrEmo uses pictograms which demonstrate different facial features portraying 14 different emotions. The core idea of PrEmo lies in facial expression as a communication tool for emotions, given that facial expression can be a more effective medium of communication to convey emotions than the verbal description of emotions. Desmet iterated PrEmo multiple times, based on the feedback he

had collected since the beginning of his study. Although this approach may overcome the effect of cross-cultural differences on the verbal description of odour, it remains unclear whether PrEmo can reliably measure product design-related emotions induced in users or emotions induced in users during their interaction with an object. Desmet acknowledged in his study that further research is needed in order to further validate whether the 14 emotions identified for PrEmo can be used as reliable measurements for emotions induced in users in the HCI context. In order to measure these emotions, researchers may need a more robust approach, given that emotions induced in users in the HCI context are significantly influenced by the dynamics of the interaction rather than the product design itself.

Prior studies often adopted a self-report questionnaire, which they designed based on the categorical and dimensional theories, to measure emotions, and this approach was also often criticised for its lack of ability to capture emotions induced in the participants in real time. The participants are often asked to complete the self-report questionnaire after their emotional experience is over. It means that there is a time lapse between when they experienced the emotion and when they are asked about the experience. This time lapse between the moment of emotional experience and the participants' recall of their emotional experience often undermines the accuracy of the emotions captured in the self-report questionnaire. In response to this shortcoming, research into emotions in psychology and HCI have started adopting a psychophysiological measurement, such as a skin conductance response and functional resonance imaging (fMRI), to capture emotions experienced by the participants (e.g. Christopoulos, Uy, and Yap, 2019; Williams, Johnson, Curtis, King, and Anderson, 2018) in real time. Although psychophysiological measurements allow researchers to measure an emotional response of the participants in real time, these measurements are unable to capture complex and mixed emotions, but only the basic emotions, such as happiness, sadness, and anger.

Given the multi-faceted nature of emotions that involve both autonomic and subjective responses, the approach to measuring emotions has always been under discussion, as it has always been challenging for the research community to reliably and accurately evaluate emotions. Also, the subjective dimension of emotions means that certain emotions are interpreted in multiple different ways (Desmet, 2003; Maggioni et al, 2019b). For example, someone who enjoys a thrilling experience may find bungy jumping triggering positive emotions in them; but this same experience could elicit unpleasant emotions, such as distress and fear, in someone who does not find a thrilling experience pleasant.

Those studies that have recognised the complexity caused by the subjective dimension of emotions started to base their analysis on appraisal theory (Arnold, 1960; Lazarus,1991). Appraisal theory is defined as 'a process that detects and assesses the significance of the

environment for well-being' (p.120). Appraisal theory considers emotions as a cognitive phenomenon and has a processual perspective towards the evaluation of emotions. It assesses the evolution of emotions by the continuous revision of appraisals. Ellsworth and Scherer (2003) describe the appraisal process as a link that bridges the gap between the human, the situation, and the context that elicits emotions in humans.

The research streams in emotions have developed many theoretical frameworks and measurement approaches. There is no one right approach to studying emotions. But understanding the interaction between a user and an SSP requires a more robust approach than basic emotions theory in order to accurately and reliably capture emotions elicited in users. SSPs, such as fitness trackers and chatbots, are used in various use scenarios, which also involve certain steps that need to be taken by users to enable SSPs to interact with them. It means that the types of emotions elicited in users are often complex and mixed. It is also important to recognise that the interaction is a dynamic event that may elicit aesthetic emotions in users.

After Kant's (1790/1989) work on aesthetic emotion, the concept of aesthetic emotion had not received much research traction outside the academic circle of the art research community. Menninghaus, Wagner, Wassiliwizky, Schindler, Hanich, Jacobsen, and Koelsch (2019) point out that prior studies had never attempted to conceptualise aesthetic emotion, and their recently published study is a response to the absence of an established conceptual definition of aesthetic emotion in prior studies. Kant (1790/1989) described aesthetic emotion as emotion elicited by aesthetic evaluation and judgement. During Kant's period, the conceptual boundary of aesthetic emotion was narrow, as studies in aesthetic emotion only focused on the emotions in the context of art. However, recent studies on aesthetic emotion have an expansive view of the conceptual boundary of aesthetic emotion, as their description of aesthetic emotion clearly conveys that the concept of aesthetic emotion encompasses a broader context: art, design, architecture, nature, and even events and experience (Perlovsky, 2014; Mennighaus et al, 2019).

Menninghaus et al. (2019) introduced four essential components that underpin aesthetic emotions in their studies as follows: 1) Aesthetic emotions are discrete emotions that always include an aesthetic evaluation/appreciation of the objects or events under consideration; 2) Individual aesthetic emotions are differentially tuned to various types of aesthetic virtues, which highlight the subjective and idiosyncratic nature of emotions. Perceived beauty is one of the well-known examples; 3) Aesthetic emotions are associated with subjectively felt pleasure or displeasure during the emotional episode; and 4) Aesthetic emotions are predictive of resultant liking or disliking (p.185). In addition to four essential components of aesthetic emotions, they introduced six additional prototypical features that represent aesthetic emotions. Within their

comprehensive conceptual review of aesthetic emotions, they made it clear that aesthetic emotions do not refer solely to positive emotions, but also to negative emotions. Their review of empirical studies in aesthetic emotions confirmed that negative emotions are often integrated into positive emotions to elicit a strong and more engaging emotional experience.

Menninghaus et al.'s study (2019) was not the only one that has recently attempted to advance conceptual thinking on aesthetic emotions. Perlovsky (2014) presented the conceptualistion of aesthetic emotions several years earlier than Menninghaus et al. He describes the concept of aesthetic emotions as 'emotions related to human satisfaction of the knowledge instinct at the top of mental hierarchy' (p.2). In his view, both cognitive and affective challenge are the source of aesthetic emotions. For example, when you have finally found a solution for cognitively challenging mathematical questions, you will experience aesthetic emotions. Perlovsky's emphasis on both cognitive and affective challenges as the source of aesthetic emotions is also supported by Menninghaus et al. (2019), who claim that cognitive and affective coping potential, as well as processing fluency, all contribute to the elicitation of aesthetic emotions.

With limited research contributions to aesthetic emotions as a distinct concept, there is a challenge in terms of how to measure aesthetic emotions and capture different types and extents of aesthetic emotions in each context. Schindler, Hosoya, Menninghaus, Beermann, Wagner, Eid, and Schere (2017) introduced the Aesthetic Emotion Scale (Aesthemos) to measure aesthetic emotions, but the conceptual boundary of aesthetic emotions and the conceptualisation of aesthetic emotions need to be further researched first to understand whether a scale like Aesthemos can reliably measure the concept of aesthetic emotions in each research context.

The aim of this doctoral research is to understand how designers can leverage the olfactory stimulus as a potential design material to design for the olfactory-enabled aesthetics of experience that may promote value co-creation in human-AI chatbot interaction. It clearly communicates that the focus of this study lies in the exploration of the link between the olfactory stimulus and olfactory-enabled aesthetic emotions, rather than ordinary emotions, experienced by users. Prior studies demonstrated that if visitors to museums and galleries, or those who have read novels and attended concerts, have experienced aesthetic emotions, this tends to increase the frequency of their exposure to the objects and events or they tend to linger in a physical space where they have experienced aesthetic emotions (Spence, 2020; Menninghaus et al, 2019; Pursey and Lomas, 2018; Cirrincione et al, 2014). Building on this empirical evidence from prior studies, this doctoral research hypothesises that aesthetic emotions experienced by users would help to improve user engagement in human-AI chatbot interaction context by promoting value co-creation between the user and an AI chatbot. This is based on the fact that users who have experienced aesthetic emotions are likely to engage with a chatbot more and are thus less

likely to abandon it. Also, aesthetic emotions could enhance users' processing fluency, which will reduce users' uncertainty about the affordance and interaction cues during the interaction with a chatbot.

This review of the current literature on emotions clearly articulates that there is a gap in the knowledge in aesthetic emotions, and the recent contributions that have rekindled the interest of the emotions research community in aesthetic emotions suggest that further contributions that can advance the current knowledge of aesthetic emotions are encouraged.

2.4 Conclusion

The review of the current literature in the design research, service marketing, and HCI disciplines reveal some areas that require further research to advance the current understanding in each discipline. However, given the nature of interdisciplinary study and limited resources available for this doctoral research, it will focus on filling the gap in knowledge identified in which all these disciplines – design research, service marketing, and HCI – overlap.

Also, it is imperative to note that the research problem – the lack of user engagement and user abandonment in a smart service system – which this doctoral research aims to explore will benefit from diverse perspectives from all three disciplines. This section is devoted to a summary of the gap in knowledge identified through the review of literature in the preceding sections and articulates the overlapping gap in knowledge that invites further contributions from interdisciplinary studies.

First, previous empirical studies that examined the emerging phenomenon of the lack of user engagement in smart service systems (e.g. Lazar et al, 2015; Clawson et al, 2015; Deghani et al, 2018; Trajkova and Martin-Hammond, 2020) shed light on the factors that cause user frustration that lead to the lack of engagement and abandonment as a result, and the factors that determine user satisfaction. It is a great first step towards understanding the phenomenon of the lack of user engagement. But, put simply, if the lack of users' value-in-use is the reason for the phenomenon, how could a value co-creation experience for human-AI chatbot interaction be designed? Further research is needed to fill this gap in the existing literature.

Second, recent contributions to smart service system research highlight the importance of creating a human-centred (smart) service system. The human-centeredness of the system requires a deep understanding of socio-cultural influence that is shaped by the institutional norms and beliefs of a particular society. Although the existing literature in SDL discusses the role of institutions from a service system perspective extensively, a similar dialogue is much needed in the smart service system research context. How do the institutional norms and beliefs that shape individual actors' needs, desires, and value systems influence individual actors' value co-creating

behaviour within a specific smart service system? This is a gap in knowledge that needs to be filled by future research.

Third, the existing literature in value co-creation elucidates that the value co-creation process has become more complex as more actors are involved in value networks (Pinho, Beirao, and Patricio, 2014). A growing complexity in value networks is also well reflected in the smart service system, in which technology actors can communicate with one another whilst they continue to interact with human actors. As the smart service system itself is new to the research community with the emergence of the fourth industrial revolution, the complexity of value networks represented in the smart service system is also a new challenge for most scholars. A limited understanding of the complexity represented by the smart service system means that the research community will benefit from a fresh perspective that comes from different schools of thought. In the research stream of value co-creation, the role of service design is becoming more prominent. The existing literature often characterises service design as a facilitating mechanism or as a catalyst for innovation (Yu and Sangiorgi, 2018; Kleinschmidt, Burkhard, Hess, Peters, and Leimeister,2016). The growing research traction of service design in the service research community suggests that further contributions from interdisciplinary studies that offer a perspective from both service marketing or management and service design would help to advance the current level of knowledge of value co-creation.

The three points above illustrate the gap in knowledge identified by the review of literature in the Services section. In the Design section, the review of the existing literature has identified the following gaps.

First, the existing literature in service design reveals two distinct patterns. One is that most previous studies focus on aspects of the service-oriented sector, such as healthcare, financial services, and tourism. In an SDL economy, products still play an important role as a delivery mechanism for services. For example, SSPs such as fitness trackers are the delivery mechanism for activity and mood tracking for keeping a healthy lifestyle, which is a smart service offered by fitness tracker makers. Users purchase fitness trackers to realise value-in-use by consuming smart services. This closely entangled relationship between products and services in an SDL economy indicates that the research streams in service design will benefit from further research that closely examines the role of service design in the product-service system.

Another pattern observed in the existing literature is the role of service design as a mid-range theory that can operationalise a higher-order concept like value co-creation. But the review of the literature has found that the role of service design in the smart service system has been rarely studied.

Secondly, the concept of aesthetics has evolved towards an experience-centric perspective, which has also introduced many concepts derived from it, such as aesthetics of experience, aesthetic interaction, and so on. Despite many conceptualisations of aesthetics as experience, the research streams in aesthetics as experience do not offer thorough insight into the ways designers can design and orchestrate the aesthetics of experience in order for users to realise it in a use context. This gap needs to be addressed by future contributions.

Third, two distinct patterns were observed in the research streams in the olfactory sense. One is the research stream that examines the olfactory stimulus as a design material for olfactory-enabled user interface design. Another pattern is the research stream that explores the effect of the olfactory stimulus on human experience, judgement, and the decision-making process. The review of the existing literature demonstrates that the studies that examine the olfactory stimulus as a design material for novel user interface design assume that user value is inherent in a physical product like a user interface. However, in an SDL context, where user value is co-created between actors in the service system and value-in-use represents the value outcome realised by the beneficiary, the latter research stream, that explores the effect of the olfactory stimulus on human experience, judgement, and decision-making process, would encourage more timely contributions that may advance the current knowledge in the smart service system.

Although more recent studies, especially from the HCI discipline, have contributed to understanding the effect of the olfactory stimulus on human experience from an experience-centric perspective, the current studies offer a limited perspective, as they rely predominantly on a scientific experimental approach and thus lack the perspective of how designers think and work during the design process. As a result, the findings from prior studies offer a limited perspective on how designers can use the olfactory stimulus as a design material to orchestrate various touchpoints throughout the user's interaction with SSPs, such as AI chatbot, and enable the aesthetics of experience in user's use context.

Last, the existing literature on emotions and aesthetic emotions shows that the conceptual boundary of aesthetic emotions has expanded to emotions beyond the context of art. Recent studies on aesthetic emotions claim that those who have experienced aesthetic emotions tend to linger in the place where they have experienced the emotions or increase the frequency of their exposure to the object that triggered them. Building on this claim, this doctoral research hypothesises that users who have experienced aesthetic emotions during their interaction with an AI chatbot are less likely to abandon it, because aesthetic emotions have enhanced user engagement and satisfaction. Despite the strong potential link that has been suggested between aesthetic emotions and user engagement and satisfaction, this connection is not supported by

the current literature on aesthetic emotions. Since after the Kant's period, the research contributions to aesthetic emotions have been modest; but the growing research traction in aesthetic emotions that has been recently observed represents an encouraging outlook. Future research that further examines the conceptualisation and the operationalisation of the concept of aesthetic emotions, especially in the context of an emerging phenomenon such as the lack of user engagement and user abandonment in smart service system would advance the current thinking on aesthetic emotions significantly.

The gaps in knowledge stated above are distilled from the literature review in this chapter, where the key constructs of this doctoral research are closely examined. The summary of the gaps in knowledge identified can be found in Table 2.5 below.

TABLE 2. 5: THE SUMMARY OF THE GAPS OF KNOWLEDGE IN THE CURRENT LITERATURE IN SERVICES & DESIGN

Key Constructs	**Relevant Knowledge Gaps in the Current Literature**
Service Dominant Logic	A lack of insight into how a value co-creating user experience in the context of human-AI chatbot interaction in a smart service system can be designed.
Smart Service System	Limited knowledge of how institutional norms and beliefs influence actors' value co-creation behaviour in a smart service system.
Value Co-Creation	More contributions from interdisciplinary studies that offer fresh perspectives from both the service research and the design research communities are needed to study emerging phenomena in complex smart service systems.
Service Design	A lack of current knowledge on the role of service design in a smart service system.
Aesthetics	There is a missing knowledge between aesthetics as experience from a theoretical standpoint and how aesthetics as experience can be brought to life in design practice.
Olfactory Sense	The olfactory sense has been under-explored in the HCI context; the scientific experimental approach used in prior studies does not offer deep insight into how a designer can use the olfactory stimulus as a design material to enable the aesthetics of experience in the context of human-AI chatbot interaction.
Aesthetic Emotions	More research is required for the conceptualisation and the operationalisation of the concept of aesthetic emotions in the context of emerging phenomena.

2.5 Research Questions

Many gaps have been identified through the literature review. However, this doctoral research is unable to address all the gaps identified for pragmatic reasons such as limited time and available funding. This doctoral research is expected to be completed within the 3 years of the PhD programme; however, the scope of the gaps in knowledge articulated means that it could easily take longer.

Instead of trying to address all the gaps in knowledge articulated above, this doctoral research has distilled two research questions from the gap in knowledge identified as common to all three disciplines – design, services marketing, and HCI.

As a result, the following research problem is further developed into the research questions, based on the common gap in knowledge identified above.

Research Problem:

The lack of user engagement observed in human-AI chatbot interaction in a smart service system.

Research Questions:

1. How could service designer use the olfactory stimulus as a design material to design for the olfactory-enabled aesthetics of experience in human-AI chatbot interaction?
2. Could the olfactory-enabled aesthetics of experience emerged in human-AI chatbot interaction enable value co-creation between the user and AI chatbot that enhances user engagement?

In the next chapter, the methodological approach that is used to seek answers for the research questions above will be discussed.

Chapter 3: Methodology

Design Research as a Methodological Approach: Debates on the Relationship between Art/Design and Science

3.1 Introduction

This chapter is about the methodology of this doctoral research and discusses the rationale for choosing this method to answer the research questions introduced in Chapter 2. The research method framework known as the Research Onion, in Figure 3.1 (Saunders, Lewis, and Thornhill, 2019), has been widely used in the literature to date. The framework was introduced in a textbook by Saunders et al. (2019), aimed at business school research students, but scholars from non-business disciplines, such as information and systems management (e.g. Alturki, 2021) and tourism and hospitality management (e.g. Abdelhakim and Badr, 2021) have also adopted this framework to articulate their research design and methodological approach.

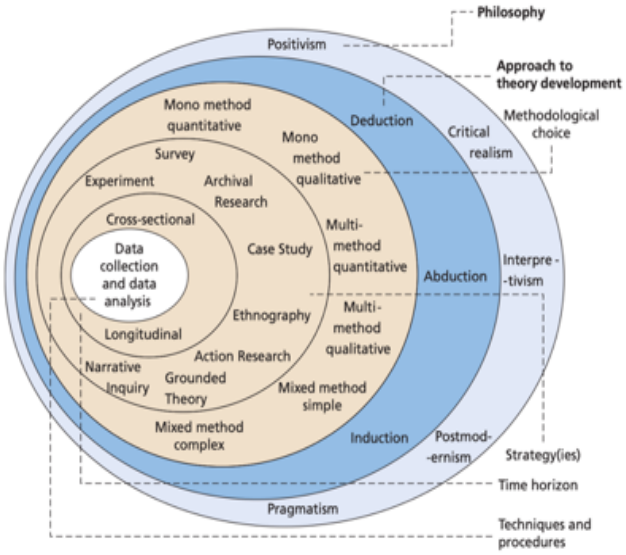


FIGURE 3. 1: RESEARCH ONION (SAUNDERS ET AL, 2019).

Using Saunders et al.'s (2019) Research Onion approach, this chapter will articulate the methodological approach of this doctoral research and present the rationale behind the chosen method.

This doctoral research is an interdisciplinary study that is situated at the intersection of design research and services marketing. As it anticipates a broad readership that includes scholars from non-design research disciplines, who are not necessarily familiar with design as an academic research discipline, this chapter also briefly introduces the historical background of design research, which dates back to the period when the tension between art and science emerged, immediately after the end of the Renaissance era. By doing so, this research aims to help scholars coming from non-design disciplines to easily grasp how the epistemological and an ontological position of design research has become what it is today. It then delves into the similarities and the differences between the philosophy of design research and that of scientific research and presents the reasons why this doctoral research has chosen a design experiment as a research method to explore the research questions introduced in Chapter 2.

3.2 Art and Science: A Historical Background of Design Research

During the Renaissance era, there was a great tendency that many scholars hold the view that art and science are two sides of the same coin (Steffen, 2014). This mainstream view blurred the boundary between art and science, which was articulated in scholarly works during this period which promoted the convergence of art and science. However, as the Renaissance period ended, positivism emerged. During this period, the polarisation of art and science was established. Positivist scholars started dismissing the experiment used in the art and design discipline as an 'experiment', based on the reason that how artists and designers use an experiment does not conform to the criteria defined by the scientific disciplines. Furthermore, even within the scientific disciplines, scientists were struggling with a fragmented view on the conceptual understanding of an experiment and how it should be conducted. This fragmented view by the scientific research community further intensified the division between an inductive and a deductive approach to an experiment.

The followers of an inductive approach (e.g. Francis Bacon, Galileo Galilei, Issac Newton, etc) advocated that experiments can only be derived from observed facts on which theory is developed. In contrast, Karl Popper, a pioneer of a deductive approach, proclaims that theory takes precedence over an experiment. In his view, the ultimate purpose of a scientific experiment is the falsification of theories. He further elaborates that one cannot claim that 'all swans are white' by observing only white swans, but one can confidently deduce the conclusion that 'all swans are *not* white' by discovering one black swan (Popper, 1979).

This intellectual tension between an inductive and a deductive approach is still ensuing in the current research traditions in science. Arguing to determine which approach is superior is a meaningless pursuit. The explanatory power of each approach is bearing on the aim of the research study and the school of thought in which a researcher's belief is ingrained. As a result, there is no one-size-fits-all approach in science. Instead, the context, the aim and the objective of the research, and the belief of a researcher become the foundational elements that determine whether an inductive or a deductive approach offers superior explanatory power.

The government's research funding allocation and an educational system which encourages students to specialise in one single discipline, whether it be art or science, have also significantly contributed to furthering the polarisation of art and science. In his notable work, *The Two Cultures*, C.P. Snow (1990) contends that the education system that encourages students to specialise in a single discipline should be re-evaluated, since ground-breaking innovation more often emerges from interdisciplinarity. Snow's claim is further supported by Massey (2018) who reviewed Snow's *The Two Cultures* through his most recent analysis of the trend emerging in the arts and the science disciplines. Massey, a physicist by training who has had several academic leadership roles in the arts, claims that Snow's depiction of a barrier between art and science disciplines is no longer valid in the twenty-first century. Although Massey's article focuses only on institutions in the United States, a growing number of academic institutions are encouraging interdisciplinary studies. A similar movement also prevails in the UK, where the Royal College of Art and Imperial College London offer a joint degree that provides students with an opportunity to pursue their intellectual curiosity in both design and engineering disciplines. Also, although a large sum of research funding is still allocated to STEM-related subjects, the UK Arts and Humanities Research Council (AHRC) focused on design research as one of the strategic priorities for its 2011-2015 delivery plan, as the value of design for the UK economic development has become increasingly recognised. The AHRC continues to support design research that tackles a wide range of industrial and societal challenges, such as an ageing society and climate change.

The current trend in the convergence of art and science promotes complementarity in which each discipline complements the other with its own unique attributes; as a result, complementarity celebrates the differences observed between these disciplines and uses them productively. As much as differences between the disciplines of art and science have prompted a heated debate in the existing literature to date, this distinction has also revealed similarities between them. For example, the concept of experiment is not exclusive to science. In the art and design discipline, the word 'experiment' has been used extensively (Schwab, 2013). But given its epistemological origin, in the art and design discipline, an experiment has a different meaning and has been used differently (Koskinen, Binder, Redstrom, 2008; Steffen, 2014; Rhienberger, 1997; Kubler, 1962).

The English term ‘experiment’ is derived from the Latin word *experimentum* and was first used in the fourteenth century (Steffen, 2014). According to the online *Cambridge Dictionary* in April 2021, an experiment is defined as follows: 1) ‘A test done in order to learn something or to discover if something works or is true’; and 2) ‘To try something in order to discover what it is like or find out more about it’. The first definition of the experiment offered by the online Cambridge dictionary was pervasive in the early days, especially during the period when the meaning of the experiment used in the art and design disciplines was significantly dismissed by the mainstream academic disciplines, such as natural science and psychology. Even now, a conceptual understanding of an experiment from a positivist perspective remains prevalent within the academic community, due to the lack of understanding of how experiments are used in the art and design disciplines.

In natural science, an experiment represents a systematic procedure which is a carefully planned activity for hypothesis-testing in order to validate or invalidate causation or correlation between pre-identified variables. Francis Bacon, a key advocate of positivism, aptly summarised that the truth of science requires an unbiased observation of the phenomena which turn observational fact into theory (Steffen, 2014). Recent work by Ansell and Bartenberger (2016) further expands the current understanding of experiments by examining the concept of experimentalism through the theoretical lens of John Dewey's pragmatism. Their study classifies experiments in three distinct categories: controlled, Darwinian, and generative. In their analysis, a scientific experiment is represented by a deductive approach based on randomisation control that tightly controls the confounding factors that may contaminate the potential causation or correlation that exist between variables under study. Taking a deductive approach, an experimenter can deduce as much an unbiased observation as possible which can be formulated into the theoretical frameworks, which can then be replicated in other study settings.

Ansell and Bartenberger’s conceptualisation of Darwinian and generative experiments rather resembles how the art and design disciplines use an experiment in the research context. They illustrate that the main aim of the Darwinian experiment is to generate as many variations as possible, in order to develop a global understanding of what works and eliminate the parts that do not work. By focusing on building the cases that work and quickly eliminating the parts that do not work, the Darwinian experiment aims for novel innovation that adapts to an emerging situation. Although the entire process of the Darwinian experiment does not fully represent the use of experiments in art and design practice, the process of learning from trials and errors closely resembles how designers conduct experiments in their practice.

According to the literature in art and design research, historically artists and designers have been using an experiment as a tool to learn from trials and errors (Hall, 2011; Borgdoff, 2013; Bippus,

2013). The generative experiment introduced in Answell and Bartenberger's (2016) study is built on Schön's (1983) concept of reflection-in-action. Schon's (1983) concept of reflection-in-action and knowledge-in-action are heavily indebted to Dewey's pragmatism. In Rosiek's (2003) interpretation, Dewey's observation indicates that academic research lacks contributions from studies that have examined the qualitative aspect of human experience experimentally and reflexively.

Dewey's observation, described in Rosiek's study, suggests that Dewey had already acknowledged the lack of awareness of design experiments in the academic research community early on. This gap in knowledge that he identified is an explicit revelation of how designers conduct an experiment in their practice. Schön (1983), whose work was significantly influenced by Dewey, recognised early on the lack of relevance of scientific experiments to the design research context, as they are unable to serve the purpose of designerly ways of working. Since then, Schön has been a strong advocate of the experiment as an exploratory approach that aims to discover 'what-if' scenarios and articulates the experimental process in the art and design disciplines as reflection-in-action. His term 'reflection-in-action' characterises an experiment used in the art and design discipline as an iterative process, in which artists and designers continuously strive for excellence in their craft through continuous reflection and action upon their reflection.

Their attributes, such as *uncertain*, *explorative*, and *flexible*, make the experiments carried out in the art and design discipline distinct from the scientific experiments that are defined by the positivist research community. When art and design researchers conduct research, they do not tend to constrain themselves with stringent experimental protocols established by natural scientists. However, this does not necessarily mean that there are no sets of rules which art and design researchers rely on to conduct an experiment; but these rules are more flexible and adaptable to each research context.

The most important distinction between the ways designers and scientists use experiments lies in their aim for conducting an experiment. It has been a long tradition in science that scientists conduct an experiment in order to discover the truth. In contrast, designers conduct an experiment to turn the current situation into a preferred state in the future (Schön, 1983; Kubler, 1965; Assis, 2013). Bippus (2013) describes the essence of artistic (or design) experiment as a process that starts with the unknown and takes an exploratory approach to discover something new, which does not need to be validated or tested. Rosiek (2003) and Dixon (2019) also identify the keeping of various future possibilities of the experimental findings as an attribute of design experiments, inspired by Dewey.

The experimental process in the art and design discipline is well illustrated by the Double Diamond design framework introduced by the British Design Council. The double diamond design framework starts with the discovery stage that observes empirical phenomena and explores the potential root causes of the wicked problem under study. As designers have gathered some initial data that show emerging preliminary patterns, they start framing potential solutions that may solve the problem identified. During this process, they prototype several solution ideas and test their ideas further with users and relevant key stakeholders until they reach the point where they feel confident that the solution will sufficiently address the problem under study. This process repeats itself multiple times, as designers gather more data on the effectiveness and efficiency of the solution and act upon the collected data.

FIGURE 3. 2: THE DOUBLE DIAMOND DESIGN FRAMEWORK

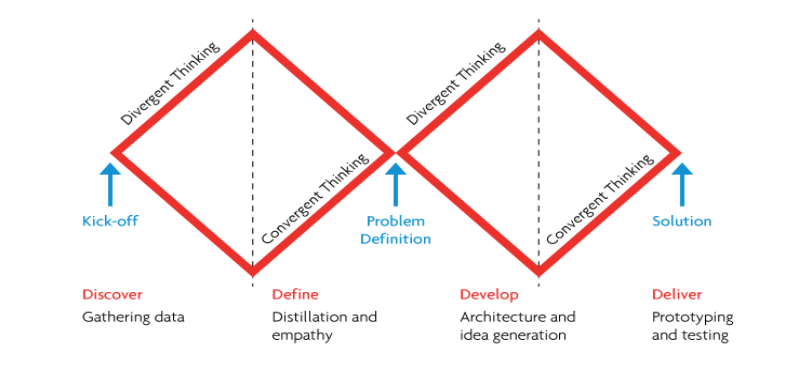


Photo: Design Council

The distinction between scientific and design experiments examined in the body of extant literature can be summarised by the characteristics as follows: scientific experiments are *reproducible*, *controllable*, *measurable*, and *generalisable,* while design experiments are *daring*, *uncertain*, and *exploratory*, challenging established norms and rules (Rheinberger, 1997; Borgdoff, 2013; Bippus, 2013). Despite the clear distinction between scientific and design experiments articulated by the body of scholarly works in the past, Rheinberger (1997), a historian of science, makes an interesting claim that scientific experiment, too, is a precarious event. In his view, an experimental system should be open to uncertain events. The experimenter themself becomes a conductor that facilitates an empirical interaction within an experimental system to discover novel insights that are moulded into a new form of knowledge. Similarly, Steffen (2012) claims that designers often seek out a causal relationship between the key variables in experimental design in practice-led design research in order to draw out novel insights and generate new design-informed knowledge.

Kuhn (2012), in his book *The Structure of Scientific Revolution*, hints at his optimistic opinion of the debate on the convergence of art and science by supporting the view that although the activity of the natural sciences is set up very well, according to pre-determined parameters, it

does not necessarily always need to be carried out by these rules. Instead, he emphasises the general applicability of a paradigm, whether it is pursued in the context of a scientific or a design experiment.

Despite Kuhn's view and that of others who share a similar concept of an experiment, the conceptual understanding of an experiment as defined by the positivists is still widely acknowledged and is the most commonly accepted by the academic research community. Because experiments in natural sciences enjoy the privilege of having a rich history with many knowledge contributions that have been made already, the legitimacy and credibility of design experiment as an academic research method has often been challenged (Glanville, 2012; Sangiorgi and Prendiville, 2014). A continuing debate on the conceptualisation of experiments and experimental approaches has further produced fragmented knowledge in both art/design and scientific disciplines.

In response to the question of the legitimacy of an experiment that does not conform to the criteria rigidly defined by the scientific research community, Ian Hacking introduced a novel concept, New Experimentalism. He describes this as 'a philosophical approach that reconciles and broadens these traditional concepts of experiments in the scientific discipline based on either the inductive or deductive approach' (Steffen, 2014 citing Hacking, 1983, p.14). More importantly, Hacking has brought a transformation to the way of thinking in the minds of experimental scientists. He claims that there are manifolds to explain the relationship between experiment and theory and makes a critical statement that makes his view different from the rest, 'any one-sided view of experiment is certainly wrong'

Hacking, like others, such as Hafner (1969), saw the limitations of experiments defined by scientists, but also the potential gains from the rapprochement between art and science. In a similar way, Levy (2009) argues for both an explicit and an implicit connection between artistic experiment and natural sciences, using an example of Kubler's essay (1970) on sequence theory. She concisely summarises Kubler's contribution as the theoretical attempt to define art production as a 'three-way conversation among art, science, and technology' (p.88).

The recent movement towards the convergence of art and science again, with active contributions from both art/design and science disciplines, represents a positive outlook because it suggests that design research is slowly gaining legitimacy in the scientific research world. For many decades, design research has been struggling to establish itself as a legitimate academic research domain, based on the fact that the types of research conducted by design researchers do not conform to the rules established by the scientific research community (Glanville, 2012; Gaver, 2012; Sangiorgi and Prendiville, 2014). But most recently, with the growing traction of

research in service design by the group of service researchers, especially from the services marketing and services science disciplines (e.g.Sangiori and Prendiville, 2014; Patricio, Gustafsson, and Fisk, 2018, Yu and Sangiorgi, 2018), design research has started to attract more interest from traditional disciplines such as social sciences and engineering management.

Despite the ongoing and inconsistent debates on the relationship between art and science to date, this doctoral research takes the position that art and science exhibit more similar traits than differences, because the body of extant literature clearly demonstrates that the distinction between art and science is man-made, and the intellectual tension between these two disciplines is rather a reflection of the power dynamics in the academic research community, especially during the period when positivism prevailed.

Both historical examples (e.g. Hacking, Rheinberger) and recent examples in artistic practice, such as Sissel Tolaas's *Smell of Fear* indicate that both artists/designers and scientists have freely explored each other's disciplinary mediums of practice to generate new knowledge that contributes to their own discipline. For example, it was not uncommon for scientists to use drawings as a form of research method to generate scientific knowledge, exemplified by Leonardo da Vinci's drawings of human anatomy (Steffen, 2014). Similarly, researchers in art and design used the apparatus commonly used in a science laboratory to generate artistic knowledge outputs. The convergence of art and science has become more prominent in recent decades, in which the education system has more openly embraced an interdisciplinary approach in research (Massey, 2018). Also, the service research community has explicitly called for further contributions to knowledge from interdisciplinary studies in order to build in-depth and expansive knowledge in an increasingly complex service system in the Fourth Industrial Revolution (Industry 4.0) era (Gustaffson and Bowen, 2017).

3.3 Design as an Academic Research Discipline

Design researchers who practise design to produce new knowledge often struggle with the presence of fuzziness around new knowledge generation in the design research discipline. Design has a long history of being known for and has contributed to the world's craftsmanship. Because of this disciplinary history, design theory is interpreted as the design of artefacts (Love, 2000). As a result, new knowledge generation in design research tends to lean towards new knowledge for the design practice rather than theoretical contributions.

Cash (2018) articulates that a lack of theoretical rigour in design research is the root cause of the limited advancement of theory in design research. He also argues that it equally limits the contributions from design research to scientific knowledge. Although Cash makes an analysis that accurately describes the current landscape of design research literature in general, his argument is not entirely credible. The contribution to knowledge generated from design research,

according to the epistemological origin of design and its historical account of practice-led activity, cannot be evaluated scientifically. As such, design research does not share the history of the intellectual culture of scientific research, which has become the backbone of what is considered to be ‘the rigour of research outputs’. Hacking (1983) explicitly points out in his book *Representing Intervening: Introductory Topics in the Philosophy of Natural Science* that a single-minded approach is often used by scholars to evaluate experimental studies, as they have become accustomed to basing their evaluation on scientific parameters that are widely accepted by the academic research community.

This historical account further reinforces the struggles many design researchers have had in the face of doubts and criticism from the scientific research community about the academic rigour of design research outputs. Cash's view that there is a lack of theoretical rigour in design research also reflects the widespread norms of the academic research community, which takes a single-minded approach to evaluating the rigour of research contributions. In essence, design research is derived from practice-led culture whose epistemological origin is inherently different from that of scientific research; therefore, the contribution to knowledge from design research should be evaluated based upon parameters other than scientific ones.

The first step towards enhancing an awareness of design research within the academic research community would be to establish general guidelines for design research which allow researchers to evaluate the rigour of research that is specifically produced within the design research discipline (Rosiek, 2003; Dixon, 2019). It might have a long way to go, according to the observations of Hacking and Cash, who emphasise the lack of coherence and consistency manifested in the literature to date as one of the key barriers to the development of theoretical rigour within design research.

However, the growing acknowledgement of design research by scientific research community indicates a positive outlook. The design research community may need to take a more active role in educating and disseminating an epistemological and ontological view of design research that is underpinned by rigorous theoretical contributions. In doing so, the community can quickly build a cohesive view on how design research has become what it is today and how it is likely to evolve over the next decades. It will also help researchers from other disciplines who adopt approaches from design research in their own work to represent design research accurately.

3.4 The Current State of Design Research

With a history of an emphasis on making, design has been known as a practice-led discipline for a long time. But the discipline's focus on practice has had an unintended consequence. Despite the growing research tractions in design by the academic research community, design research, to date, has not been able to build a strong and cohesive theoretical ground that underpins

design research. The lack of strong theoretical ground in design research has recently been raised by design researchers themselves. Dixon (2019) explicitly points out that the lack of epistemological frameworks that define design research in scholarly works remains a limitation of design research. Similarly, Cash (2018) makes a bold claim that design research could be at risk of being superseded by other disciplines that adopt design as a method or a subject of inquiry if the design research community does not actively contribute to the development of theory that underpins design research.

Both Dixon and Cash raise concerns over the lack of strong theoretical concepts and epistemological and ontological underpinning that define the discipline-specific approach, which generates new knowledge and evaluates the research impact within and beyond the design research discipline. In the academic research community, there is a widely accepted view that academic research must be scientific, and its aim should be the pursuit of finding the truth (Steffen, 2014). But designerly ways of working, such as knowledge-in-action (Schön, 1983) and tacit knowledge does not necessarily fit into this frame of thinking (Simon, 1996; Glanville, 2012). The distinction of design as an academic research discipline suggests that an epistemological and ontological underpinning of design research does not need to conform to the parameters defined by the traditional academic research community. Previous efforts to make design research more scientific have led to the emergence of the design science discipline that rationalises design practice (Simon, 1996); but Dixon's (2019) recent study elucidates that design science is no longer in a dominant position in the academic research community. This is because its failure to accurately capture emergent phenomena has encouraged a shift of focus from design science to design inquiry, which investigates the creativity of designers and design as making (Buchanan, 2007 cited by Dixon, 2019).

A shift of focus towards design inquiry suggests that the time has arrived now to focus on the intersection of design and science rather than the differences between these two disciplines that un-qualify design as a legitimate academic research discipline. Glanville (2014) has already claimed that design and research cannot be separated from each other and elaborates that ‘research is a restricted form of design, in terms of both experiments carried out and the creation, assembly and integration of new knowledge within the range of existing’ (p.13). His description of a restricted form of design clearly rejects the claim that research is a scientific activity, and thus design needs to become more scientific in order to establish its presence in the academic research community. Instead, Glanville, as Dixon (2019) and Cash (2018) claim, identifies the creation of knowledge as the foundation of the legitimisation of design as an academic research discipline. But the challenge faced by the design research community is an explicit articulation of the integration of design practice into research and its contribution to strong theory-building,

which becomes part of new knowledge creation that advances the disciplinary knowledge in the academic community.

Nevertheless, despite some challenges along the way, Cross (2019) and Cooper (2019) expressed their optimism over the progress made by the design research community in advancing design research as a legitimate academic research discipline in a special issue of *Design Studies* journal, commemorating 40 years since its first publication. Cooper (2019) also highlights design research as a discipline that promotes interdisciplinarity, as wicked problems which designers grapple with often require a close collaboration with, and perspectives from, other disciplines.

The emergence of smart service systems and the increasing complexity manifested within and across these systems encourage both academics and practitioners to develop an interdisciplinary perspective that could help them understand the problem from multiple perspectives (Patricio et al., 2018). For example, the phenomenon of the lack of user engagement and abandonment observed in the smart service system cannot be resolved by scientific knowledge alone. It is a problem of human behaviour. An enhanced user engagement in smart service system can be attained when the key actors of the smart service system collectively work together to make technology work for humans. These key actors include not only the scientists behind these cutting-edge technologies, but also business practitioners and designers who help to build SSPs that may solve users' problems and enhance the quality of users' lives.

3.5 A Design Experiment as a Research Method for this Research

In positioning the research problem under study at the intersection of art/design and science, this doctoral research has chosen a design experiment as a research method, taking a research through design approach. The previous section, in discussing the nature of the experiment in the context of art and science disciplines, has illustrated the lack of awareness of the experiment that is undertaken in non-scientific disciplines. This is also proven by the journal submission review process I have experienced as a design researcher conducting interdisciplinary research. Considering a broader readership of interdisciplinary research, I submitted several articles emerging from this doctoral research to academic journals in both the design and service management disciplines. Interestingly, the types of questions and curiosity it prompted in the reviewers from the journals in each discipline were in stark contrast to each other. Reviewers from the service management discipline definitely expressed their curiosity about design experiment as a research method and were keen to learn more about what it is, how it differs from scientific experiments, which have been a more widely accepted form of research method in the academic research community to date, and how to conduct design experiments in their work. In contrast, the reviewers in the design discipline posed no specific questions about what a

design experiment is and what it can do. In their world, the design experiment is already well understood as a legitimate academic research method that requires no further justification or explanation about what makes a design experiment a legitimate research method and how to adopt this method in academic research.

In response to reactions from the reviewers within the service management discipline who are not familiar with the design experiment as a research method, this doctoral research goes a little deeper into research through design, in which the design experiment is often used as a research method, explaining what the design experiment is, and describing how design researchers conduct design experiments in order to fulfil the aims of their research.

3.6 A Design Experiment in Research through Design

The term 'research through design' was introduced by Bruce Archer in the 1970s (Pedgely and Wormald, 2007) and was further popularised by Christopher Frayling in the 1990s when he used the term in his working paper, *Research in Art and Design*, published by the Royal College of Art. In this publication, Frayling describes research through design as one type of research methodology, which is often known as studio-led or practice-led work, at the Royal College of Art. He suggests that this methodology is exemplified by three different types of research activity, namely, materials research, development work that is about radical innovation, and action research.

Following the introduction of research through design by Archer, and the popularisation of the term by Frayling, researchers beyond the discipline of design have started to actively discuss what it means to carry out practice-based or practice-led research and have introduced their own definition of research through design. Godin and Zahedi (2014) define research through design in their conference paper for the Design Research Society as 'an approach to scientific inquiry that takes advantage of the unique insights gained through design practice to provide a better understanding of complex and future-oriented issues in the design field' (p.1). Zimmer and Forlizzi (2014), from the HCI discipline, also offer their view on research through design as an 'approach to conducting scholarly research that employs the methods, practices, and processes of design practice with the intention of generating new knowledge' (p.167).

Although there is a slight variation between the definitions shared by Godin and Zahedi (2014) and Zimmerman and Forlizzi (2014), they all acknowledge that research through design is a research methodology that incorporates design activity, and the purpose of integrating design activity in research is to enable the generation of new knowledge that may help the research community to improve their current understanding of the subject being studied.

Pedgley and Wormald (2007) pointed out the lack of a clear definition of research through design, or practice-based research in general. They describe practice-based research as a 'misnomer' because the research itself is practice-based activity. Regardless of the discipline, a PhD degree is conferred on the PhD candidate who has demonstrated best practice in terms of the research process and outputs. In their view, practice-based research in the design discipline should be specifically defined as the types of research in which design activity or the design project is an integral component of the research. They also astutely point out the lack of research contributions on the structure of the design PhD in which design practice is a vital part of the final PhD research output. In response to this lack of contributions in 2007, their study attempted to introduce the four specific types of research through design by analysing three design PhD theses as case studies.

The four specific types of research through design proposed by Pedgley and Wormald include 1) Simple forms – artefacts demonstrating or describing principles or techniques; 2) The communication of process – artefacts arising from a process make the process explicit; 3) Artefacts within research – artefacts are instrumental in advancing the research by communicating ideas or information; and 4) Knowledge elicited by artefacts – artefacts provide a stimulus or context which enables information to be uncovered (p. 82). They emphasise that the final research output of a design PhD should communicate its contribution to knowledge through the component of a design project or artefacts created during the process of research.

Building on the interpretation of research through design by Pedgley and Wormald (2007) and Zimmerman and Forlizzi (2014), this doctoral research adopts a research through design approach by designing a boundary object (AI chatbot in this doctoral thesis) that will be used for the purpose of uncovering new information that becomes the basis of the new contribution to knowledge of the research. How the boundary object is used with a research through design approach in this research suggests that it is not the boundary object itself that conveys new knowledge, but the contextual data collected from the design context in which this boundary object is used.

The extent of the integration of the design project into this doctoral research and the role of the design artefact or boundary object – AI chatbot – in this research context explicitly indicate that this doctoral research is a thesis-based design PhD rather than a practice-based one at the Royal College of Art. As mentioned above, the boundary object, which is an AI chabtot in this research, does not produce knowledge itself. Instead, an AI chatbot is designed to be used to elicit new knowledge. According to this description, this doctoral research belongs to Pedgley and Wormald's fourth category of a PhD in design, where the artefact is used as a stimulus or context to uncover new information.

According to Zimmerman and Forlizzi's definition of research through design, a design experiment can be understood as one of the methods design researchers employ in their scholarly research to generate new knowledge. Despite the wide adoption of design experiment by design researchers in their work, whether or not their studies have explicitly stated this, the conceptual understanding of a design experiment has not yet been firmly established. Neither has its procedure been actively discussed in the literature to date (Bang and Eriksen, 2014; Krogh, Markussen, and Bang, 2015; Cash, Stankovic, and Storga, 2016). This is perhaps because many designers have relied on their *tacit knowledge* (Schön,1983) to conduct a design experiment and produced new insights which they have translated into new knowledge. Documenting a design process has rarely also been a part of design practice (Pedgely and Wormald, 2007).

But recently, more design researchers have realised this gap in the literature and focused their efforts on conceptualising and operationalising the design experiment and introducing the typology of the design experiment. For example, Bang and Eriksen (2014) examined the role and characteristics of the design experiment in design practice through the lens of Schön's reflection-in-action and operationlised the design experiment in the context of research through design. They explain that Schön (1983) recognised the differences between the way designers and scientists use experiments and defined the three types of design experiments: exploratory, move-testing, and hypothesis-testing. In Bang and Eriksen's observation, an exploratory design experiment is conducted to explore the subject of study to see if it leads to any type of discovery. A move-testing design experiment refers to Schon's 'reflection-in-action' process. When designers try to make an intended change to the design artefacts, they pause and try to understand the situation or the artefacts that are being designed. Meanwhile, 'back-talk' takes place to help shape the intended change. Last, hypothesis-testing is about the process of disconfirming competing hypotheses.

Furthermore, Bang and Eriksen (2014) introduce the typology of the design experiment, which describes how the role of the design experiment evolves against the research phase. Bang and Eriksen's study is a good starting point to advance the current knowledge in design experiment; however, their study has some limitations.

Their study was not based on a rigorous review of previous studies but their own PhD research; therefore, their findings may have been biased. Secondly, their interpretation of Schön's contributions in terms of the articulation of the design experiment or designerly ways of working still needs to be further expanded with a more in-depth review of Dewey's work, that has significantly shaped Schön's contributions to design experiments. Despite the call for more research contributions to address Dewey's design experiments many decades ago, the design

research community has not yet been able to actively respond to this call, which is supported by limited methodological work on design research in the current literature. More contributions with a robust and systematic approach that examine the design experiment as a method in design research are needed in order to advance current knowledge to the next level.

The knowledge gap in the operationalisation of the design experiment is widely recognised by the design research community. Krogh et al. (2015) have also recognised the paucity of literature that explores different forms of design experiment conducted in the research through design context. In order to address this gap, they introduced a typology that entails five forms of design experiments conducted in research through design. Krogh and Koskinen (2020), in their recent book chapter 'New Experimentalism', explore design experiment as a 'key vehicle for knowledge creation' and illustrate what design experiment means in constructive design research and how its characteristics resemble the concept of new experimentalism.

Cash et al.'s (2016) book *Experimental Design Research: Approaches, Perspectives, Applications* is a great initiative that addresses the lack of systematic approaches that explain experimental practice in design research and how it generates scholarly knowledge. But despite their good intentions, their work evaluates the design experiment based on the experimental parameters defined by natural science. The distinction between scientific and design experiments explained previously clearly describes what makes an experiment either one or the other. For example, the scientific experimental process relies on stringently developed parameters, and it is conducted in a highly controlled environment to either validate or invalidate hypotheses. But the purpose of a design experiment is not to seek the truth by disconfirming competing hypotheses. Hypothesis-testing is still used in design experiments, but the fundamental difference that makes an experiment a *design experiment* is its primary raison d'etre in being conducted. Design researchers and designers conduct an experiment to realise a utopianist view through learning from a series of 'what-if' scenarios (Schön, 1983). Their learning from trials and errors to realise this utopianist view has also introduced a sub-set of methods, such as design fiction (Sterling, 2009) and speculative design (Dunne and Raby, 2013).

The reach and impact of the design experiment in design research has gradually grown in recent years. According to the data provided by ScienceDirect, design studies that have adopted experiments have grown from 2% in 1990 to 24% in 2014 (Cash et al, 2016). This observation clearly signals that solid groundwork on the philosophical foundation of, and experimental practice in, design research is becoming increasingly necessary. Some examples, introduced above, suggest that a reasonable amount of effort has already been made to advance scholarly knowledge in design experiment through its conceptualisation and the operationalisation in the context of design research. But these studies still have limitations, given that they have not been

able to conduct a systematic analysis of prior studies that date back to periods when the tension between art and science emerged.

Further contributions, such as a systematic review, with an in-depth background overview of design experiment, could address the limitations of the current studies on design experiment. Similarly, a more robust approach to operationalising design experiments will help design researchers to determine when to use what type of design experiment in order to fulfil the purpose of design research. In addition, it will continuously challenge design researchers to iterate and refine their design experimental approach. But in order to do so, design researchers will also need to understand what best practice in design experiment means. To the best of my current knowledge, existing studies have yet to identify evaluative criteria that would help design researchers to assess the process of design experiments that directly influence the robustness of the experiment's result.

Despite some mixed reactions from the design research community, the design experiment should not be evaluated based on the parameters defined by scientific experiment. This is clearly also supported by Simon, who takes a middle-ground view of design and scientific experiments. In his book *The Sciences of the Artificial* he makes a clear distinction between science and design by introducing the logic of design, as follows.

> We must start with some questions of logic. The natural sciences are concerned with how things are. Ordinary systems of logic the standard propositional and predicate calculi, say serve these sciences well. Since the concern of standard logic is with declarative statements, it is well suited for assertions about the world and for inferences from those assertions. Design, on the other hand, is concerned with how things ought to be, with devising artefacts to attain goals. We might question whether the forms of reason that are appropriate to natural science are suitable also for design. One might well suppose that introduction of the verb "should" may require additional rules of inference, or modification of the rules already embedded in declarative logic (Simon, 1996, p.126-127).

As illustrated by the quote above, Simon was already acknowledging that the parameters of scientific experiments were ill-suited for the design experiment, which is also supported by design researchers such as Glanville (2012). Glanville claims that evaluative criteria derived from natural science are neither relevant nor valid in the context of design research. In his view, the design research community needs to devote more effort to building its discipline-specific, evidence-based evaluative criteria that will help design researchers to assess the rigour of their experimental research process and outputs. Doing so will help not only the design researchers

who work with design experiments in their practice, but also scholars from non-design disciplines who wish to adopt design experiments in their research.

Similarly, the design research community should raise awareness of how the procedure of design experiment is different from that of scientific experiment, following its different reason for running an experiment. For example, a tight control of confounding variables is not considered critical in design experiment. Scientific experiment must generate the findings that can be repeated in other controlled environment; therefore, both the internal and external validity of the experimental finding are important, as they determine the rigour and the robustness of the findings. In contrast, as design experiments combine a technical approach of testable data analysis and a designerly way of working, such as welcoming unexpected result which designers integrate into the sequential experimentation to construct new knowledge, a complete control of confounding variables in design experiment remains loose in comparison to scientific experiment. This is supported by Hall (2011) who articulates that 'variables in design experiment are "soft" and beyond useful calculation, because it relies on experiential and innate abilities in combination with the variables that can be usefully calculated in the pursuit of innovation' (p.20).

The lack of awareness of the difference in procedure and the evaluative criteria between design and scientific experiments needs to be further investigated, but an in-depth discussion of them is beyond the scope of this doctoral research. Future studies in design research may offer a more thorough comparative view ingrained in epistemological and ontological background of design research that articulates how the procedure of design experiment is different from that of scientific experiment, and as a result, how the rigour of findings from design experiment should be assessed.,

3.7 Design Experiment and Speculative Design

In contemporary design research scholarship, design experiment is also often depicted as speculative design practice which has been popularised by Anthony Dunne and Fiona Raby through their research at the Royal College of Art in London, UK. Dunne and Raby's (2013) earlier work described their speculative design process as critical design which focuses on critiquing why culture and society are in the way they are and why current technologies operate in the way they do. Critical design then promotes imagining the alternative future where technologies, society, and culture could have evolved in other direction (Jakobsone, 2017). Malpass (2013) describes the definition of critical design coined by Dunne and Raby in 1997 as design practice that sets free from artificial boundaries that are established by technologies and societies for commercial benefits.

Although the term, speculative design, is widely understood, at least, in the design research community, its definition remains unclear, as speculative design practice often overlaps with

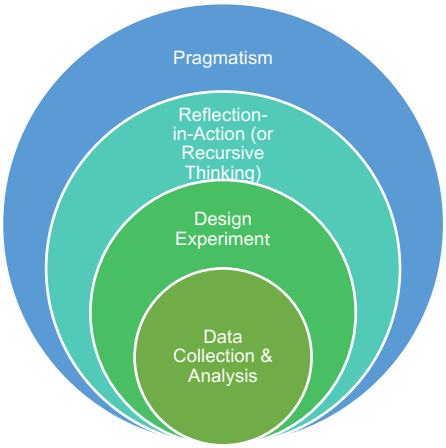
other adjacent design practices, such as design fiction. Auger (2013) tried to entangle the differences between speculative design and similar practices, such as design fiction and design probes, based on semantics. He argues that the layperson who is introduced to this practice is likely to assess each practice based on semantic differences. Design fiction suggests that the practice takes place in a fictional context, referring to the word, fiction, whilst speculative design connotes the present and future that breaks free from the boundary between fictional and real world.

Speculative design practice has often been adopted in the context of gallery exhibitions, and previous studies often described speculative design are usually practiced by an exclusive elite group of design practitioners, as speculative design practice "often does not move beyond the realm of the museum exhibit" (Forlano and Mathew, 2014, p.11). This doctoral thesis posits speculative design as one type of design experiment conducted by design researcher. By doing so, it challenges the conventional view that speculative design is not an appropriate approach to inquiring into the real-life phenomena emerging in the present world to explore the alternative state of preferred future that may offer pragmatic solutions. Kozubaev's study (2016) that depicts speculative design practice based on Dewey's pragmatism illustrates well how the speculative design process can generate design outcomes that are materialised in real-life context. They demonstrated this through an iterative design experiment they conducted over several phases of experiments to explore how the citizen's privacy rights are likely to evolve into the future, using the concept of Nigma.

3.8 Method Rationale – So Why a Design Experiment?

This chapter has provided a historical overview of the relationship between art/design and science that explains how a design experiment has become what it is today and the current state of knowledge on design experiment in the design research community. In a concluding remark, the anatomy of research design for this doctoral research is visualised, shown in Figure 3.3 on next page.

FIGURE 3. 3: RESEARCH ONION FOR THIS DOCTORAL RESEARCH



The Research Onion of this doctoral research, illustrated in Figure 3.3, shows the philosophical foundation of the research method chosen for this research study. Design experiment is strongly grounded in Dewey's pragmatism, as discussed in the preceding section. Pragmatism, which has significantly influenced Schön's reflection-in-action practice, emphasises a recursive approach, the process of learning from trials and errors and continuous iteration until new insights are discovered that solve the problem. The aim of this doctoral research is closely aligned to the recursive process used in reflection-in-action practice. This recursive process that defines reflection-in-action practice is the core element of a design experiment. It is also worth mentioning that design experiment brings in the perspective of a future-oriented approach - speculative design - to explore alternative future. In this doctoral research, it intends to explore how designers can use olfactory stimulus as a potential design material to design for an interactive user experience that improves user engagement in human-AI chatbot interaction. The extant literature claims (Obrist et al., 2014) that olfactory sense has been under-explored in HCI, and design experiment that embraces speculative design approach offers additional rigour to its approach to exploring answers for the research questions under study.

Figure 3.3 is a visual example that illustrates how this doctoral research has arrived at the decision to use a design experiment as a method. Three specific points elaborated below explain why a design experiment makes a strong research method for this doctoral research.

First, the aim of this doctoral research is neither to test nor validate existing theories and hypotheses in this research context. As discussed from the outset, its purpose is to explore the research problem, the lack of user engagement in user-AI chatbot interaction, with under-explored design material – the olfactory stimulus – to envision an alternative preferred future state for the users of AI chatbot. The outcome is uncertain, but this study takes a reflection-in-action approach to learn from many instances of trials and errors to realise future that is desirable and culturally feasible. The purpose of this doctoral research itself clearly conveys that this research can be well served by the design experiment, whose aim is to work with uncertainty, explore under-explored territory, and realise a preferred future state through learning from trials and errors. More specifically, how designers can leverage the olfactory stimulus as a material to design for the olfactory-enabled aesthetics of experience in user-AI chatbot interaction is an unknown territory where alternative future thinking is required. The aim of this doctoral research and the research context is to clearly indicate that a design experiment offers an explanatory power that is superior to that of a scientific experiment for the research questions under study in this doctoral research.

Secondly, this doctoral research is an interdisciplinary study that is situated at the intersection of design and services marketing. Also, the research problem it explores – the lack of user

engagement in user-AI chatbot interaction – represents the dialogue between design and science/technology. These two disciplines hold different epistemological and ontological views that are derived from different segments of the philosophy of research. But, as mentioned in the preceding section, although variables in control in design experiment are rather considered 'soft' and thus a tight control of confounding variables is not sought, a complete control of variables is required in scientific experiment to achieve an optimal result.

This distinction makes the design experiment more relevant for this doctoral research. An under-explored research problem in service research, specifically the lack of user engagement in user-AI chatbot interaction and experimenting with the olfactory stimulus as a design material for olfactory-enabled aesthetics of experience design in the context of user-AI chatbot interaction, requires curiosity and open-mindedness as a pre-requisite that goes beyond useful calculation of controlled variables, and the design experiment fulfils this requirement, whereas a scientific experiment does not.

Lastly, this doctoral research does not seek the 'right answer'. This research takes a view that a single answer only exists in a utopian world. Along with this view, it believes that there is no single right answer for any research problems that are investigated. Instead, the intention of the research is to learn from what it was in the past and what it is now in order to explore what it might hold in the future to shape the world that is desirable. As such, this study contradicts the notion of the search for the truth which is the golden rule for all scientific experiments.

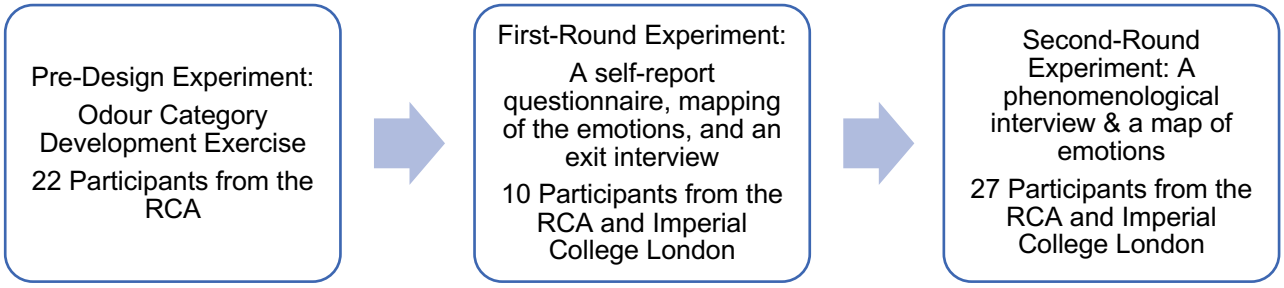
The three specific reasons above confirm that the design experiment offers a more robust and analytical lens for this doctoral research to achieve the aim of the research.

3.9 Research Design Process: The Design Experiment

Design experiments are conducted in three phases. Figure. 3.4 on page. 94 illustrates the overarching view of how the design experiment was planned and conducted at each phase. Prior to conducting a design experiment, this research conducted the Odour Category Development Exercise to identity the sets of odours that will be used throughout the experiments. The body of extant literature reveals that visual sense has been a dominant sense in academic research to date; therefore, olfactory stimulus, unlike visual stimulus such as colour, lacks a standardisation in odour-related vocabularies. Having observed this gap, this research saw the need for the development of odour palettes before starting the design experiments. A detailed discussion on the purpose and process of the odour category development exercise is discussed in the section 3.9.3 of this chapter and Chapter 4 which is devoted to the discussion of process and result from the odour category development exercise.

The first-round experiment was conducted with the odour scored the highest rating on pleasantness. After the first-round experiment, the reflection-in-action process took place to refine the design of the first-round experiment. Based on the outputs from the reflection-in-action process after the first-round experiment, some aspects of experimental design were refined for the second-round experiment, such as a bigger sample size and the replacement of a self-report questionnaire with a phenomenological interview. More detailed discussion on the first-round experiment can be found in the section 3.9.4 of this chapter and Chapter 5. Similarly, more information on the second-round experiment can be found in the section 3.9.5 of this chapter and Chapter 6.

FIGURE 3.4: DESIGNING DESIGN EXPERIMENTS



3.9.1 AI Chatbot as a Smart Service Product

As Section 3.6 – A Design Experiment in Research through Design – states, this doctoral research is thesis based and aims to make contribution to knowledge for the design research community by using a boundary object that elicits new knowledge. In this doctoral research, AI chatbots simulate a boundary object for a specific reason. In contrast to the proliferation of academic papers on wearables, AI chatbots and voice assistants have received less attention from the academic community. It may be worth noting that after the introduction of ChatGPT by OpenAI in November 2022, the academic papers that studied the role of ChatGPT and its implications in various aspect of human life, society, and businesses have been extensively discussed by the proliferation of publications, but this doctoral thesis was submitted in April 2022 prior to the current rise of ChatGPT, and the lack of academic papers on AI chatbot strictly refers to the time when this doctoral research was conducted from September 2017 until March 2022.

Despite limited academic research contributions that explored the lack of user engagement challenge, specifically in user-AI chatbot interaction during the period when this doctoral research was carried out, Ashfaq et al. (2020)'s article demonstrated the determinants of users' satisfaction and continued intention to use AI-powered service agents. Similarly, Trajkova and Martin-Hammond (2020) looked at the reasons for older adults living in a Life Plan Community (retiree village) in Maryland, United States, to either use, limit their use of, or abandon a voice assistant.

In recent years, AI bots, such as chatbots, and voice assistants like Amazon's Alexa and Google Home have experienced a surge in market adoption (Accenture, 2017). But despite this positive market receptivity, a frustrating user experience with voice assistants and chatbots remains a big challenge for SSP service providers (Scates, 2020; Goode, 2018). In a similar vein, PwC's research report published in 2018 reveals that the growing adoption of a digital voice assistant, especially among the younger generation, does not lead to increased usage.

This observation describes a very similar challenge to that faced by most wearables several years ago. The growing adoption of wearables had not necessarily led to an increase in usage, for numerous reasons, such as a mismatch between the performance of the wearable and user expectations, and a lack of examples of use that create value for users identified by the existing literature.

The limited use of AI chatbots and voice assistants, despite their growing adoption, suggests that the user value, co-created by the users' interaction with these SSPs, remains limited. The lack of current understanding of how smart service providers can deliver a value co-creating user experience with SSPs like AI chatbots and voice assistants calls for new contributions to knowledge from the design research community.

To that end, three AI chatbots were developed in this doctoral research to simulate SSPs in order to explore closely the lack of user engagement in a smart service system. This study decided to build an AI chatbot rather than using an off-the-shelf one that already existed on the market, because when an initial assessment of several off-the-shelf AI chatbots as a potential simulating SSP was conducted in 2018, it came to conclusion that the research study design could be dictated by the nature of the AI chatbot, as most chatbots in 2018 were not intelligent enough to hold natural conversation with end users, prior to the introduction of ChatGPT in November, 2022. To overcome this challenge, three AI chatbots were developed, with the help of a machine learning engineer, on the Heroku platform, a cloud application platform that is widely used by the global developer community.

The chatbot scripts were designed based on the example of use in which an AI chatbot is used as a social companion that provides emotional support to users and helps users maintain their mental well-being. The script was then fed into three AI chatbots by a machine learning engineer. More than one AI chatbot was developed to control the visual aesthetics of the chatbot. Beauty is a subjective term – as the saying goes, 'beauty is in the eyes of the beholder'. One participant may find chatbot *A* attractive and would like to talk with it, whilst another participant may find that the same chatbot looks unappealing and would therefore prefer to chat with a chatbot *B* if possible. This study saw the need for keeping visual aesthetics at high throughout all the

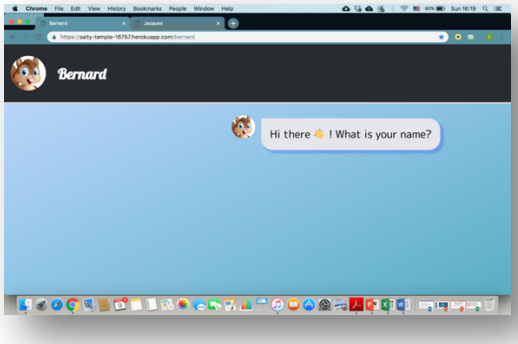
experimental sessions, because the focus of this study is the olfactory sense, and therefore to capture the effect of the olfactory stimulus on the user's emotional response and the quality of interaction with a chatbot precisely. In doing so, the study can control the potential confounding effect of visual aesthetics on experimental findings.

In order to effectively control the effect of visual aesthetics, three chatbots were developed with three different types of user interfaces (UI) to reflect three different levels of visual aesthetics – a low level of visual aesthetics (Jacques), neutral (Robert), and a high level of visual aesthetics (Bernard). Before starting each session of the design experiment, each participant was asked to choose the chatbot they found the most attractive and that they would like to chat with during the session. By doing so, it was possible to make sure that the visual aesthetics were controlled by keeping it at the highest level for all participants. Controlling the level of visual aesthetics allowed this research to focus on the effect of the olfactory stimulus on participants' emotions and their perceived quality of interaction with an AI chatbot.

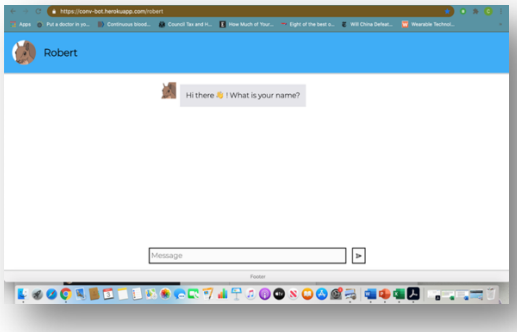
Three types of visual attractiveness were articulated through each chatbot's UI, in the form of low aesthetics vs. neutral vs. high aesthetics and were validated by the participants in the Odour Category Development Exercise.

FIGURE 3. 4: THE AI CHATBOT AS A SMART SERVICE PRODUCT

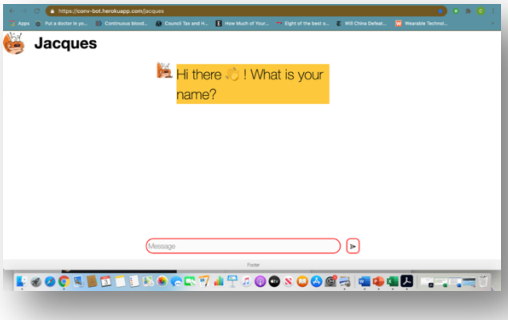
Bernard – High Visual Aesthetics



Robert – Neutral



Jacques – Low Visual Aesthetics



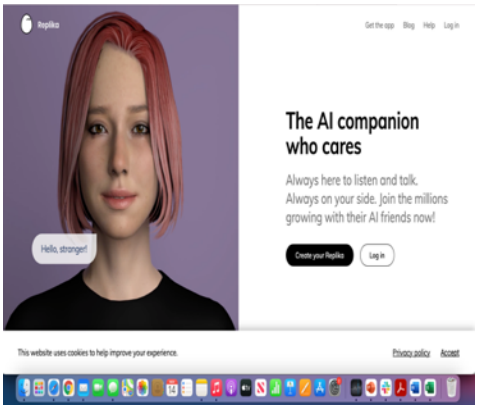
3.9.2 Smart Service Product Application Context – Mental Well-Being

Three AI chatbots – Jacques, Robert, and Bernard – were developed to simulate an SSP that would act as a social companion for postgraduate students to help this user group maintain their mental well-being more proactively. Recent research findings from both academia and industry signal that there is a growing need to provide a good support structure of care for the mental well-being of younger generations, especially Millennials and PhD students (Fathadhika, Hafiza, and Rahmita, 2019; Levecque, Anseel, de Beuckelaer, Van der Heyden, and Gisle, 2017).

The topic of mental health has been a concern for many PhD students for some time. The study by Levecque et al. (2017) reports that one in two PhD students suffers from psychological distress, while one in three PhD students is on the verge of developing a psychiatric disorder. Although the study by Levecque et al. is restricted to a sample of PhD students in Belgium, a similar finding was also published by the *Nature* journal in 2019. According to the results of *Nature*'s biennial PhD survey conducted in 2017, 29% of a total of 5700 respondents identified mental health as the area of most concern, and the latest survey result shows that the situation has not improved since then. Although 71% of the 6300 PhD student respondents expressed their general satisfaction with their PhD work, approximately 36% reached out for help to control the anxiety and depression caused by their PhD studies (*Nature*, 2019). The reason for this growing number of PhD students who suffer from mental health issues seems to be related to burnout from work and the uncertain future concerning their academic careers. Despite the ongoing concern for PhD students' mental health, it seems unclear as to what coping mechanisms are available for these students, and if so, whether they have been provided with an opportunity to access these mechanisms and manage their level of psychological stress from burnout.

Recently, several smart service providers have introduced AI chatbots that can interact with users and provide emotional support and thus help users to lead a healthier life. Figure 3.6 below shows two well-known examples, the Woebot mental health support chatbot and an AI-driven emotional chatbot called Replika.

FIGURE 3. 5: THE AI CHATBOTS FOR MENTAL WELL-BEING



However, despite these good intentions, the ability of these chatbots to help users maintain their mental well-being remains unclear. If these chatbots can help users regulate their emotions better, and thus users can improve their mental health, these chatbot service providers will need to ensure that users interact regularly with a chatbot. Without regular interaction, it is unlikely that chatbots can make a positive difference to users' mental health.

A frustrating user experience that results in a lack of user engagement and satisfaction has been an ongoing challenge for most smart service providers, according to industry reports (Accenture, 2017) and the academic literature (Ashfaq et al, 2020; Eden-Walker et al, 2021; Dehghani et al, 2018). SSPs represent a wide array of smart devices that are enabled by emerging technologies like AI, and in this doctoral research, an AI chatbot was chosen to simulate an SSP, because AI chatbot has recently experienced a phenomenal growth in market adoption as explained previously, but smart service providers are struggling to retain users, as frustrating user experiences with an AI chatbot has discouraged users from continuing to interact with the device. More importantly, extant literature that examines the phenomenon of the lack of user engagement and abandonment has largely focused on wearable devices, and therefore the current knowledge of frustrating user experiences with AI chatbots lacks in-depth insight from a design research perspective.

To simulate an AI chatbot as an SSP in this doctoral research, an AI chatbot was used in the context of users interacting with an AI chatbot to proactively look after their mental well-being. The user sample in this doctoral research is a group of postgraduate students, for two reasons. The first is the representativeness of this user group. This group has been identified as a key beneficiary of mental health support (Levecque et al, 2017; *Nature*, 2019). The second is the easy access to this user group.

With the user group of postgraduate students, this research conducted the Odour Category Development Exercise. The data collection process for this exercise is elaborated further in the following section.

3.9.3 Data Collection: Odour Category Development Process Design

Prior to running a first-round design experiment, the odour category development exercise was conducted. Chapter 4 discusses in detail the purpose of this exercise, its process, and the findings. However, as this chapter discusses the methodology of this doctoral research, this section provides a brief background to the sampling and design processes for this exercise.

Unlike a visual stimulus, such as colour, there is a significant lack of standardisation in odour-related vocabularies. In response to this, this doctoral research has developed the odour palettes that reflect the common understanding of each odour by participants in the experiments. By doing so, the odour palettes can be used as a design material for service designers who intend to design for the olfactory-enabled aesthetics of experience that may enable a value co-creating user experience in human-AI chatbot interaction.

The participants in the Odour Category Development Exercise were recruited from the Royal College of Art (RCA), London. The selection of postgraduate students as the sample user group for this doctoral research was intentional, as explained in section 3.8.2. Postgraduate research students have been identified as key beneficiaries of mental health support (Levecque et al, 2017; *Nature*, 2019). *Nature* journal's biennial PhD student experience survey, noted above, was conducted among PhD students from scientific disciplines, specifically technology, engineering, and mathematics (*Nature*, 2019). As a result, the voices of postgraduate students in art and design are missing in this dialogue.

The RCA is the major postgraduate art and design school in the UK. Recruiting the sample user group from the RCA means that the findings from this research may expand the findings of the *Nature* survey. Also, as a PhD student at the RCA, I have easy access to a pool of students who meet the requirements for the sample user group for this research. Therefore, the Call for Participants for the Odour Category Development Exercise was circulated across the RCA, and a total of twenty-two students were recruited for the Odour Category Development Exercise. The exercise was conducted in collaboration with a perfumer from Prof. Barry Smith's Centre for the Study of the Senses (CenSes) at the Institute of Advanced Studies at the University of London. The design process of the Odour Category Development Exercise is discussed in detail in Chapter 4.

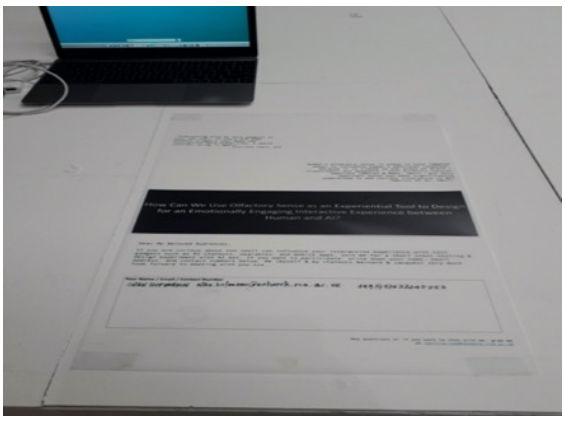
3.9.4 Data Collection: First-Round Experiment

A purposive sampling approach was adopted for the first-round experiment. The sample user group for this doctoral research is postgraduate students who have normally functioning olfactory and visual senses, have experienced mild depression or anxiety for the past three months, and have experience of using AI chatbots or other SSPs. The term 'mild depression or anxiety' was specified as a mental state that does not require clinical support but is instead considered as day-to-day mood swings that ordinary healthy individuals experience. SSPs were also specified as smart technology-embedded consumer products that include a broad array of smart devices that are granted material agency (Leonardi, 2011), such as AI chatbots, voice assistants, and wearables.

In order to recruit participants for the first-round experiment, the Call for Participants was sent out to twenty-two students from the RCA who had participated in the Odour Category Development Exercise. Of the twenty-two students, four expressed interests in participating in the experiment. An additional Call for Participants was circulated during the week of the Work-in-Progress Design Show held at the RCA in January 2019. Another four RCA students responded to this. Design research, which is rather qualitatively driven, does not aim for a large sample, given that its intention is not to generalise the findings to the population. This doctoral research is not intended to test theories or hypotheses. Instead, its research questions clearly indicate that it is exploratory research that studies the effect of olfactory stimulus on users' emotions and users' perceived quality of interaction with an AI chatbot. As a result, it does not require a large sample. In the first-round experiment, the data was collected through three different methods – a self-report questionnaire used twice in the pre-engagement and post-engagement stages of the user journey respectively, a map of emotions, and an exit interview. This meant that there was sufficient amount of data per participant to triangulate data from each source and make sense of them.

Campbell, Greenwood, Prior, Shearer, Walkem, Young, Bywaters, and Walker (2020) emphasise that when the researcher determines the sample size for qualitative research, it is important to base their decision on the scope of the research, the nature of the topic, and the study design. The way that the first-round experiment was designed suggested that a sample size of ten was a reasonable number. Therefore, this research set the target sample size as ten, and when eight students from the RCA responded, the Call for Participants was sent to Imperial College London, located next to the RCA, to recruit two more postgraduate students.

FIGURE 3. 6: PARTICIPANT RECRUITMENT AT THE WORK-IN-PROGRESS DESIGN SHOW 2019 AT THE ROYAL COLLEGE OF ART, LONDON, THE UK



The vanilla-based Odour 8 received the highest valence score in the Odour Category Development Exercise. The highest valence score indicates that most participants found the odour 8 pleasant. In the first-round experiment, Odour 8 was used as a design material to explore its effect on participants' emotions and their perceived quality of the interaction with an AI chatbot.

A total of ten participants were randomly allocated to two groups – the control group, with no exposure to Odour 8, and the treatment group, with exposure to it. In a room set aside for the experiment with the treatment group, Odour 8 was diffused across the room via an aroma diffuser one hour prior to the experiment. The intensity of Odour 8 for the treatment group was kept consistent across all experimental sessions by scheduling each session for different days and using a mixture of three drops of Odour 8 with 30ml water for all the sessions. The same room was used for all ten sessions to make sure that the size of the room did not affect the intensity of the odour. An additional ten drops of Odour 8 were applied to the table on the right- and left-hand sides of the laptop immediately before each session began.

As described in Section 3.9.1, three AI chatbots were built for this study in collaboration with a machine learning engineer on the Heroku platform, a cloud-based platform that allows developers to build applications. Three chatbots were built in varying degrees of visual aesthetics to reflect the lower, neutral, and higher levels of visual aesthetics of the chatbot. The level of visual aesthetics was then validated by the study participants during the Odour Category Development Exercise. The results from the validation by the participants in the exercise confirmed that the participants' responses matched the level of visual aesthetics articulated through the appearance of each chatbot and the typography of the chat screen.

All participants were then allowed to choose and interact with a chatbot. The purpose of allowing participants to choose the chatbot they found most attractive and would like to chat with during the session was to keep a high level of visual aesthetics throughout all the sessions of the experiment. By doing so, it was able to control the potential effect of visual aesthetics on participants' emotional response during the interaction with the chatbot and the participants' perceived value of the chatbot in a given usage context and perceived overall quality of experience.

During the process of developing chatbots with a machine learning engineer, it became clear that it might be almost impossible to train all three chatbots to be able to handle every type of conversation with each participant within a given set amount of time. Also, as proved by the commercially available voice assistants and chatbots on the market, most are still a long way from handling complex dialogue with a human. After some trials and errors experienced whilst training chatbots with data sets, I decided to adopt a Wizard of Oz approach for this research. A Wizard of Oz is a prototyping approach in which a human mimics the intelligence of the potential system, an AI chatbot in this case, and interacts with a user through a mock interface (Maulsby, Greenberg, and Mander, 1993; Dahlback, Jonsson, and Ahrenberg, 1993). In executing a Wizard of Oz approach for the experimental session, I played the role of the Wizard and controlled the back end of the chatbot from the room next to the room where the experiment was held. There was no pre-determined chat script for this experiment, but the chat was guided by the general structure that starts with the introduction and askes the participant about any aspect of their life where they may need emotional support for their mental well-being. The sample of chat script can be found in section 5.5 in Chapter 5. It is imperative to note that the potential effect of the content of chat script on participants' emotions was minimised as best as possible in the experimental context, as the general content structure stayed identical across all participants. However, how participants make sense of their emotions and evaluate the quality of interaction with an AI chatbot is beyond the control of experimental process, as participants' sense-making process is influenced by individual and socio-cultural elements which have shaped their personal belief system and values, and as a result, participants determined user value from the interaction with the chatbot uniquely and phenomenologically (Vargo and Lusch, 2016).

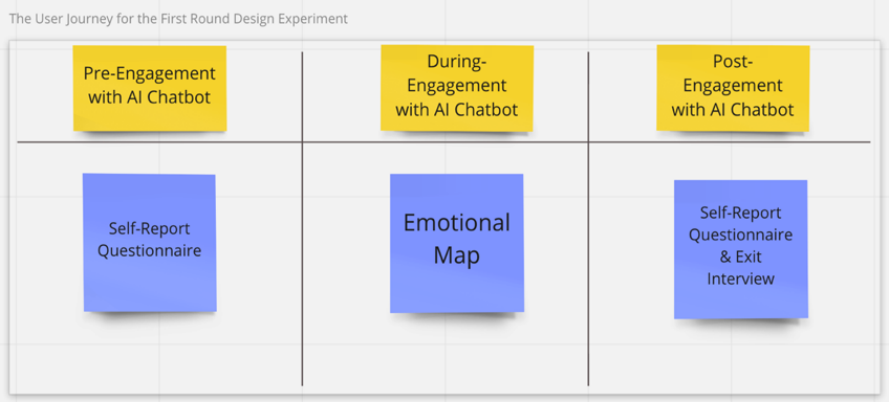
During the experimental session, the data were collected through three different methods, in three different stages of the user journey. Figure 3.8 presents the types of methods used in each stage of the user journey. Participants were first asked to complete a simple questionnaire that collects their demographic profiles. They were then asked to complete the questionnaire that assesses their perceived value of using an AI chatbot and their perception of how sensory elements, such as visual, auditory, and olfactory stimuli may affect their interaction with an AI chatbot. The questionnaire was designed based on the Theory of Consumption Value (Sheth,

Newman and Gross, 1991) which was used to assess the level of user acceptance for a hedonic digital artefact in previous study (Turel, Serenko, and Bontis, 2010). The questionnaire assessed perceived user value based on three items – emotional value, utilitarian value, and the user's future behavioural intention. Each question was presented on a differential semantic scale: from strongly disagree to strongly agree on a scale of 1 to 5 in which 1 represents strongly disagree and 5 strongly agree. A copy of the questionnaire can be found in the Appendix.

Once the participants had completed the questionnaire, they were invited to choose the chatbot they found the most visually attractive and would like to chat with for 15 minutes for this experiment. They were also asked to draw their emotional responses during the interaction on the emotional map provided for the experiment. The purpose of using this map was to capture participants' emotional responses during their interaction with an AI chatbot in real time. Measuring emotions through a self-report questionnaire often raises doubts about its accuracy and reliability due to the time-lapse experienced by the respondent between when they 'felt' emotions and 'reported' emotions (Scherer, 2005). The use of a map for emotions in this experiment was intended to eliminate this time-lapse and thus enhance the accuracy and reliability of emotional data collected.

The map used in the experiment was created based on Russell's (1980) Circumplex Model of Affect which measures emotions using two parameters – valence and arousal. Russell's model is based on the dimensional theory which labels human emotions within the spectrum of pleasure-displeasure and activation-deactivation. Because the model measures emotions based on valence and arousal only, it is unable to capture the rich details of emotions that may differentiate between types of emotions on a granular level. This shortcoming is also acknowledged by Russell (2003) himself. Despite its shortcomings, the model can still capture mixed and complex emotions that are not easily captured by Ekman's (1992) six basic categories of emotions. Russell's model also allows the participants a significant degree of freedom to express their emotions in drawings of how their emotional status has evolved during their interaction with the chatbot.

FIGURE 3. 7: THE METHOD USED AT EACH STAGE OF THE JOURNEY IN THE FIRST-ROUND EXPERIMENT



As soon as the participants had completed a 15-minute chat session with the chatbot, they were invited back to complete the same self-report questionnaire they had completed before they started interacting with the chatbot. The aim of using the same self-report questionnaire again in the post-engagement stage was to identify whether there were any changes in participants' perceived quality of interaction with an AI chatbot and their perception of how sensory elements may influence the quality of interaction after they had interacted with the chatbot. When they had completed the questionnaire, the participants were then invited to a 15-minute exit interview with me. During the exit interview, any unclear parts of their drawings on their maps were clarified, and the participants also had a chance to expand their drawings and share richer details of any changes in their emotional responses during the interaction. The participants in the treatment group were not informed of the presence of Odour 8, because the recent study by Rimkute, Moraes, and Ferreira (2016) confirms that the participants' awareness of the presence of the odour impacts the integrity of data collected from participants. The participants in their study demonstrated the tendency to adjust their responses intentionally, taking into consideration their exposure to the olfactory stimulus.

The findings from the first-round design experiment are discussed in detail in Chapter 5.

3.9.5 Data Collection: Second-Round Experiment

The second-round experiment scaled up the first-round one by using additional odours that were identified as pleasant in the Odour Category Development Exercise and increasing the sample size. The purpose of scaling up the first-round experiment was not to generalise the findings, as stated previously, but to generate more rigorous findings that may reveal the essence of similarities manifested in the user experience during their interaction with the AI chatbot. A slightly bigger sample than that of the first-round experiment may also uncover information that might have not been discovered in the first-round experiment.

The method for the second-round experiment was guided by the results from the first-round experiment. This doctoral research takes a research through design methodological approach informed by Schön's (1983) reflection-in-action process. Building upon this discussion, this research went through the reflection-in-action process prior to conducting a second-round experiment. The first-round experiment presents early findings that illustrate how the olfactory stimulus influences users' emotions throughout the three stages of the user journey. The reflection-in-action process undertaken prior to the second-round experiment helped me to critically assess the experimental design of the first-round experiment and identify the areas that could be iterated to improve the rigour of the research findings. The areas that were iterated in the second-round experiment can be summarised in three points, as follows.

First, the second-round experiment increased the sample size to build an in-depth understanding of any further common patterns that may emerge across the participants who were exposed to different types of odours. The body of extant literature that discusses sampling strategy in qualitative research depicts an inconsistent view on how to determine a sample size for a chosen qualitative method. Trotter II (2012) discusses these challenges in the sampling strategies of qualitative research and introduces a sampling framework, 'expert sampling', which recruits individuals who have the most extensive expertise in specific areas of social and cultural knowledge within a certain community. The sample of this doctoral research is very specific, as the research aim and the research questions specifically address the user groups of SSPs, regardless of whether they are current or former users. Sim, Saunders, Waterfield, and Kingstone (2018) examine whether the sample size in qualitative research can be determined a priori, given that redundancy and saturation are the commonly accepted approach by the qualitative research community to conduct sampling. But in their study, they introduce guidelines for determining a sample size in qualitative research, based on the review of the literature: the average sample size for qualitative research appears to be 30 (Adler and Adler, 2012; Marshall, Cardon, Poddar, and Fontenot, 2013; Lincoln and Guba, 1985). In the light of this, the second-round experiment aimed to recruit up to 30 participants.

Second, the self-report questionnaires were replaced by a phenomenological interview in the second-round experiment. With a small sample size of less than 30 individuals, it is unlikely that this research can offer statistical analysis with data collected from the self-report questionnaires. Also, more importantly, the phenomenological interview that emphasises the importance of understanding human behaviour through a holistic lens (Giorgi, 2012), is more closely aligned to the aim of design research than a self-report questionnaire that objectifies users based on measurements on a consumer value scale. In addition, having a phenomenological interview with each participant during the pre- and post-engagement stages allowed me to capture in-depth accounts of the role played by the olfactory stimulus in the context of the participant's interaction with an AI chatbot.

It may be worth elaborating on a brief background of phenomenology. It will help the readership of this doctoral research to understand better the rationale for replacing a self-report questionnaire with a phenomenological interview.

Phenomenology was first introduced in the early twentieth century by Edmund Husserl (Giorgi, 2012; Bevan, 2014; Sadala and Adorno, 2001). Husserl, a philosopher and a mathematician, had realised the shortcomings of positivism in the understanding of humans. A positivist approach that has its roots in natural science, often takes a highly reductive stance towards humans. As a

result, early studies in psychology treated humans as measurable units (Englander, 2012; Girogi, 2012), and the phenomenon under study in early studies was largely dictated by the notion of what is measurable through a positivist lens. In response to the lack of a holistic understanding of human science, Husserl introduced phenomenological research, which examines the phenomenon as it manifests in lived experience and highlights the identification of the essence of the experience that represents the structure of lived experience. Husserl's followers, including Heidegger and Merleau-Ponty, have further developed phenomenological research and have expanded its conceptual boundary as philosophy and as a research methodology. As a result, the body of extant literature in phenomenological research is highly diverse and depicts a fragmented view, which is largely divided into two camps: descriptive phenomenology (the Husserlian approach) and interpretive phenomenology (the Heideggerian approach).

The second-round experiment adopted a Heideggerian interpretive phenomenology. An in-depth discussion on the differences between a descriptive and an interpretive phenomenology is beyond the aim of this doctoral research and therefore it is not discussed in detail here. However, I will provide a brief overview of the distinct features of each approach and my rationale for choosing an interpretive approach over a descriptive approach as a research method for the second-round experiment.

In descriptive phenomenology, the relation between the human consciousness and the lifeworld is strongly emphasised. Researchers in phenomenology who adopt this approach must distance themselves to avoid contaminating the data collected from the subjects in the study with their perception and prior knowledge and experiences (Sloane and Bowe, 2014; Reiners, 2012; Englander, 2012; Wojnar and Swanson, 2007). Maintaining the researcher's objectivity throughout the research process is termed *transcendental subjectivity;* Lopez and Willis (2004) describe transcendental subjectivity as follows: 'An impact of the researcher on the inquiry is constantly assessed and biases and preconceptions neutralised, so that they do not influence the object of study' (p.728).

In contrast, interpretive phenomenology embraces the researcher's prior knowledge and preconceptions, and new knowledge generated from the study findings is co-constructed between the researcher and participants in the study (Frechette, Bitzas, Aubry, Kilpatrick, and Lavoie-Tremblay, 2020; Lopez and Willis, 2004). The distinct aspect of an interpretive phenomenology is its emphasis on *Dasein,* or 'being-in-the world'. In interpretive phenomenology, the central tenet of phenomenology research lies in the ontology which assumes that there is a complex relationship between humans and the world that cannot easily be separated. Heidegger believed that the daily experience of humans is intertwined with the cultural, social, and political context in which they live; therefore, it is not possible to inquire into

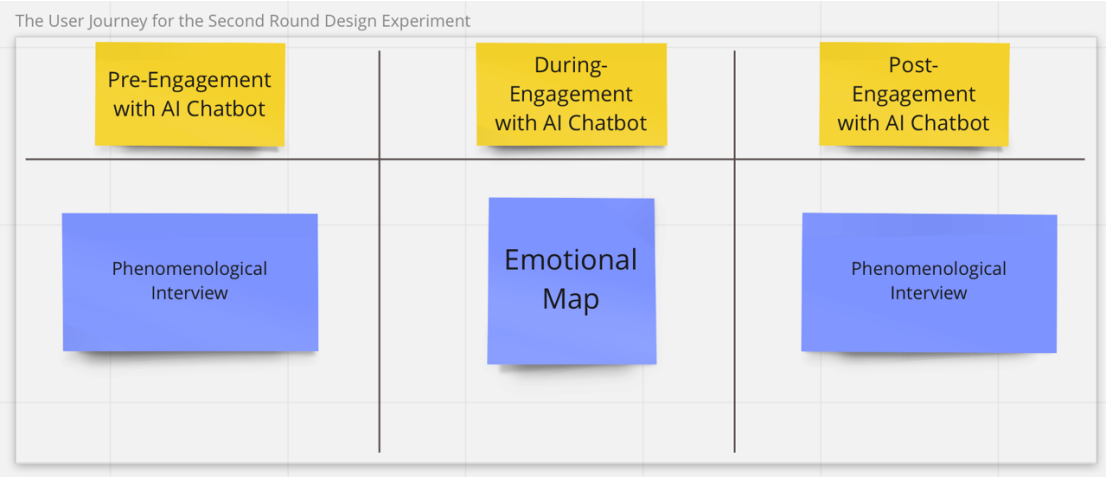
the lived experience of a human without an understanding of the contextual features that constitute this experience (Reiners, 2012; Sloane and Bowe, 2014).

Although most phenomenology researchers agree that neither a descriptive nor an interpretive approach is a perfect method, they tend to hold a certain view towards each approach. For example, Lopez and Willis (2004) argue that descriptive phenomenology best suits research that examines the phenomenon that has been incompletely conceptualised by previous studies, whereas interpretive phenomenology allows researchers to collect more relevant data for their research if the aim of the research is to understand the contextual factors that shape lived experiences and explore potential implications for practice – in their case, nursing practice. Conversely, Wojnar and Swanson (2007) present a slightly different view, claiming that phenomenology researchers often choose an interpretive approach when the aim of the research is merely to understand the holistic human experience and to take account of rich contextual details, but a descriptive approach is adopted for research that aims to distil the essence of lived experience and introduce practical interventions.

As already noted in the existing literature, the research stream in phenomenology remains highly diverse and fragmented; therefore, it is still uncertain which phenomenological approach offers stronger explanatory power for which type of research. Having reviewed previous studies, written from 1970 to 2020, I have concluded that the aim of this research and the research question can be more thoroughly explored through an interpretive approach. This is because the user's emotional response during the interaction with an AI chatbot and how the user evaluates an interactive experience with it are expected to be significantly influenced by various contextual factors. As a result, the hidden layers within lived experience of each user are more likely to be individual- and culture-specific, and interpretive phenomenology which holds the view that lived experience of humans is embedded in the world they live in offers a close alignment to the aim of the research and the research question of this study. Additionally, interpretive phenomenology that appreciates the researcher's involvement in knowledge generation with participants of the study reflects a designerly way of working. Co-creation and collaboration are among the fundamental principles of service design (Sanders and Stappers, 2012), and interpretive phenomenology offers an approach that directly responds to the way most service designers work. Hence, the findings from interpretive phenomenology are likely to suggest practical implications that are more relevant for service designers.

Last, four additional odours that are rated as pleasant were used in the second-round experiment to understand whether any variation in odour influences how participants make sense of their emotions and to evaluate the quality of their interaction with an AI chatbot.

FIGURE 3. 8: THE METHOD USED AT EACH STAGE OF THE JOURNEY IN THE SECOND-ROUND EXPERIMENT



The emotional map was used in the 'during engagement' stage of the user journey, to measure participants' emotions in real time during their interaction with a chatbot. Emotions are known to be a nebulous concept, with many competing definitions in the literature (Scherer, 2005). The traditional emotional measurement approach such as a self-report questionnaire has often suffered from a time lapse between when the participant has felt the emotions and when they have recalled them, as well as from the vague words used to describe emotions, with prescriptive choices presented to participants. An emotional mapping exercise used throughout the experimental sessions allowed participants to express their emotions in a non-verbal format that eliminates the difficulties of articulating their emotions in concise verbal language. This non-verbal data from the emotional mapping exercise was also the source for data triangulation with additional sets of data collected from interviews with participants.

Subjectivity brought by the researcher during the data interpretation is unavoidable in qualitative research, and a data analysis process based on interpretive phenomenology graciously embraces this process rather than discarding it, as do descriptive phenomenology researchers. In order to enhance the robustness of the findings from data interpretation, the data collected from phenomenological interviews were triangulated with data from the emotional maps produced by the participants.

The first-round experiment focused on understanding how the participants make sense of their emotions and assessing whether a change in participants' emotional responses through their interaction with an AI chatbot influences the participants' level of engagement with the chatbot and the participants' satisfaction as users. This exploration continued in the second-round experiment. A detailed discussion on the purpose, the process, and the result of the second-round experiment can be found in Chapter 6.

Chapter 4: Odour Category Development Exercise

Pre-Design Experiment

4.1 Introduction

Chapter 3 discussed the historical background of the tension between art and science and delineated the design experiment by looking closely at what makes a design experiment distinct from scientific experiment, and why it has been disregarded by the mainstream academic community for so long. It also discussed how speculative design practice is often used as a design experimental approach to explore the unknown territory through a continuous reflection-in-action process without being constrained by a complete control of variables that are often imposed in a scientific experiment. It then moved on to explain why this doctoral research chose a design experiment as a methodological approach to examine the research questions stated in Chapter 2.

The theoretical framework that emerged in this doctoral research is underpinned by one pre-experimental session and two design experimental sessions. This chapter illustrates a pre-experimental session – the Odour Category Development Exercise – which was conducted at the Royal College of Art (RCA) in October 2018. The purpose of the Odour Category Development Exercise was to create a palette of odours that would be used throughout the experiments. Odour, unlike colour, is significantly under-explored, especially in Western society, where visual stimuli have remained dominant (Bordegoni, Carulli, Shi, and Ruscio, 2017). The colour red is understood by most people, regardless of which part of the world they come from. But the same level of standardisation in odour-related vocabularies has yet to emerge. Also, the human perception of olfactory stimuli is known to be significantly cultural- and individual-specific (Ferdenzi, Joussain, Digard, Luneau, Djordjevic, and Besafi, 2017), which makes it challenging for researchers to standardise odour-related vocabulary. The absence of an odour palette that can be used as a standard odour-related language system in the extant literature suggests the need for sets of odours to be developed that can be used throughout the design experimental sessions in this doctoral research; for this purpose, this research collaborated with a perfumer who works with Prof. Barry Smith's CenSes Lab at the Institute of Philosophy, School of Advanced Studies, University of London, to develop the sets of odours which would be used during two rounds of design experiments conducted as part of this doctoral research. This collaboration with the perfumer from CenSes Lab was also critical for this exercise to begin with the sets of odours that have achieved a certain level of standardisation in its odour descriptive language and perception across culture and gender through previous research projects.

This doctoral research had an option to start this exercise with selecting the odours from scratch rather than starting with the sets of odour brought from previous research, but given the absence of standardised odour-related language with the observation that odour is known to be a highly

culture- and individual-specific design material (Ferdenzi et al., 2017), co-designing the odour palette with participants from scratch was not the most viable option. Instead, this research still adopted a co-design process by engaging with participants to further validate the sets of odours that are brought by the perfumer to contextualise the odour sets within this doctoral research and refine the selection of ten odours by the perfumer and created the odour palette that is specifically for olfactory-enabled aesthetics of experience design for human-AI chatbot interaction.

Chapter 3 introduced the three AI chatbots that were developed to simulate an SSP in this research context. SSPs represent a group of smart products enabled by artificial intelligence that extends material agency to SSPs (Leonardi, 2001) and that allows SSPs to autonomously sense their environment, respond to, and interact with users, based on contextual information accumulated over time. The emergence of SSPs that underpin a smart service system is a recent phenomenon; thus, there is no widely accepted standard terminology that describes a group of smart products that have acquired material agency. According to the extant literature in service research (e.g. service management, service science, and services marketing), these products are described as smart devices, smart wearable technology, or intelligent devices (Silverio-Fernandez, Renukappa, and Suresh, 2018). Building on the notion of SDL, this study adopts the term Smart Service Product (SSP) – which clearly conveys that product is a means to an end rather than an end in itself. In the era of the Smart Service Experience Economy, the product is used as a medium of delivery for smart services used by the beneficiary. Beneficiaries are then expected to realise value-in-use through the consumption of services.

This chapter is dedicated to explaining the process of the Odour Category Development Exercise that was conducted with the support of a perfumer from the CenSes Lab at the Institute of Philosophy, School of Advanced Studies, University of London. The background information on the Odour Category Development Exercise, such as the conceptual definition of SSPs in this research context and how AI chatbots were developed in collaboration with a machine learning engineer, was discussed in Chapter 3, which introduced the research methodology of this doctoral research. The use scenario in which AI chatbots were used throughout two rounds of design experiments was also discussed.

In light of emerging chatbots that tackle societal challenges, such as mental health and growing concerns for postgraduate students' mental health, this doctoral research simulated AI chatbots as social companions that could provide emotional support to users in order to help them proactively maintain their own mental well-being. The vast majority of postgraduate students are Millennials, and they are identified as digital natives and early adopters of SSPs, according to the research conducted by Accenture in 2017. Postgraduate students' significant exposure to SSPs

and experience of using these devices suggest that they represent a relevant sample for this doctoral research. The design process for the Odour Category Development Exercise is discussed in detail in the next section.

4.2 Design Process for the Odour Category Development Exercise

The Odour Category Development Exercise was conducted in collaboration with a perfumer who works at the CenSes Lab, as detailed above. The perfumer provided support for Prof. Barry's sensory research at the Lab, and thus he has had extensive exposure to the academic sensory research.

Before conducting the Odour Category Development Exercise, the perfumer selected ten different types of odours from his past projects at the CenSes Lab. His selection of these ten odours was based on two parameters: the level of valence and the level of arousal experienced by the participants who had participated in the CenSes Lab's previous research projects. He intentionally selected five odours from the group that were identified as pleasant and another five from the group that were identified as unpleasant. Table 4.1 below lists these ten odours, with a description and the properties of each.

TABLE 4. 1: SELECTED TEN ODOURS AND THEIR PROPERTIES

Odour Number	Odour Description	Odour Determining Materials
1	Grapefruit, citrus, bergamot	Limonene, Linalyl acetate, Grapefruit mercaptan
2	Pungent, blue cheese, meat	Methyl thiobutyrate
3	White musk	Galaxolide
4	Warm woods, masculine	Kephalis, Frankincense, amber,
5	Earthy, soil, rain	Geosmin, Earthy Pyrazine
6	Herbal, chamomile, lavender	Chamomile oil, lavender oil
7	Floral, rose	Iso E Super
8	Vanillin, vanilla	Vanillin
9	Overheated electrical goods, plastic	2,6 Xylenon, Benzophenone, Para cresol
10	Transparent, floral, jasmine	Methyl dihydrojasmonate

How the olfactory stimulus is perceived and experienced by humans is known to be individual- and culture-specific (Ferdenzi et al, 2017, Candau, 2004). Taking this into account, this research used the ten odours selected as a starting point to build two categories, pleasant odours and unpleasant odours, which will then be further validated with the participants of the odour category development exercise through a co-design process. The odour palette that is created at the end of this exercise will be used throughout the design experiments. As explained in Chapter 3, Section 3.8.3, the participants in this exercise were recruited from the RCA, a postgraduate art and design school in London, UK.

Before any data collection activities began, the research was granted research ethics approval from the Research Office at the RCA in May 2018. In October 2018, the Call for Participants for the Odour Category Development Exercise was circulated across the RCA and recruited twenty-

two students in total. Unlike a scientific experiment that is heavily quantitative-driven, a design experiment is qualitative-driven and therefore serves the purpose of exploratory research like this doctoral research. The sampling strategy in qualitative research is still in an ongoing debate, with inconsistent perspectives from multiple disciplines, but the general consensus is that the average sample size for qualitative research is 30 (Adler and Adler, 2012; Sim, Saunders, Waterfield, and Kingstone, 2018). Informed by this general view held by the qualitative research community, the Odour Category Development Exercise recruited a total of twenty-two students.

Of the twenty-two students, ten students self-identified as males and twelve students as females. Sixteen different nationalities in total were represented in the sample, reflecting the highly diverse student body at the RCA. Most of the participants were from the Millennial age group and were born between 1981 to 1996, except for two students who were from the 40 to 50 age group. During the participant recruitment process, all participants were informed that they should meet three criteria: 1). The participant should have a normally functioning visual and olfactory system; 2). The participant should have no allergic reaction to any types of odours; and 3). The participant should have experienced mild depression that has not been diagnosed as a clinical condition in the past three months.

Before asking participants to complete a short questionnaire that collected their demographic information, they were informed of the purpose of the use of their data and were asked to give their consent if they were happy to participate in this research. They were also informed that they could withdraw their participation at any time without explanation.

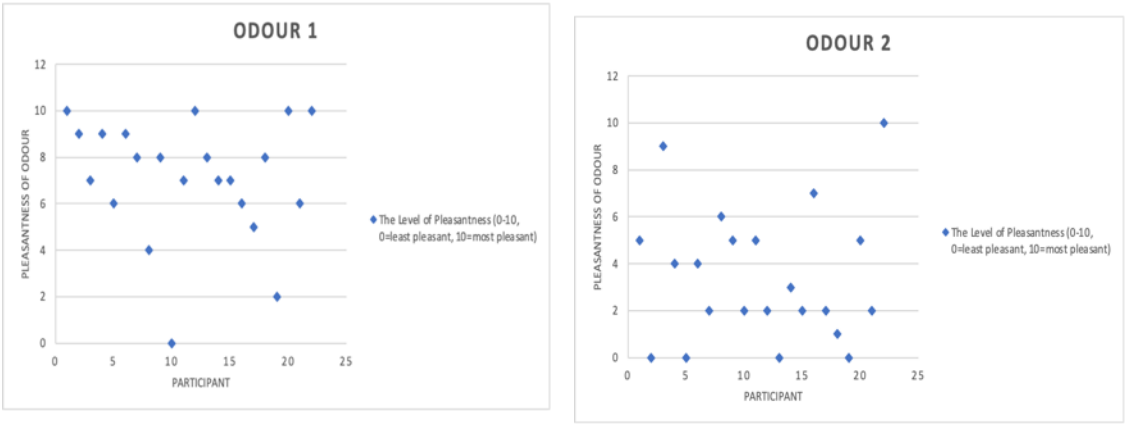
Upon the completion of the questionnaire, the participants were asked to choose one of three AI chatbots – named Bernard, Jacques, and Robert – which they considered the most visually appealing to them and that they would like to chat with. Once they completed the questionnaire and chose the chatbot, they were given ten paper strips, each of which was saturated with one of the ten selected odours. They were asked to smell each odour and evaluate the levels of pleasantness and intensity on a semantic differential scale (Most pleasant-Most unpleasant, Most intense – Least intense) of 0 to 10. The participants were also invited to share their thoughts on whether each odour was familiar to them and any emotions that they experienced while they were smelling the odours. Figure 4.1 demonstrates how the Odour Category Development Exercise was set up.

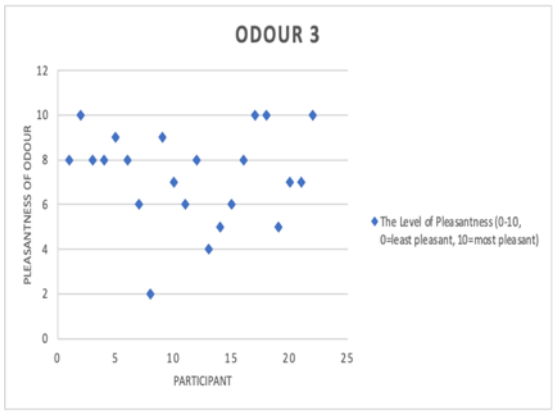
FIGURE 4. 1: THE ODOUR CATEGORY DEVELOPMENT EXERCISE AT THE RCA, LONDON, THE UK

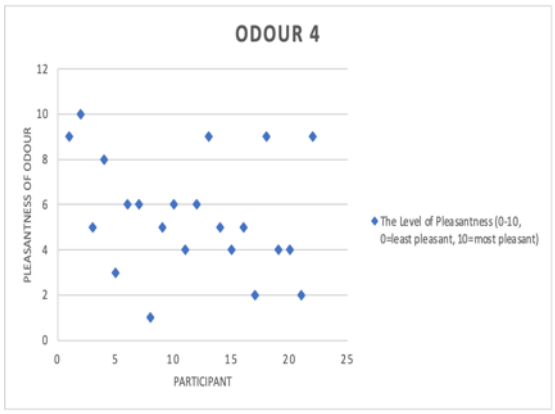
4.3 Results

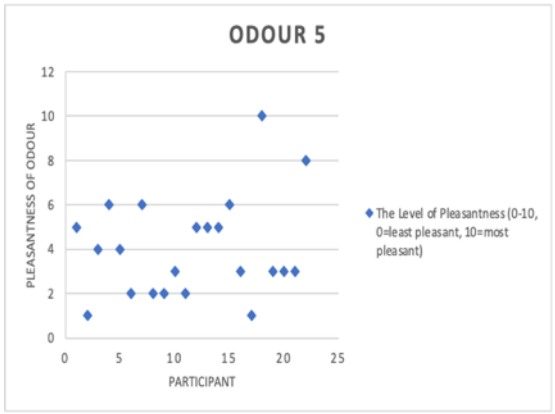
Most participants rated Odour 8 with the highest score for pleasantness. Odour 8 consists of vanilla-based odour properties. In contrast, Odour 2 received the lowest score for pleasantness. Figure 4.2 below illustrates how participants evaluated the level of pleasantness of each odour. According to the results, most participants found Odours 8, 3, and 1 pleasant. The mean score of Odour 8 was 7.4, that of Odour 3 was 7.3, and that of Odour 1 was 7.1. The participants also gave a mean score of more than 6 for Odours 6, 7, and 10.

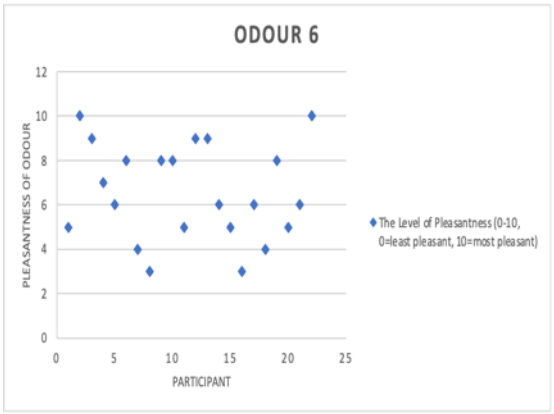
FIGURE 4. 2: THE VALENCE OF ODOUR

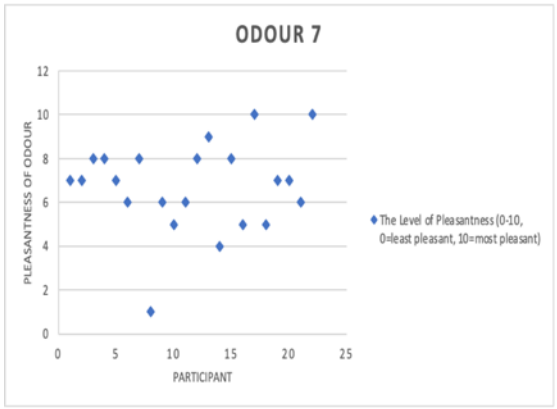


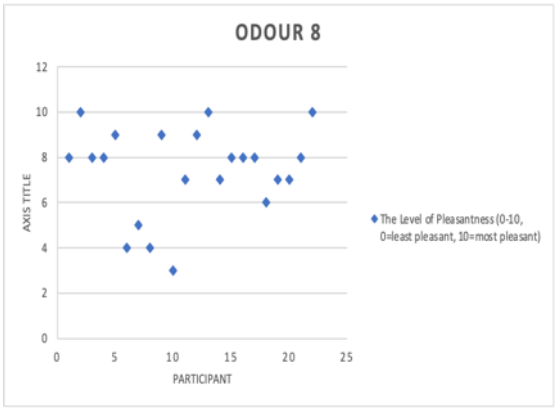

ODOUR 3
PLEASANTNESS OF ODOUR
PARTICIPANT
The Level of Pleasantness (0-10, 0=least pleasant, 10=most pleasant)

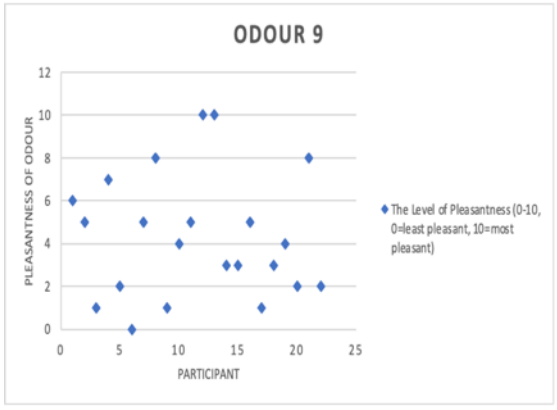

ODOUR 4
PLEASANTNESS OF ODOUR
PARTICIPANT
The Level of Pleasantness (0-10, 0=least pleasant, 10=most pleasant)

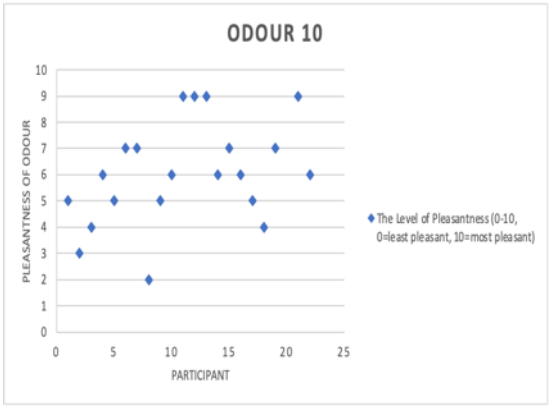

ODOUR 5
PLEASANTNESS OF ODOUR
PARTICIPANT
The Level of Pleasantness (0-10, 0=least pleasant, 10=most pleasant)


ODOUR 6
PLEASANTNESS OF ODOUR
PARTICIPANT
The Level of Pleasantness (0-10, 0=least pleasant, 10=most pleasant)


ODOUR 7
PLEASANTNESS OF ODOUR
PARTICIPANT
The Level of Pleasantness (0-10, 0=least pleasant, 10=most pleasant)


ODOUR 8
AXIS TITLE
PARTICIPANT
The Level of Pleasantness (0-10, 0=least pleasant, 10=most pleasant)


ODOUR 9
PLEASANTNESS OF ODOUR
PARTICIPANT
The Level of Pleasantness (0-10, 0=least pleasant, 10=most pleasant)


ODOUR 10
PLEASANTNESS OF ODOUR
PARTICIPANT
The Level of Pleasantness (0-10, 0=least pleasant, 10=most pleasant)

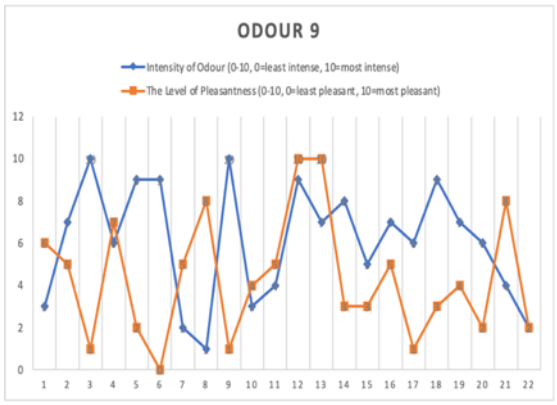
The extant literature claims that how people experience and perceive odour is highly subjective, as it is determined by individual- and culture-specific elements that retrieve past experiences stored in humans' long-term memory systems (Brewster, McGookin, and Miller, 2006). However, the results of the exercise reveal that the descriptive language used by the participants to express their thoughts and emotions whilst smelling each odour was rather similar than different. In one specific example, participants unanimously described Odour 8 with words such as 'desserts', 'chocolates', *'*vanilla*'* and 'sweets', as illustrated in Figure 4.4. As such, a definite similarity is observed in their descriptive language. In a similar vein, most participants associated Odour 7 with words such as 'woman', 'perfume', and 'bathing products'. Despite a highly diverse sample in which sixteen nationalities were represented, the similar language used by the participants in describing and characterising the odours suggests that the cultural differences exhibited in earlier generations might have been increasingly neutralised in the Millennial population, potentially by the influence of globalisation in recent decades.

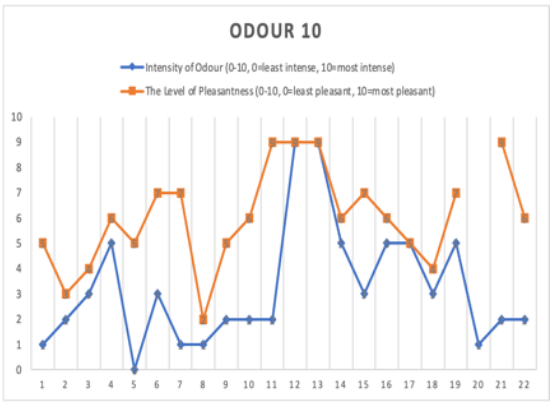
Globalisation has propelled the process of the homogenisation of youth culture across the world. Although there are some exceptions – for instance, those brought up in the underdeveloped world, with no or limited access to digital connectivity, or in a country that has strict media censorship by a government that bans foreign media content – most Millennials in this research sample were brought up with McDonald's, Pokémon, MTV, and most importantly, digital technologies, which have brought the world ever closer to one another.

In contrast to the minimal cultural differences observed in this result, the gender effect was manifested in the participants' descriptive language. While male participants often associated certain odour with automobiles, none of the female participants mentioned automobiles in their description. However, there was no gender effect on the participants' evaluation on the levels of valence and intensity of the odours. Neither did gender affect the level of familiarity with each odour expressed by each participant.

Figure 4.3 below shows the relationship between the valence and the intensity of the odours as evaluated by the participants. The graphs highlight that the participants found pleasant odours less intense than unpleasant odours. This finding suggests that the stronger the intensity of the odour, the less it is perceived as pleasant by the participants.

FIGURE 4. 3: THE INTENSITY OF ODOUR VS. THE VALENCE OF ODOUR



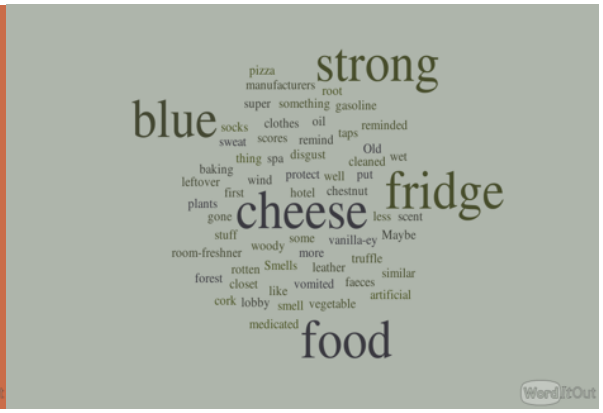


A word map for each odour was also created, as shown in Figure 4.4. Participants had a chance to share their thoughts and feelings whilst they smelled each odour. Figure 4.4 shows a word map of these feelings and thoughts that were shared by all participants. The map is a visual indication of which words were repeatedly used by participants to describe each odour. For example, many participants used the words ‘orange’, ‘citrus’, and ‘grapefruit’ to describe Odour 1. Similarly, Odour 2, which received the lowest valence score, was described by the participants as being strong and like blue cheese. It is noticeable from the word maps that odours that are perceived as pleasant by participants are often associated with perfume used by women, sweetness, and fruit. There was no noticeable difference in the description of each odour by participants, taking into account many synonyms in the word maps of the ten odours.

FIGURE 4. 4: DESCRIPTION OF THE ODOURS BY PARTICIPANTS

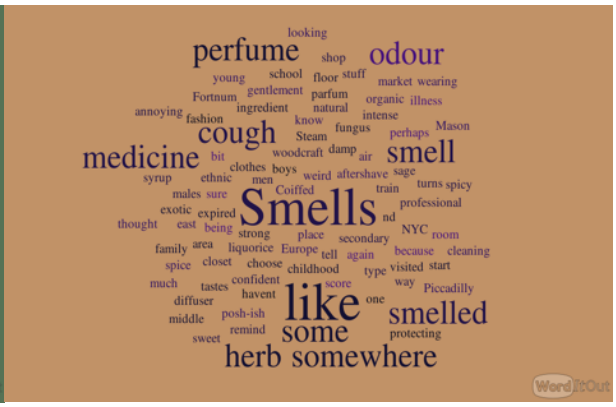
Odour 1

Odour 2

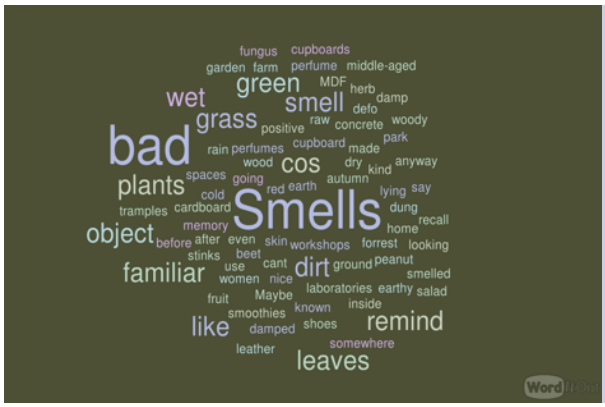


Odour 3

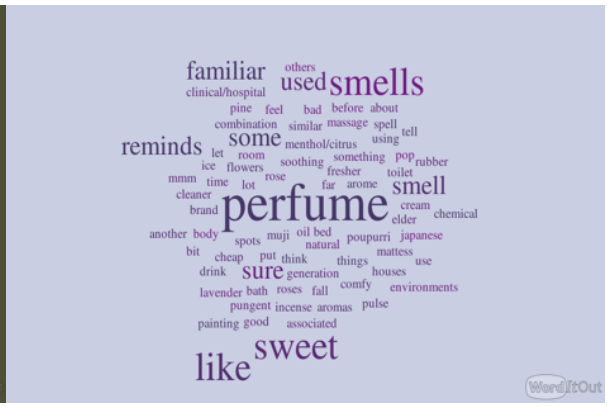
Odour 4



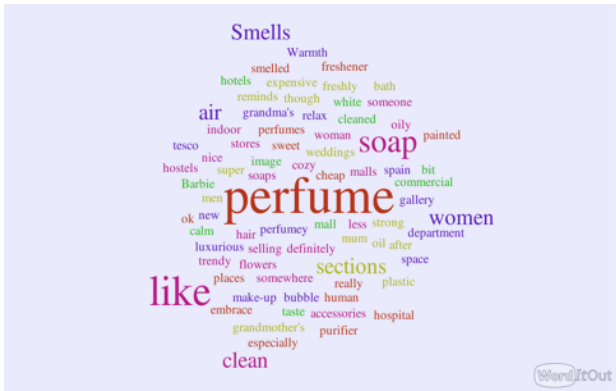
Odour 5



Odour 6



Odour 7



Odour 8

Odour 9

Odour 10

4.4 Discussion

The findings of the Odour Category Development Exercise helped to develop the classification of the ten odours into two specific categories: pleasant odours and unpleasant odours. Table 4.2 presents the mean score of the valence of each odour, which measures the level of pleasantness of the odour. The ten odours were then placed in categories of pleasant odours and unpleasant odours by averaging the level of valence of each odour rated by all the participants. The odour that received a mean valence score below 5 was categorised as unpleasant. Of the ten odours, seven received a mean valence score above 5.

TABLE 4. 2: ODOUR CATEGORY

Pleasant Odour Group	Mean Score of Valence	Unpleasant Odour Group	Mean Score of Valence
Odour 8	7.41	Odour 2	3.45
Odour 3	7.32	Odour 5	4.05
Odour 1	7.09	Odour 9	4.32
Odour 7	6.73		
Odour 6	6.55		
Odour 10	6.05		
Odour 4	5.55		

The group of pleasant odours identified through this exercise was used for a series of design experiments to explore how designers can leverage the odour stimulus as a design material to accomplish their design goals. Chapter 5 takes a close look at the design experiment that used Odour 8 as a design material for olfactory-enabled aesthetic experience design in the context of human-AI chatbot interaction. Chapter 6 describes the scaling up of this process by using four additional odours that were considered the next most pleasant odours after Odour 8 to explore emerging patterns in the context of olfactory-enabled aesthetic experience design for human-AI chatbot interaction.

4.5 Conclusion

This chapter introduces the empirical research context of the doctoral research. The research built three AI chatbots – Bernard, Jacques, and Robert – to simulate an SSP to investigate the phenomenon of lack of user engagement in a smart service system. The extant literature that studies the phenomenon of lack of user engagement in smart service systems has mostly focused solely on wearable devices. With the rapidly growing market adoption of AI chatbots and voice assistants, an AI chatbot was a strong candidate for an SSP in this research, as these service providers face a challenge in relation to the lack of user engagement that leads to abandonment caused by frustrating user experiences (Scates, 2020; Goode, 2019; Trajkova and Martin-Hammond, 2020).

The purpose of building three chatbots rather than a single chatbot for this research was to allow each participant to choose the chatbot they found visually attractive and thus wanted to chat with during the design experimental sessions. Two centuries ago, Margaret Wolfe Hungerford famously said, 'Beauty is in the eyes of the beholder' (Naini, Moss, and Gill, 2006). Beauty is a highly subjective term. One study participant may find one of the AI chatbots built for this research – Bernard – visually attractive, but it does not mean that the other participants will find Bernard equally attractive.

The visual aesthetics appeal of chatbots is a potential confounding variable that needs to be controlled in order to focus on the effect of olfactory stimulus on participants' emotions and their perceived quality of interaction with an AI chatbot. With the intention of controlling visual aesthetics appeal of chatbots, this research built three AI chatbots with varying degrees of visual aesthetic appeal. The level of visual aesthetic appeal assigned to each chatbot - Bernard with a high level of visual aesthetic appeal, Jacques with a low in visual aesthetic appeal, and Robert with a neutral visual aesthetics - were validated by the participants of the Odour Category Development Exercise. The participants had freedom to choose the chatbot which they find visually most appealing and that they would like to chat with, and by doing so, this research maintained the highest visual aesthetics across all participants.

The findings from this exercise confirm that there were no notable cultural differences manifested in the way each participant described the odours. For example, most participants, regardless of which cultural background they came from, described Odour 8 with words such as 'sweet', 'dessert', 'vanilla', and 'ice cream'. Sixteen different nationalities were represented in the research sample for the Odour Category Development Exercise, but despite a highly diverse sample, the results of the Odour Category Development Exercise challenges the enduring argument that odour is culture-specific (Murray et al., 2013; Ferdenzi et al, 2017; Novakova et al., 2018). This research attributes this finding to the effect of the demographic profile, given that the majority of participants were from the Millennial generation, who have been significantly

exposed to the homogenisation of youth culture across the world with the advancement of globalisation in the twentieth century. The word maps presented in Figure 4.4 highlight many synonyms, which represent the collective thoughts and feelings shared by participants while they were smelling each odour. Table 4.2 is a summary of the findings that classifies ten odours into two groups of pleasant and unpleasant odours. The participants evaluated the majority of odours as pleasant, and seven odours out of a total of ten received a mean valence score greater than 5. Figure 4.3 also shows that most participants found odours with a high intensity less pleasant.

The purpose of this exercise was to develop a palette of odours that can be used throughout the design experiments in this doctoral research. Odour has been significantly under-explored, especially in the Western society where visual sense has been a dominant one for a long time; as a result, although visual stimulus, such as colour, benefits from a highly standardised language system, a similar level of a standardised language system does not yet exist for olfactory stimuli. Also, olfactory sense is known to be highly cultural- and individual specific, according to the extant literature (Candau, 2004; Murray et al., 2013; Ferdenzi et al., 2017; Novakova et al., 2018), and these attributes make the olfactory stimulus a more challenging material for designers to work with. However, the Olfactory Category Development Exercise produced the palette of odours that are categorised into the groups of pleasant and unpleasant odours. The group of pleasant odours will be used throughout the design experiments introduced in Chapter 5 and 6 respectively.

Chapter 5 discusses the first-round experiment which used Odour 8 as a design material to examine the effect of the olfactory stimulus on each participant's emotional response and the perceived quality of their interaction with an AI chatbot. The design experiment was conducted in a context in which an AI chatbot serves the role of a social companion to the user who is looking for social and emotional support for proactively looking after their mental well-being.

Chapter 5: First-Round Design Experiment

5.1 Introduction

In the previous Chapter, the odour category development exercise was conducted with twenty-two participants recruited from the Royal College of Art (RCA), London, the UK. The purpose of this exercise was to identify the sets of odours that can be used as a design material during the design experiments in this research. Given that the standardisation in the odour-related vocabularies is lacking in comparison to visual stimuli (Ferdenzi et al., 2017), this doctoral research observed the need for identifying the sets of odours that can be used for the design experiments, which were conducted to explore the research questions articulated in Chapter 2. However, this research has not chosen to adopt a co-design approach to identify the sets of odours from the very beginning, because the lack of standardisation in the odour-related

vocabularies and description may affect the validity of the odour palette that comes out of this study. As such, this research started the odour category development exercise with 10 odours that were validated as pleasant and unpleasant by previous research studies conducted in CenSes lab. These 10 odours were then used as baseline data that need to be further validated through the odour category development exercise where participants had a chance to co-create the odour palette, which was then used throughout the design experiments conducted in this doctoral research. Although a co-creation approach was not adopted from the very beginning of the olfactory category development exercise, the odour palette that came out of this exercise was a result of co-creation with participants, which reflects the fundamental approach of service design – exploring the problem through the lens of users. The decision to start the odour category development exercise with initial sets of odours that were validated by previous research was based on the reason that it would make the co-creation process with participants more robust when there is a lack of standardisation in the odour description and odour-related vocabularies.

The result of the odour category development exercise reveals that although five out of ten odours chosen by the perfumer from the CenSes Lab for this exercise were identified as pleasant in previous research conducted by CenSes Lab, the participants of the odour category development exercise in this doctoral research found the seven odours out of the total ten odours selected for the exercise pleasant, whilst they found the other three odours unpleasant. The valence of the odours measures the level of pleasantness on a semantic differential scale (Most Pleasant vs. Most Unpleasant) on a between 0 to 10. The result from the odour category development exercise informs that the odour 8, a vanilla-based odour, has received the highest valence mean score, while the odour 2, a blue cheese and meaty-based odour, has received the lowest valence mean score.

The review of literature in design research, service marketing, and human-computer interaction (HCI) that studied the phenomenon of the lack of user engagement in a smart service system has identified the knowledge gap in the current literature. This gap has informed the research questions as follows.

1) How could service designer use the olfactory stimulus as a design material to design for the olfactory-enabled aesthetics of experience in human-AI chatbot interaction?
2) Could the olfactory-enabled aesthetics of experience emerged in human-AI chatbot interaction enable value co-creation between the user and AI chatbot that enhances user engagement?

5.2 The Purpose of First-Round Design Experiment

In exploring answers for the research questions in this doctoral research, this chapter discusses the process and the findings from the first-round design experiment conducted with the odour 8, which was used as a design material. Before starting a design experiment, the participants were asked to choose the chatbot they would like to chat with. Once they have chosen the chatbot, they were asked to interact with their choice of the chatbot.

By collecting data from three different sources – a self-report questionnaire in the pre- and post-engagement stages of the user journey, the maps of user emotions drawn during the interaction with the chatbot, and an exit interview with each user in the post-engagement stage, the first-round design experiment examined how the odour is influencing the participants' emotions during the interaction with the AI chatbot and participants' perceived quality of the interaction with the chatbot. It is important to note that those participants who were exposed to the odour 8 were not informed of the presence of the odour 8 in the experimental room, as previous study confirmed that participants' awareness of the presence of odour influences an evaluative behaviour of participants (Rimkute et al., 2016).

As much as the design experiment is a novel approach to discover potential new knowledge in the effect of the olfactory stimulus on user's emotions and the user's perceived quality of interaction with an AI chatbot, the findings discussed in this chapter are likely to inform service designers of whether the olfactory stimulus used in this experimental session can be a good medium of design for olfactory-enabled aesthetics of experience design in human-AI chatbot interaction.

5.3 The First-Round Design Experiment Process

The experimental process was discussed in the section 3.8.4 in Chapter 3. The total ten participants were recruited from the RCA and Imperial College London through a purposive sampling approach. As stated in Chapter 3, this doctoral research does not intend to test theories or hypotheses but to explore the olfactory stimulus as a design material and the effect of an olfactory stimulus on users' emotions and their perceived quality of interaction with an AI chatbot. The aim of this research clearly indicates that it does not require a large sample. Also, the first-round experiment is designed to generate preliminary findings which the second-round experiment can build on; therefore, the sample size of ten was justified as sufficient to conduct the first-round experiment.

As the details of the experimental process was already discussed in Chapter 3 section 3.8.4, this section provides a brief summary of what was discussed in Chapter 3. Figure.3.8 in Chapter 3 section 3.8.4 illustrates the data collection process in the first-round experiment. The data were collected by a self-report questionnaire, the maps of emotions, and an exit interview at three

different stages of the user journey. The self-report questionnaire was used in both pre-engagement and post engagement stages to assess if there were any changes in participants' perceived quality of interaction with an AI chatbot and their perception of the olfactory stimulus as a design material for human-AI chatbot interaction. Participants produced the maps that illustrate the evolution of their emotions on a copy of provided emotional map template based on Russell's (1980) Circumplex Model of Affect, while they were chatting with a chatbot. The purpose of using this map was to capture any change in participants' emotional responses during the interaction in real time. The exit interview, which was held for 15 minutes in the post-engagement stage, was intended to clarify any unclear aspect of the participants' maps of their emotions and to give participants an opportunity to share any further thoughts on how their emotions evolved during their 15-minute interaction with a chatbot. More detailed information on the first-round experimental process can be found in the section 3.8.4 in Chapter 3.

5.4 Result

The first two participants experienced technical errors at the start of the experiment, as the chatbot's message was not delivered to them; therefore, usable data were collected from a total of eight participants.

5.4.1 Self-Report Questionnaire used in the Pre- and Post-Engagement Stages of the User Journey

In the post-engagement stage, one participant gave a rating of 1 to the perceived effect of visual aesthetics on the level of engagement with an AI chatbot and their decision to continue to use an AI chatbot. This is an insignificant number; however, none of the participant gave this rating in the pre-engagement stage, and this small change could still be an indication that the view of Tractinsky (2004) and Norman (2004), *'What is beautiful is usable'* is being challenged. Also, it reinforces the claim by Minge and Thüring (2018) for the hedonic and pragmatic halo effects at an early stage of the user experience.

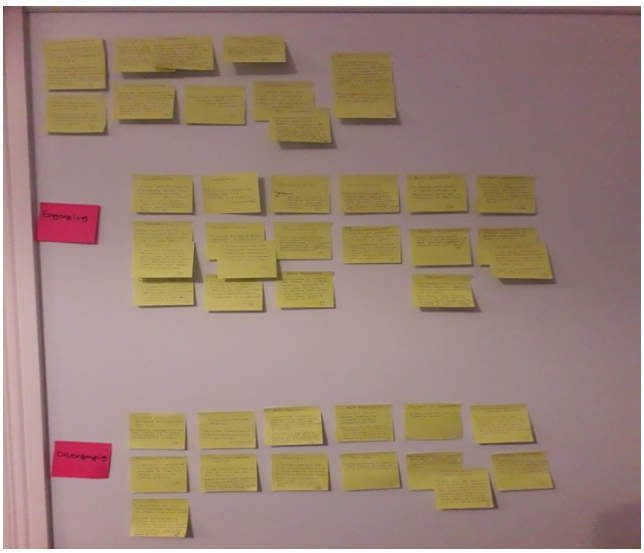
In relation to the participants' perceived effect of the olfactory stimulus on the level of participants' engagement with the chatbot and their decision to continue to use it, seven participants gave ratings of 4 and 5 in the pre-engagement stage. In the post-engagement stage, the number of participants who gave ratings of 4 and 5 was reduced to five. This finding suggests that the olfactory stimulus may not be an effective design material for aesthetics of experience design in human-AI chatbot interaction. However, it is early to make a definitive statement, because the effect of the olfactory stimulus is often processed at a subconscious or unconscious level (Deluca and Botelho, 2020); therefore, it remains unclear whether participants were simply not aware of its effect, especially on their level of engagement. With the data collected from a self-report questionnaire that was deployed in the pre- and post-engagement stages alone, it is difficult to draw any firm conclusions, as the findings still stay at a premature stage.

An additional finding from the self-report questionnaire is that many participants from the treatment group responded that they enjoyed chatting with the chatbot and expressed their desire to chat with the chatbot again in the future. The participants from the control group equally expressed their positive experience with the chatbot; however, they did not express further interest in chatting, or intention to chat, with the chatbot again in the future.

5.4.2 Exit Interview held during the Post-Engagement Stage

A verbatim record of exit interviews was sorted and grouped into clusters using the affinity diagram, shown in Figure.5.1 below.

FIGURE 5. 1: EXIT INTERVIEW DATA ANALYSIS & SYNTHESIS PROCESS



During the data analysis process, a number of common themes emerged. These themes were grouped into two categories – *Engagement* and *Disengagement*. Each theme was matched with associated emotions shared by the participants in their maps of emotions. As illustrated in Table. 5.1, the four key themes were grouped into the engagement category, and each theme shows all the associated emotions expressed by the participants by their drawings on the maps. All four themes unanimously represent participants' positive emotions, satisfaction, and willingness to use the chatbot again in the future.

TABLE 5. 1: ENGAGEMENT CATEGORY[1]

Key Themes	Quotes from the Participants	Associated Emotions
Theme 1: Anthropomorphism	"*It was interesting to interact with Robert. I felt that there was a human inside of the bot.*" Participant 7 "*In the beginning, I was a little sceptical, but the experience was positive. I felt that there was someone behind the bot.*" Participant 9	Happy; Excited; Engaged; and Interesting; Relaxed

[1] Please note that some participants were international students who spoke English as their second language. The quotations from the interview scripts may contain grammatical errors.

	"*Bernard is intelligent. I think it is different from other AI chatbots I interacted with before. I felt that Bernard is tailored to therapy, and it was a good listener."* Participant 3	
Theme 2: The content of the conversation largely determines the overall quality of interaction.	"*The bot started asking questions about me and that got me interested in chatting with him."* Participant 5 "*How Bernard has responded me was the key factor that has influenced the quality of my interaction with him*." Participant 8 "*When I first talked, he (can I say he?), he said, 'Lovely to e-meet you'. It was very cute*." Participant 2	Engaged; Cute; Interested
Theme 3: Psychological safety guaranteed by non-human actor	"*This is a bit easier to talk with because it is not human. So it's more easy to talk with. Why is, is it nothing concerned with the reaction of the real human."* Participant 7 "I feel good that I talk to someone about this with like how to say no consequence…no judging..nothing about that at all." *Participant 6* "*Uh, I want to talk some rubbish to the AI bot. I say, ah, I'm tired, and the AI bot just give me some uh, relaxed words like, or give me some music*." Participant 3	Easy; no concerns; feeling good; relaxed
Theme 4: Accessibility	"*If you are going to see the counsellor, you have to book, and maybe you are worried about what if this person is not trustworthy, but AI bot is something you can just click on and turn on*." Participant 2 "*I feel comfortable talking to friends but at the same time I don't want to bother them too much also. Yeah, they are busy…and I really appreciated this (chatbot) because it feels like he is actually thinking about you*." Participant 9	Feel warm; helpful; feeling appreciated; convenient

The first theme that emerged in the Engagement category confirms that the participants appreciated the resemblance of an AI chatbot to a human. Most participants praised the chatbot's intelligence highly, as well as the ability to hold conversations in the same way that humans do. Some participants also made a comparison between the chatbot and the other AI chatbots they had used in the past and described this chatbot's superior intelligence. Participants were particularly impressed with the chatbot's ability to comprehend the sentences accurately and follow the flow of the conversation. A few participants also mentioned the empathy portrayed by the chatbot by being attentive to the problems the participants shared with it.

The second theme relates to the importance of the content of the conversation. The finding from the exit interview confirms that the content of the conversation positively influenced the level of participants' engagement with the AI chatbot. Most participants' emotional responses quickly changed depending on the types of the questions the chatbot asked them, or how the chatbot responded to the participants' messages. For example, Participant 5, who found the start of the conversation boring, suddenly found himself becoming more engaged with the chatbot when it started asking more questions about him and his areas of interest. A similar change in emotional response was also observed in Participant 4's interaction with the chatbot. Her initial negative emotions – annoyance – changed to excitement when the chatbot started attentively asking more questions about her. On the other hand, the content that did not meet the expectation of the participants also triggered negative emotions in them, which directly influenced the quality of interaction with the chatbot at that point.

The third theme that emerged was the psychological safety that was guaranteed by the chatbot's non-human condition. It was noticeable during the interviews that most participants were concerned about other people's reactions towards them. They also alluded to their fear of being judged by the therapists or counsellors. They felt that talking to an AI chatbot gave them more psychological safety, given its non-humanness. Participant 3 also pointed out that the chatbot's non-humanness allows him to be more carefree with the chatbot, because he can talk about non-sense and trivial matters without worrying too much about negative reactions from the chatbot.

The last emergent theme observed in the engagement category is accessibility. The chatbot is easily accessible from anywhere, at any time. Most participants raised their concerns over becoming a burden to their family and friends if they reach out to them frequently. They thought that this gap in their life could be filled by an AI chatbot, since it is accessible from anywhere at any time, by just one click away from their phone or computer. Participant 2 also raised the point that seeing a human therapist or counsellor on-site at the university campus requires a booking in advance, and she needs to do some homework before she goes to see them. Talking with an AI chatbot requires none of these administrative arrangements; therefore, it offers a reassuring option for her to proactively look after her own mental well-being.

Four emergent themes were also observed in the Disengagement category, as shown in Table.5.2.

TABLE 5. 2: DISENGAGEMENT CATEGORY

Key Themes	Quotes from Participants	Associated Emotions
Theme 1: **A time lapse between messages triggered negative emotions in users.**	"*The first response was a bit slow, and it made me bored*" Participant 5 "*He responded me a bit slowly, so it made me feel awkward and confused."* Participant 6 "*I'm trying to type my message. He asks another question. I feel a bit rushed and hurried*." Participant 8	Bored; Awkward; Confused; Feel rushed.
Theme 2: **Initial attraction from the chatbot's face quickly dissipated as the conversation unfolded.**	"*Because at the end, I felt so annoyed by his face. It was interesting because at first, it was originally the face that led me talk to him*." Participant 4 "*His face is annoying. I mean when I got annoyed by him, I could picture him smiling at me and he was, it just got worse. I would say it's also a bit childish cartoonish, so it doesn't feel professional*." Participant 9	Annoyed; Feel Unprofessional
Theme 3: **User concerns over AI such as addiction to the chatbot, emotional attachment to the chatbot, and data privacy deterred further user engagement.**	"*Sometimes bots can do something better than human. It really helped, um, but, um, I don't want to be like addicted to talking to the computer*." Participant 6 "*I do not trust robot because of my data security*." Participant 4 "*Maybe you could get lost in it. Like you imagine you have a friend and supporting you, but at the end it's a machine. So it can be tricky again."* Participant 9	Feeling Afraid; Cautious; Lack of Trust
Theme 4: **A sudden closure of the conversation triggered negative emotions in most users.**	"*So it says, um, I have to go now. It makes me feel sad. I didn't assume it will leave*." Participant 2 "*You know, like at the end of chat, he said, um, the time is over. I was a bit sad. I was like, oh no, I still want to tell you my story*." Participant 6 "*I must say, like towards the end, the conversation was getting really interesting. I mean, I was starting to appreciate him and so on. And then he told me my time is up and then I got really annoyed*." Participant 9	Sad; Annoyed

The first theme – a time lapse between messages – refers to a brief waiting moment from the point when the participant sends the first message to the chatbot until the chatbot responds to the participant. Given the adoption of a Wizard of OZ approach in this experiment, I, as a

researcher for this experiment, had to move to the room next door after I provided instructions to each participant on the experimental session and about what to expect. Although moving from one room to another took no longer than a minute, and the first messages back to participants were all sent within a three-minute timeframe, all the participants unanimously responded that they found this brief moment of waiting confusing and boring.

The second theme emerged from the observation that some participants negatively reacted to the face of the chatbot. They had chosen the chatbot because they liked its face, but after several interactions with it, at a certain point, the participants expressed their frustration over the chatbot's face. Participant 9 confessed that he was very annoyed by the smiley face of the chatbot he had chosen. Similarly, Participant 4 shared that she initially liked the face of the chatbot she had chosen but the responses from the chatbot made her feel annoyed by the chatbot's face. This finding supports Minge and Thuring's study (2017) which examines hedonic and pragmatic halo effects at an early stage of user experience. Their study claims that users' product-related perception and emotions change easily during the early stage of interaction, and the second theme from this experiment further reinforces their claim.

The third theme refers to the participants' concerns about the unintended consequence of AI technology. This subject has recently gained significant interest from both industry and academia, as the impact of the unintended consequence of AI technology is increasingly recognised, such as face recognition algorithms that repeatedly fail to accurately detect faces of certain races and gender (Najibi, 2020).

Although most participants evaluated their interaction with an AI chatbot positively, they also raised their concerns over the potential addiction to technology and the emotional attachment to the chatbot. Participant 4 who did not enjoy the interaction with the chatbot responded that she does not trust robots in general, because of her concerns over her own data security.

The last theme in the Disengagement category is about the chatbot's sudden closure of the conversation, as it was trained to chat with each participant for 15 minutes. The chatbot's abrupt interruption in the middle of the conversation to remind a participant that he needs to leave the chat upset several participants. These participants described their emotions using negative emotional words, such as *disappointed* and a*nnoyed*. They explained their emotions as the consequence of their desire to chat with a chatbot longer, and the chatbot did not reciprocate this with the participants.

5.4.3 The Perceived Effect of the Olfactory Stimulus on User Emotions and the Quality of the Interaction with the AI Chatbot

During this experimental session, a change in participants' emotional responses during their interaction with a chatbot was measured by the emotional mapping process. Although participants were able to sense Odour 8 in the experimental room, they were not informed of the presence of the odour in the experimental room, as explained earlier, because previous study (Rimkute et al. , 2016) demonstrated that the awareness of the presence of the olfactory stimulus affected the evaluative behaviour of customers, which resulted in a lack of accuracy and reliability in research data collected. All the participants were given a chance to share their thoughts on their perceived effect of the olfactory stimulus on their emotions and the quality of their interaction with the chatbot during the 15-minute exit interview held in the post-engagement stage of the user journey. During the exit interview, the participants were able to make sense of their emotions and provided additional explanations of the evolution of their emotions during the interaction with the chatbot. Also, their perceived effect of ambient odour on their emotions and the quality of their interaction were assessed through a self-report questionnaire which was used in both the pre- and post-engagement stages of the user journey.

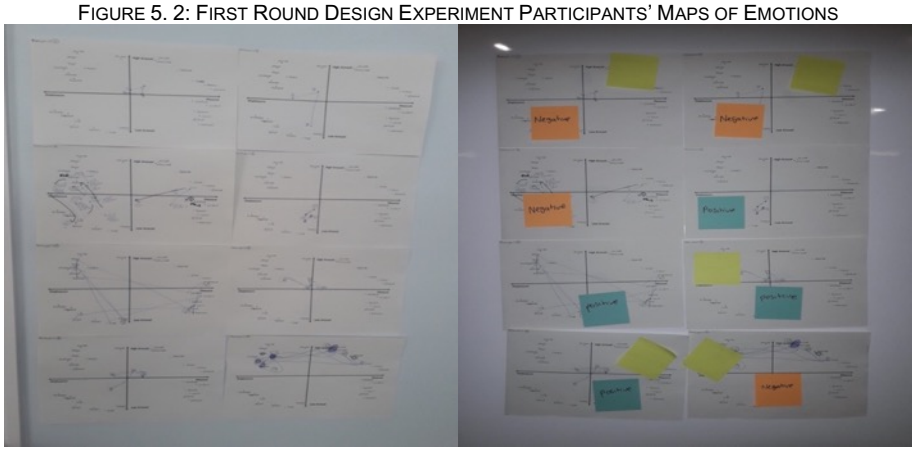
The findings from both the self-report questionnaires and exit interviews reveal that the treatment group can be categorised into two distinct camps: the participants who recognised the odour in the room and articulated its effect on their emotions and the quality of the interaction, and the participants who recognised the odour in the room but felt no effect on their emotions and the quality of the interaction. Participants used emotional words such as *calm* and *relaxing* to describe the positive effect of the olfactory stimulus on their emotions and the quality of the interaction with the chatbot. All the participants who were exposed to Odour 8 and had a positive experience with the chatbot highlighted the soothing effect of the olfactory stimulus on their emotions. For example, Participant 7 sensed the odour when she entered the room. At the beginning, she was a little nervous and excited at the same time when she was provided with the instruction materials for the experiment and was about to start chatting with the chatbot, but she felt that the odour she smelled in the room helped her quickly bring herself back into a calm state. She explained that '*scent helped me calm myself down, so it positively influenced me in some ways*. Participant 2 shared a very similar experience. He said '*I was nervous before talking to the bot. I was lost on the way to this experiment, so I felt rushed. But scent helped me to get relaxed in the beginning*.'

However, there were some participants who recognised the odour but were not able to articulate its effect on their emotions and the quality of interaction with the chatbot. Participant 9 vividly described his experience as follows: '*When I entered the room, I found the smell of the room pleasant, but I got used to it, and I am not sure whether it has influenced my emotions during the interaction with the bot.'* According to the literature, olfactory information is often processed at a

subconscious or unconscious level (De Luca and Botelho, 2021); therefore, it is difficult to confirm that participants' inability to articulate its effect on their emotions and the quality of the interaction automatically nullifies the potential effect of the olfactory stimulus in human-AI chatbot interaction. Their emotions and how they evaluate the quality of interaction could have been influenced by the olfactory stimulus in the room, but they might have not been able to consciously make sense of it. However, at this stage, it is still premature to make any conclusions based on these early findings from the first-round experiment.

5.4.4 Maps of Emotions

FIGURE 5. 2: FIRST ROUND DESIGN EXPERIMENT PARTICIPANTS' MAPS OF EMOTIONS



Unexpected technical errors that happened to two participants precluded them from the research sample. As a result, usable data were collected from a total of eight participants. Figure. 5.2 presents the maps from these eight participants. The maps with yellow sticky notes are from the participants who were exposed to Odour 8 during the interaction with the chatbot. The sticky notes – positive in blue and negative in orange – indicate the emotional state of participants when they ended the conversation with the chatbot. Since five maps are from the treatment group and three maps from the control group, it is difficult to draw a reliable conclusion; however, according to available data from the maps in Figure. 5.2, three participants out of five in the treatment group and one participant out of three in the control group ended the conversation with a chatbot with negative emotions. These negative emotions experienced by the participants at the end of the conversation with the chatbot were largely caused by participants' unfulfilled desire to chat with the chatbot longer.

The pattern that emerged across participants in this mapping exercise identifies that the mapping of their emotions by the participants who were exposed to Odour 8 leans slightly towards the positive quadrants of the map. Although this tendency is subtle, the maps with yellow sticky notes illustrate this pattern.

5.5 Discussion

The first-round experiment in this chapter aimed to generate preliminary knowledge for the sub-set questions introduced in Chapter 2: 1) How could service designers use the olfactory stimulus as a design material to design for the olfactory-enabled aesthetics of experience in human-AI chatbot interaction? 2) Could the olfactory-enabled aesthetics of experience emerged in human-AI chatbot interaction enable value co-creation between the user and AI chatbot that enhances user engagement? The first-round experiment also aimed to explore how participants' emotional responses evolved throughout the user journey that passes through three specific stages, pre-, during-, and post-engagement with an AI chatbot. Additionally, it closely examined the effect of the olfactory stimulus on participants' emotions and the perceived quality of interaction with an AI chatbot.

The results of this experiment present a mixed view of the effect of the olfactory stimulus on participants' emotions and the perceived quality of interaction with an AI chatbot. A self-report questionnaire completed by participants in the pre-engagement stage reveals that the total seven participants believed that the olfactory stimulus would enhance the level of participants' engagement with an AI chatbot, and therefore positively influence the participants' decision to continue to use an AI chatbot. However, when the same question was presented to the participants in the post-engagement stage after they had interacted with the chatbot, only five participants responded that the olfactory stimulus positively influenced the level of their engagement and their decision on whether to continue to use an AI chatbot.

The results from the self-report questionnaire explicitly show that in the participants' view, the olfactory stimulus does not significantly affect the level of their engagement with the chatbot and their decision on whether to continue to use the chatbot. But during the exit interview, some participants shared a view that completely contradicts the result of the self-report questionnaire. These participants highlighted how the ambient odour in the room helped them to relax, which positively contributed to their engagement with the chatbot and thus their intention to continue to use the chatbot.

Their mixed opinions uncover a gap between the data collected from the self-report questionnaire and the data collected from the exit interview. It suggests that this gap requires further investigation through the second-round experiment. An additional finding from this experiment is the variations in the treatment group participants' perception of the effect of the olfactory stimulus on their emotions and the quality of their interaction. All the participants in the treatment group sensed the ambient odour in the experimental room. It was much expected, given that all participants responded that Odour 8 is familiar to them. But only a half of the participants in the treatment group were able to articulate the effect of the olfactory stimulus on their emotions and the quality of their interaction. One participant who was not able to articulate

the effect of the olfactory stimulus on his emotions and the perceived quality of the interaction with a chatbot specifically stated that he was accustomed to the odour during the experiment, and by the end of the experimental session, he was no longer able to detect the odour.

According to Feldman and Lynch (1988), humans tend to rely on information, such as memories and past experiences stored in their subconscious world to form attitudes or make decisions when they have no access to specific information or attributes that allow them to consciously activate their cognitive process. Feldman and Lynch's view suggests that it is still early to make a conclusion that the olfactory stimulus did not affect the participants' level of engagement with the chatbot, because the participants responded that they were used to the odour and were no longer able to detect it. Their inability to detect the odour suggests that they had no access to the olfactory stimulus or information that can activate their conscious cognitive process. In the absence of the information required for the conscious cognitive process, they could not consciously make sense of the effect of the stimulus on the level of their engagement with the chatbot. Given the limited sample size, it is difficult to make any conclusions at this stage; but the maps of emotions, the data from the self-report questionnaires, and the exit interviews support the view that participants' emotions and their perceived quality of interaction were influenced by the olfactory stimulus and thus the level of their engagement and their decision on whether to continue to engage with the chatbot in the future. However, the participants were not able to consciously make sense of the effect of the olfactory stimulus on their experience during the exit interview.

During the exit interviews held in the post-engagement stage, it was uncovered that most participants, regardless of their exposure to Odour 8, considered the content of the conversation as the most important design material for them to co-create value with an AI chatbot. One participant from the control group shared her experience as follows: '*It is interesting because initially his face allured me to talk to him, but in the end, I found his face annoying because of his response.*' Her remark supports the view that the effect of the visual aesthetics of an object cannot sustain the user engagement in the long run if other important aspects of an interactive experience, in this case, the content of the conversation, do not meet the expectations of users (Minge and Thuring, 2018). However, another participant from the treatment group shared an opposite experience. '*And Robert face has a neutral face, so I don't need to force myself to be happy or outgoing. I don't need to pretend my personality.*' This participant offers a different perspective on the effect of visual aesthetics on the participants' interaction with the chatbot, as Robert's neutral face, which is the visual aesthetics of an SSP, positively affected her interaction with him.

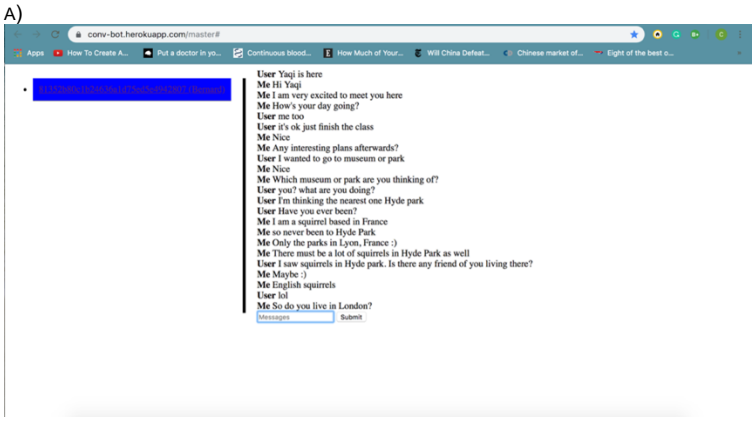
In the during-engagement stage, participants produced the maps of emotions that represent how their emotions evolved during their interaction with the chatbot. In Figure. 5.2, the maps from the participants from the treatment group show the tendency to have the drawings leaned towards the positive quadrants of the map, while the maps from the participants from the control group show a more even distribution of the drawings across four quadrants of the map. This finding suggests that the participants' emotions might have been influenced by Odour 8 at a sub-conscious level. Also, more participants from the treatment group expressed their desire to engage with the chatbot again in the future. It is still early to conclude that the participants' desire to engage with the chatbot again in the future and their drawings of emotions in the maps tilted towards the positive quadrants of the map were caused by the presence of Odour 8 in the experimental room. But this finding can serve as preliminary insights, which this research can build on to inquire into the research question further through the second-round experiment.

The findings from the first-round experiment present a mixed view on the effect of the olfactory stimulus on participants' emotions, their perceived quality of the interaction with the AI chatbot, and as a result, the level of their engagement that may affect their decision to continue to use the chatbot. It is also imperative to note that the chat script was not pre-determined, although the general structure of the conversation between each participant and the chatbot of participant's choice stayed the same across all participants. Specifically, the general content of the chat started with a simple introduction between the chatbot and each participant, and they moved onto discussing about participants' life challenges that may require chatbot's emotional support.

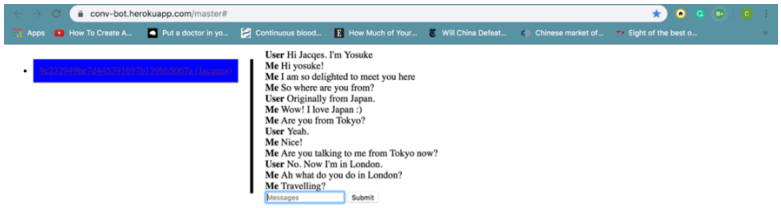
Although the general structure of the chat stayed identical across all participants, the conversational flow was not necessarily the same for all participants, given the absence of pre-determined chat script, which is shown by three examples of chat scripts in Figure 5.3. The chat scripts in Figure 5.3 were the back-end of the chat which I controlled as a Wizard during the experiment. The purpose of not having a pre-determined chat script was to facilitate a conversation that as natural as possible.

FIGURE 5.3. AN EXAMPLE OF CHAT SCRIPT FROM DESIGN EXPERIMENT

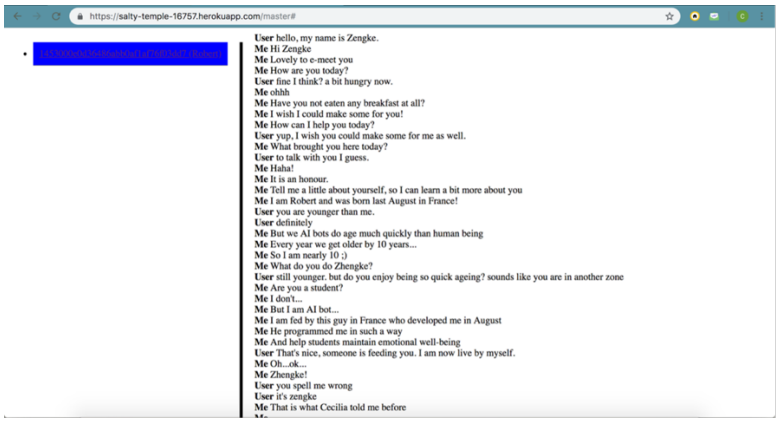
A)



b)



c)



The findings also highlight the importance of the content of the conversation between the chatbot and the participant. Most participants unanimously pointed out the content of the conversation as the most important aspect of the engaging interaction with a chatbot. This observation suggests that it may be worth looking into whether the olfactory stimulus influences participants' information-processing fluency. According to Herrmann, Zidansek, Sprott, and Spangenberg's (2012) study, if the olfactory stimulus is easily processed by customers in a retail context, it can directly influence customer behaviour, which leads to positive business outcomes, such as increased sales. Since Hermann et al.'s study was conducted in a retail setting, the replicability of their findings in this doctoral research is not warranted. Therefore, studying the potential effect of the olfactory stimulus on the participants' information processing capability may reveal some important information that is hitherto unknown about the relationship between the olfactory stimulus, the user's information-processing capability, and the user's perceived quality of the interaction with the chatbot. In Chapter 6, the second-round experiment will explore whether the olfactory stimulus that is easily processed by participants supports participants' information processing, such as making sense of the content of the conversation with a chatbot.

5.6 Reflection-in-Action prior to the Second-Round Experiment

This doctoral research takes a research through design approach that is deeply ingrained in Schön's (1983) reflection-in-action process. At the end of the first-round design experiment, I paused and reflected on the process and the results of the experiment and assessed what needed to be refined for the second-round experiment to enhance the rigour of the process and the robustness of the findings.

The details of the reflection-in-action process that I took before I begin the second-round experiment are discussed in Chapter 3 section 3.8.5. The reflection process identified several areas that could be refined for the second-round experiment to improve the robustness of the findings. The action outputs that emerged from the reflection process can be summarised in three specific points. First, the sample size was scaled up to 30 in order to generate more robust findings that could reveal the essence of similarities observed in user experience across participants. Secondly, additional odours that were identified as pleasant during the odour category development exercise were included in the second-round experiment to develop a holistic understanding of whether the variations in the odour would make any differences to the participants' perceived effect of olfactory stimulus on their emotions and the quality of the interaction with the chatbot. Lastly, the self-report questionnaires used in the pre- and post-engagement stages and an exit interview held in the post-engagement stage were replaced by a phenomenological interview. More detailed discussion on the outputs of the reflection-in-action process can be found in Chapter 3 section 3.8.5.

Chapter 6: Second-Round Design Experiment

6.1 Introduction

In Chapter 5, it used Odour 8 to conduct a design experiment with ten study participants recruited from the Royal College of Art (RCA) and Imperial College London. The purpose of the experiment was to explore two sub-set research questions introduced in Chapter 2: 1) How could service designers use the olfactory stimulus as a design material to design for the olfactory-enabled aesthetics of experience in human-AI chatbot interaction? 2. Could the olfactory-enabled aesthetics of experience emerged in human-AI chatbot interaction enable value co-creation between the user and AI chatbot that enhances user engagement?

The findings from the experiment conducted in Chapter 5 revealed several important points to be considered when planning for the second-round experiment.

First, all participants unanimously claimed that the content of the conversation is the most important aspect of building the engaging interaction with a chatbot. Their claim is also well supported by how participants described how the conversational content with a chatbot positively

influenced their emotions, which led to their positive evaluation of the overall quality of interaction with a chatbot.

Secondly, the participants presented a mixed opinion on the effect of the olfactory stimulus on the level of their engagement with an AI chatbot and their decision on whether to continue to interact with it. The self-report questionnaire was used in both pre- and post-engagement stages. The self-report questionnaire used in the post-engagement stage revealed that five participants gave the ratings of 4 and 5 to the effect of the olfactory stimulus on the level of participants' engagement with the chatbot and their decision to continue to use an AI chatbot, whilst seven participants gave the ratings of 4 and 5 in the pre-engagement stage. The results from the self-report questionnaire alludes to the fact that the olfactory stimulus may not be an effective design material for aesthetics of experience design in human-AI chatbot interaction. However, the exit interview held for 15 minutes in the post-engagement stage uncovered the information that contradicts the results of the self-report questionnaire. During the exit interview, most participants responded that the olfactory stimulus positively affected the level of their engagement with the chatbot and their decision on whether to continue to use it. Thus, their responses during the interview describe that the olfactory stimulus is a potentially effective design material for aesthetics of experience design in human-SSP interaction.

Lastly, the importance of the content of the conversation highlighted by the participants suggests a potential effect of the olfactory stimulus on the users' information-processing fluency, which may have contributed to enhancing the level of user engagement and therefore user's continued intention. Hermann, Zidansek, Sprott, and Spangenberg's (2013) study demonstrated that the olfactory stimulus that is easily processed by customers directly affects customer behaviour in retail context, which leads to positive business outcomes. Their study result offers empirical evidence, which suggests that designers can leverage the olfactory stimulus to improve the users' information-processing fluency that may directly and positively affect the conversational flow between the user and an SSP.

In this Chapter, as explained in Chapter 3 section 3.8.5, the second-round design experiment scaled up the first-round experiment by using additional positive odours identified during the odour category development exercise and increasing the sample size. The aim of this chapter is to build on preliminary insights discovered in Chapter 5 to generate more rigorous findings that may lead to original and new knowledge that may help answer the research questions of this doctoral research.
As stated in Chapter 3 section 3.8.5, in the second-round design experiment, a self-report questionnaire used in the pre- and post-engagement stages in the first-round design experiment was replaced by a phenomenological interview to delve deeper into the participants' world and

capture their lived experience during the interaction with a chatbot. The rationale for this change is the robustness of the phenomenological interview for data collection in exploratory research that studies human's lived experience. A self-report questionnaire is a method that offers prescriptive choices to the participants; therefore, it has limitations in delving deeper into the participants' world and understanding the situation through the eyes of participants. But, a phenomenological interview, especially an interpretive approach used in this research, fills this gap a self-report questionnaire had in the first-round experiment.

6.2 The Second-Round Design Experiment Purpose

In addition to the purpose of the second-round design experiment stated in the introduction section of this chapter, the second-round design experiment was designed to inquire into whether an authentic emotional response elicited in participants can help them experience the aesthetics of experience. By observing this, this research aims to understand whether aesthetics of experience emerged in participant-AI chatbot interaction can enable value co-creation that enhances user engagement, satisfaction and thus users' continued intention for a chatbot.

6.3 The Second-Round Design Experiment Process

In interpretive phenomenology research, a purposive sampling is highly encouraged (Smith et al, 1999; Alase, 2017; Noon, 2018) because interpretive phenomenology aims to understand lived experiences of participants from a certain group. This research explores how users interact with AI chatbot and whether the olfactory stimulus that triggers an authentic emotional response in users can make any positive differences to the users' perceived interactive experience. In Chapter 3 where the research methodology is extensively discussed, the sampling strategy of this research was discussed. In reference to the extant literature in qualitative research, the number 30 is considered an average sample size for qualitative research (Sim, Saunders, Waterfield, and Kingstone, 2018). Taking this into consideration, the second-round experiment aimed at recruiting up to 30 participants. The Call for Participant was circulated across the RCA and Imperial College London in summer 2019. Twenty-five PhD and MA students from the RCA responded to the call, and additional two PhD students from Imperial College London responded. As a result, twenty-seven participants in total were recruited for the second-round experiment.

Of twenty-seven participants, 16 participants identified themselves as females and 11 participants as males. Although the majority of the participants were from the art and design college, this research was able to achieve a fairly evenly distributed gender ratio in the sample population. It is worth mentioning that most participants spoke English as their second language. Both RCA and Imperial College London have a large international student body. Given that the Call for Participant was circulated during the summer break, most students who have responded to the Call from the RCA were from the students who were attending the intensive academic English course during summer prior to the new academic year. A large proportion of sample was made up of international students who spoke English as their second language means that some

participants were not able to fluently describe their emotions in English. To minimise language barriers, they were asked to use a dictionary or Google Translator as needed during the interview. Twenty-four participants were from the age group of the Millennials. Of the total participants, eleven participants were from the age group of 20-25, while eight students were from the age group of 30-35. All participants were randomly allocated to the odour groups as shown in Table 6.1. Usable data were collected from twenty-six participants, as one participant in the baseline group had experienced technical errors during the interaction with the chatbot.

TABLE 6. 1: PARTICIPANTS ALLOCATION TO EXPERIMENTAL STUDY GROUPS

Odour 1	Odour 3	Odour 6	Odour 7	Baseline
6 Participants	5 Participants	5 Participants	6 Participants	5 Participants

As mentioned earlier, in the second-round experiment, an interpretive phenomenological interview replaced a self-report questionnaire used in the pre- and post-engagement stages in the first-round experiment. Each participant was first asked to complete the user profile questionnaire that collects demographic information of the participants. Upon the completion of the questionnaire, the participant then had a phenomenological interview with me for 15 minutes. The aim of this interview prior to chatting with an AI chatbot was to understand participants' prior exposure and experience with AI chatbot or other types of SSPs and assess their preconceived views on using AI chatbot as an aid to maintain their mental well-being. By doing so, the second-round experiment was able to build an initial understanding of how each participant describes user value in a given use context. Participants were also asked to share their views on the potential effect of sensory stimuli, such as the olfactory, visual, and auditory stimuli on their emotions during the interaction with AI chatbot and their decision on whether to continue to engage with it. Before closing the interview, all participants were given an opportunity to choose an AI chatbot they would like to chat with for 15 minutes during the experiment.

After an interview, the participant started chatting with an AI chatbot of their choice for 15 minutes. In this experiment, I adopted again a Wizard of OZ Approach to control the backend of the chatbot from the room next door to minimise the potential technical errors that may occur during the experiment. Participants were given as much freedom as possible to chat about any subjects they would like to during their interaction with the chatbot, but they were informed in advance prior to their interaction with the chatbot that these chatbots were built to be used as a social companion that can help users more proactively look after their mental well-being. Therefore, although there was no predetermined chat script, the content of the conversation was naturally focused on specific problems the participants were experiencing in their lives that challenge their mental well-being.

The second-round experiment also adopted an emotional mapping exercise used in the first-round experiment. All participants were asked to draw how their emotions evolved during their interaction with the chatbot on the map of emotions, which was created based on Russell's (1980) Circumplex Model of Affect. The key distinction of design as a research method lies in its use of *making* as a research method that provides participants with an opportunity to express their thoughts, feelings, and experiences by producing design artefacts. In doing so, the making process becomes a part of research process that generates important data for research. Once the participants completed chatting with a chatbot for 15 minutes, they were called back again for a 15-minute interview to assess whether their interaction with the chatbot and any other contextual elements, especially the olfactory stimulus used in four groups, either positively or negatively influenced their emotional response and the quality of the interaction with the chatbot. A post-engagement interview was also an important avenue to further probe participants' drawings in the maps to assess if there were any gaps between how they made sense of their emotions in real-time through drawings and how they articulated a change in their emotional responses after they disengaged from chatting with the chatbot during the interview.

6.3.1 Interpretive Phenomenology Data Analysis

The research streams in phenomenology offer some guidelines on how to conduct phenomenological interviews and carry out interview data analysis (e.g. Frechette, Bitzas, Aubry, Kilpatrick, and Lavoie-Tremblay, 2020; Noon, 2018; Bevan, 2014; Hycner, 1985). Despite some research tractions in a how-to guide for data analysis, most previous studies in phenomenology concur with a view that some of these guidelines are not underpinned by a solid philosophical foundation (Englander, 2012; Frechette et al, 2020).

An interpretive phenomenology interview used in this experiment is based on the Heideggerian approach that focuses on meanings that emerge during the interaction. As such, this study pays close attention to contextual elements that have shaped how each participant makes sense of his or her emotions and an interactive experience with an AI chatbot. One of the challenges in carrying out phenomenology research is a paucity of literature on the data analysis process. Previous work by Smith et al. (1999), Noon (2018), and Hefferon and Ollis (2006) provide some guidelines as to how interview data analysis can be conducted following the philosophical foundation of interpretive phenomenology research, but they also unanimously agree that their work should not be taken as a prescriptive guideline for other phenomenology research. Instead, they encourage other phenomenology researchers to use their guidelines as a reference to explore the data analysis process that best serves the aim of one's study.

Building on the study of Smith et al. (1999), this study performed the analysis of data collected from the pre- and post-engagement interviews. Following the suggestions made by previous studies, I read each transcript multiple times. Alase (2017) stresses that phenomenology researchers conducting interpretive phenomenology analysis should read the transcript at least three times. I started re-reading the interview transcripts from all participants. Any thoughts or ideas that struck my mind during this reading process were all noted on the left-hand side of the margin in the transcript, while emergent themes from each transcript were noted on the right-hand side of the margin as shown in Figure 6.1.

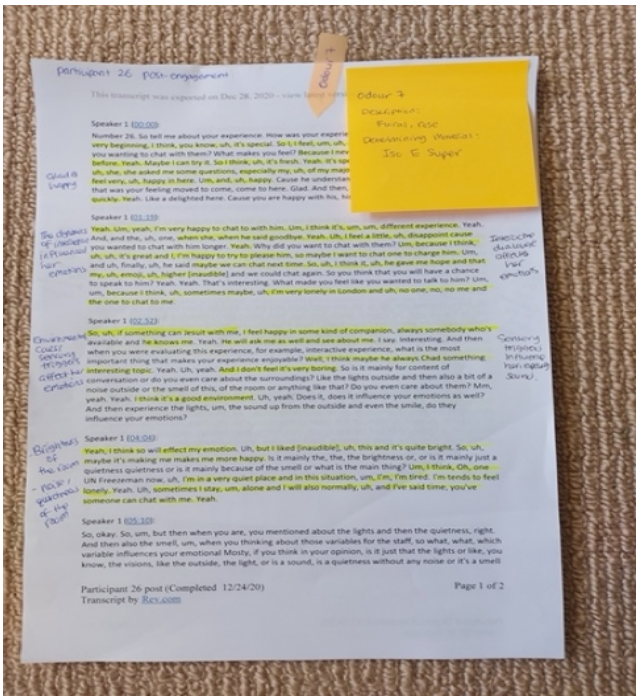
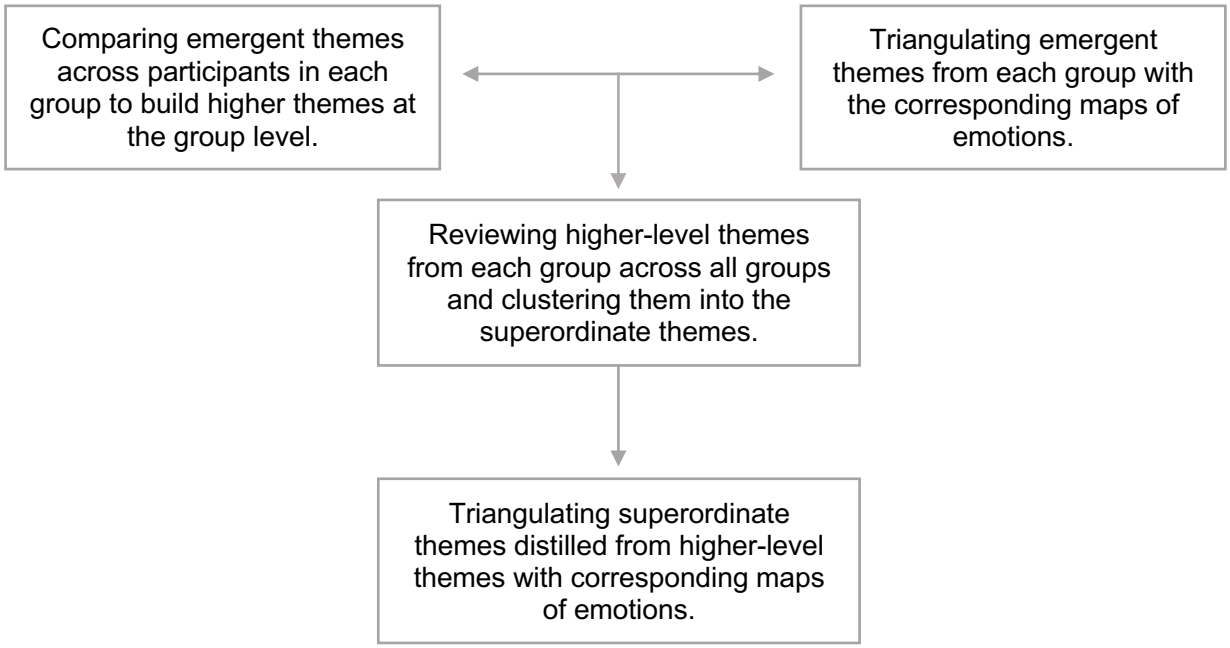


FIGURE 6. 1: NOTES AND EMERGENT THEMES ON TRANSCRIPT

The emergent themes noted on the right-side margin of the master synthesis template were reviewed across all groups who were exposed to the odours 1, 3, 6, and 7. The comparison of emergent themes across participants also helped eliminate any redundant meanings in the themes and distil higher-level themes that articulate the essence of how participants made sense of a change in their emotional responses and evaluated their interactive experience with an AI chatbot.

FIGURE 6. 2: GROUPING, CLUSTERING, TRIANGULATING AND DISTILLING HIGHER-LEVEL THEMES



All grouped themes were triangulated with the maps of emotions created by each participant to enhance the robustness of findings from the data interpretation. The process is illustrated in Figure. 6.2 and the maps of emotions from participants can be found in Appendix section 3.

6.4 Result

6.4.1 Odour 1 (Grapefruit and Citrus)

Among the group that was exposed to Odour 1, three emergent themes were identified. Table 6.2 illustrates these themes.

TABLE 6. 2: ODOUR 1 EMERGENT THEMES [2]

Theme 1: **The effect of the olfactory stimulus on emotions and the quality of interaction is subtle, but it augments the positive interaction with an AI chatbot.**	"*I was not aware of them consciously because I was into the conversation with a chatbot, but I think they helped me at an unconscious level to relax, because I felt that the smell in this room invited me to relax*." Participant 6 *"If I numerically categorise the things that have influenced my emotions and the quality of interaction with the chatbot is probably 70% the content of the conversation, 15% the sensory stimuli such as landscape and smell, 7% the soft smell from you, and the rest is the interaction with you." Participant 10*
Theme 2: **AI intelligence that allows the AI to understand and follow the flow of the conversation is the most important element of the interaction.**	*"So it is that meshing of conversations and those connections." Participant 14* *"With this chatbot was positive because the conversation was very fluent." Participant 24*
Theme 3: **Because an AI chatbot is just a machine, it makes users feel psychologically safer.**	**"***If it is not a real person, I do not have to worry about whether I would get along well with it, so I feel psychologically more safe with a chatbot*." Participant 24 "*Even if I speak in a bad temper, he wouldn't get offended like a human*." Participant 9

More than a half of the participants in this group sensed the olfactory stimulus when they walked into the room. They described it as pleasant, soft, or women's perfume. Only Participant 10 was able to consciously describe how the olfactory stimulus in the room affected his emotions and the quality of the interaction with the AI chatbot. This participant attributed this pleasant odour to the perfume worn by me (please note that I had not worn perfume whilst I was conducting the experimental sessions to make sure that the olfactory stimulus used for the experimental session is not mixed with other synthetic odours). He then described his overall experience as a pleasant one with the emphasis of the role of the sensory stimuli, although he numerically rated the effect

[2] Please note that the majority of participants were international students who spoke English as their second language. The quotations from the interview scripts may contain grammatical errors.

of the olfactory stimulus to only 15% of his positive interaction. Similarly, Participant 6 sensed the ambient odour in the room, but as he was immersed in the conversation with the chatbot, he forgot about the surroundings. But he further explained that the ambient odour in the room affected his emotions and the quality of the interaction with a chatbot positively at an unconscious level, because he found the ambient odour in the room inviting, which made him to relax.

The second theme is about the intelligence of the AI chatbots. As already repeatedly mentioned by the participants from the first-round experiment, all the participants from the odour group 1 claimed that the chatbot's ability to understand the context of the conversation and carry on the conversation is the most important element that influences their decision to continue to use the chatbot. Also, the types of questions and responses from the chatbot appeared to have affected the participants' emotions, as the participants used emotional words, such as nervous or happy, with a specific example from the conversation. Participant 14 found the chatbot very smart and intelligent because despite it being a chatbot with a squirrel face, it was able to weave the connections in the context of the conversation and continue chatting with her. Participant 24 described the communication experience with the chatbot as extremely fluent, which made him wanting to chat with it again in the future.

The last theme is the psychological safety offered by the chatbot. According to what the participants shared during the interviews, many of them found it much easier to interact with the chatbot. Some participants even confessed their social anxiety, such as their concerns over hurting others or making others feel uncomfortable by what they say. In their view, a chatbot is merely a machine without human's cognitive ability and emotions; therefore, they do not have to worry about exercising common social etiquette or using their interpersonal skills. Participant 9 explained that she would feel more comfortable interacting with the chatbot because she can speak to the chatbot in bad temper, and it will not be offended as humans are.

6.4.2 Odour 3 (White Musk)

The interview transcripts from the odour group 3 manifest three emergent themes as shown in Table. 6.3.

TABLE 6. 3: ODOUR 3 EMERGENT THEMES

Theme 1: **AI intelligence that allows the AI to understand and follow the flow of the conversation is the most important element of the interaction.**	*"If the content does not pull its weight, I'm not going to use it."* Participant 8 "*It was noticing that I was putting in jargon and that was kind of funny. I found that quite amusing"* Participant 2
Theme 2: **Because an AI chatbot is just a machine, it makes users feel psychologically safer.**	"*I can talk about more privacy with AI. Because if I talk to you, maybe I cannot see everything is true from you, so I think it's more faith."* Participant 7

	(The participant can trust AI more than humans) "*Not that I can trust, but I know it's anonymous, so it's not like I'm thinking like X is going to feel this way by my response."* Participant 8
Theme 3: **Participants' sensemaking process for a change in their emotional responses often involves associating sensory stimuli with their previous experiences and (or) knowledge.**	"*The view from the window of this room is similar to the view from my sculpture department and it reminded me of my frustration."* Participant 5 *"When I go to outer hotel, this is good hotel. I feel, this is the same perfume. Maybe. I guess it made me feel like home. It is not too much but feels just right."* Participant 7

Two themes out of total three emergent themes observed in the odour 3 group were already observed in the odour 1 group. The participants in the odour 3 group also unanimously claimed that AI intelligence that allows the chatbot to comprehend and follow the flow of the conversation is the most important element that makes the interaction engaging. Participant 8 responded that because she uses AI chatbot for a specific purpose, she will not use it unless it serves the purpose of her use. Her comment precisely supports Vargo and Lush's (2004) SDL thinking, which argues that in a service economy, user (or customer) value embodies dynamic form which is realised through value-in-use. Therefore, in SDL thinking, the conventional notion of user value which is understood in static terms – value is embedded in physical goods - is no longer relevant. When Participant 4 was asked if any external stimuli such as sensory triggers influenced his emotions and the interaction with an AI chatbot, he responded, "*That is hard to say. I was focusing on the chatbot.*" This response illustrates that when users are immersed in the flow state of experience, the effect of external stimuli, such as ambient odour is less likely to be perceived by the user.

The participants from this group also pointed out the AI chatbot's non-human condition as an advantage when it comes to psychological safety. Participant 7 confessed that she is more likely to talk about her personal matters with an AI chatbot more easily than with a human therapist.

The last them is about the participant's sensemaking process for a change in their emotional responses. The interview data clearly showed that the participants' emotions were influenced by the association the participants made between the sensory stimuli and their previous experiences or knowledge. For example, Participant 5 explained that the park view from the experimental room is very similar to the view from her sculpture department where she often goes to see her supervisors. Her association between the visual stimulus, which is the view from the experimental room and that of her sculpture department triggered negative emotions, frustration, in her, because she was going through the phase of frustration with many unknowns and the uncertain direction of her research at that time. Similarly, Participant 7 made an

association between the ambient odour in the hotel she had been in the past and the ambient odour in the experimental room. She elaborated that the ambient odour in the experimental room made her to relax, because of its pleasantness like women's perfume, its familiarity that makes her feel like at home, and just the right level of the intensity that is not too strong or too weak.

When it comes to the effect of the olfactory stimulus on the participants' emotions and the quality of the interaction, the odour 3 group showed mixed opinions. Few participants responded that they do not think that the sensory stimuli, such as the olfactory stimulus affected their emotions and the quality of the interaction with the chatbot. However, how they described their interaction with the chatbot suggested that sensory stimuli influenced their emotions and the quality of the interaction. For example, Participant 8 shared that the face of the chatbot, Bernard, made her imagine a certain persona of the chatbot in her mind. This persona, combined with the flow of the conversation with the chatbot, made her think that the interaction with it is amusing.

Participant 4 made a cautious statement that having a 15-minute interaction with the chatbot is not long enough for him to judge whether any sensory stimuli in surroundings affected his emotions and the quality of the interaction with the chatbot, while Participant 2 lamented that he will not use the chatbot again, because he felt that the nature of the interaction with it was very mechanical, as the chatbot was merely trained by the natural language processing. He also added that the human-machine interaction can never supersede human-human interaction, at least for now. His negative testimony on his interaction with the chatbot implies that the olfactory stimulus was not able to make any positive influence on the interaction between this participant and the chatbot.

There was also the participant from an extreme user case. She highlighted that odour is very important to her when she was asked whether any external stimuli affected her emotions and the quality of the interaction with the chatbot. Moreover, she used an analogy of her first encounter with her husband to describe how sensitively she reacts to the olfactory stimulus. "*Smell is very important to me because actually when I first met my husband, I felt…he was so attractive. From his body, I smelled special perfume. I really liked this smell."* She also explained that she was lost three times on the way to the experimental room, as the campus building was very complex, and she could not easily locate where the experimental room was located. By the time she finally found the room, she was already exhausted, but once she entered the room, she immediately sensed the odour of freshness and pleasantness, which helped her bring down the level of stresses. She felt immediately relaxed. Her description clearly depicts that her initial negative emotions quickly turned into a positive one with the aid of the olfactory stimulus.

6.4.3 Odour 6 (Herbal, Chamomile, Lavender)

The emergent themes identified in the interview transcripts from the odour 6 group are summarised in Table. 6.4.

TABLE 6. 4: ODOUR 6 EMERGENT THEMES

Theme 1: **Participants were not able to easily perceive the olfactory stimulus, neither did they easily make sense of its effect on their emotions and the quality of the interaction.**	*" I think it helps that it's in a calm room, this noise, and it really bothered me actually, the light, I think just makes you calm and the trees all that."* Participant 3 "*None of them in fact. I didn't notice that." Participant 13*
Theme 2: **AI intelligence that allows the AI to understand and follow the flow of the conversation is the most important element of the interaction.**	**"***I was nervous because I was thinking how, how do I say about service design?* Participant 12 "*Yes, I think it is because it makes me like it. It is like friend. It asks me about my life and we talk about it. "* Participant 25.
Theme 3: **Because an AI chatbot is just a machine, it makes users feel psychologically safer.**	*"If it has a human face, I think it would be scary. I won't tell any secrets. It is a cartoon face. Squirrel, so I know that this is just a machine. Animal."* Participant 13 "*I feel comfortable talking to the chatbot. When I talk with local people, I always need to think about how I should I say this. Is it mistake in their culture?"* Participant 12

The interview transcripts exhibit that the participants were not able to clearly articulate whether the odour influenced their emotions and the quality of the interaction with an AI chatbot. The first emergent theme is participants' lack of ability to perceive the olfactory stimulus in the room and to make sense of its effect on their emotions and the quality of the interaction. For example, Participant 13 responded that she sensed the ambient odour that is like perfume or flowers in the room during the interaction with the chatbot, but when she was asked whether she thinks that this odour affected her emotions and the quality of the interaction with the chatbot, she said she did not notice this aspect. Similarly, Participant 3 was aware of sensory stimuli around him. He described that the visual stimulus like trees outside helped him to relax, and the sound stimulus, such as traffic noise, from the outside distracted him, but he was not able to sense the olfactory stimulus.

The second and third themes repeatedly appear as emergent themes in each odour group. All participants in the odour 6 group also agreed that AI intelligence that allows the AI to understand and follow the flow of the conversation affects the level of engagement with a chatbot. The third theme is about psychological safety guaranteed by non-human condition of the chatbot. Many participants from the odour 6 group responded that talking to a machine offers them more psychological protection. According to Participant 13's description, she will not share any secrets with the chatbot if it has a human face, because she doesn't know who is behind it. Participant 12

who is an international student and recently moved to London to study at the RCA expressed that she would find it easier to interact with the chatbot than with local people in London, because she is nervous about making mistakes in English and is not sure what is commonly accepted social norms and etiquettes in the UK. But this psychological burden simply doesn't exist when she interacts with a chatbot.

6.4.4 Odour 7 (Floral, Rose)

In the interview transcripts from the odour 7 group, three emergent themes were identified as shown in Table. 6.5.

TABLE 6. 5: ODOUR 7 EMERGENT THEMES

Theme 1: **The positive effect of the olfactory stimulus on the quality of the interaction with an AI chatbot is augmented when the participants can quickly establish a positive association between the olfactory stimulus and other sensory stimuli and (or) a physical space.**	"*You know, the smell, everyone has their own smell. So your home, you will have a familiar smell when you smell it. You will find this is my home. You can also feel a sense of security…Maybe I feel more security in my home, so I maybe say more private things, this kind of thing."* Participant 19 "*Yeah, quietness and the smell*." Participant 26
Theme 2: **AI intelligence that allows the AI to understand and follow the flow of the conversation is the most important element of the interaction.**	"*And after that I ask, uh, the squirrel, he told me, um, I am just squirrel and one year old. It sounds very cute and I was satisfied"* Participant 17 "*So I think at first I was relaxed, but when I asked, are you a real squirrel? He said yes as if he was trained by AI. I felt a little tensed*." Participant 16
Theme 3: **The users have experienced negative emotions and thus negatively reacted to the interaction with an AI chatbot when the response from the chatbot was either too slow or too fast.**	"*I think uh, he sent the message, maybe a bit quick. Sometimes I cannot write down my thoughts….I feel maybe uh, struggling*…." Participant 15 "*I was nervous a bit because the chatbot responded to me a bit fast and, um, I'm not good at typing."* Participant 17

Most participants in the odour 7 group responded that sensory stimuli are critical to enabling the engaging interaction with an AI chatbot. The first emergent theme is derived from the observation in which those participants who quickly established a positive association between the ambient odour they sensed in the room and other sensory stimuli, such as sound or a physical place like their own home. The participants were able to describe vividly how the olfactory stimulus positively influenced their emotions and the quality of the interaction with an AI chatbot. Their description suggests that the olfactory stimulus enabled the aesthetics of experience, which ultimately promoted the value co-creation process between the participants and the AI chatbots.

To take a specific example of Participant 26, she often finds a quiet place nerve-wracking. The quiet place triggers negative emotions in her, such as loneliness, because it reminds her of being away from her family and friends back in her home country. However, she noticed that the

quietness of the experimental room did not trigger negative emotions in her. Instead, she felt that the pleasant ambient odour in the room helped her stay at ease throughout the interaction with the chatbot, and the quietness of the room was rather an added benefit to her, as she was able to focus on the conversation with the chatbot, which in result, made her evaluate the overall interaction with the chatbot as engaging and enjoyable.

Similarly, the Participant 19 responded that her emotions are easily influenced by external stimuli, such as sensory triggers. She thinks that she reacts most sensitively to the visual stimulus. Although the olfactory stimulus is more subtle in nature in comparison to the visual stimulus, she thinks that the olfactory stimulus still influences her emotions. She then explained further by making an association between the olfactory stimulus and the meanings she attaches to her home and how different her interaction with the chatbot would have been, had she interacted with it from her home. She thinks that she would have revealed about herself more to the chatbot if she had interacted with it from her home, because of the odour of her home that gives her a sense of security.

The second theme for the odour 7 group is also about the importance of AI intelligence for the engaging and enjoyable interaction. Most participants from this group also unanimously pointed out AI intelligence that allows the chatbot to comprehend accurately and follow the flow of the conversation is the most important factor that would determine the participants' decision to continue to use the chatbot. It is very clear from the interview that participants' emotions were significantly influenced by the chatbot's responses and the types of the questions or the conversational topics exchanged between the participants and the chatbot. Participant 17 specifically referred to how the chatbot introduced itself to him intrigued his curiosity about the chatbot more because he found the chat messages came in through from the chatbot very natural and even cute, which made him think that he was chatting with another human rather than the chatbot. Participant 18 also shared a very similar view. He highly praised the intelligence of the chatbot and made a comparison with the chatbot he previously used, which was a disappointing experience, as it was not as intelligent as this chatbot.

Participant 16 shared a slightly different story. He did not like the fact that the chatbot responded to him that it is a squirrel when he asked it whether it is a real squirrel. He thought that the chatbot was not smart enough or honest enough to give him the right answer because at the end of the day it is a chatbot trained by AI. He could not understand why the chatbot did not respond to him honestly that it is a chatbot trained by AI rather than a squirrel. This interaction made him think of a certain persona of the chatbot, such as the chatbot with the lack of integrity and intelligence, which as a result, negatively affected his emotions and his decision on whether to continue to use the chatbot.

The last theme – negative emotions triggered by either a fast or a slow response from the chatbot – alludes to the fact that the rhythm of the conversation that is controlled by the right level of pace is very important for user engagement and satisfaction. Participant 15 said the chatbot's fast response at the beginning of the chat session made him struggle, because of his slow typing speed. Participant 17 also shared the same frustration. When the chatbot responded to him fast, he had become nervous because he could not type fast enough to keep the pace with chatbot's responses.

However, these narratives from the participants may require further investigation. The participants who shared their frustration because of either a fast or a slow response from the chatbot were all Chinese students from the age group between 20-25. These students were attending the intensive academic English course during the summer period. They may not have had many opportunities to type in English language until they move to the UK for further education, and they might have needed more time to digest the questions to continue the conversation in English. Also, few participants from this demographic profile lamented their boredom when the first response from the chatbot was slow. Participant 16 was bored in the beginning when he had to wait for a few seconds for the response from the chatbot, and shortly after, he had become irritated by many questions from the chatbot. This pattern of user behaviour was not observed in other demographic profiles in this odour group, but based on the findings from this second-round experiment only, it is still early to conclude that this specific pattern of user behaviour is attributed to the demographic profile of the participants.

6.4.5 Meta-Synthesis: Higher-level Common Themes across All Groups Exposed to Odours

This doctoral research conducted meta-synthesis by further clustering emergent themes from each group into meta-level common themes as summarised in Table.6.6.

TABLE 6. 6: META-SYNTHESIS OUTPUTS

Theme 1: **Participants who can quickly establish a positive association between the olfactory stimulus and other sensory stimuli, physical space, or even another person are more likely to sense the aesthetics of experience that enables value co-creation.**	*"You know, the smell, everyone has their own smell. So your home, you will have a familiar smell when you smell it. You will find this is my home. You can also feel a sense of security…Maybe I feel more security in my home, so I maybe say more my private things, this kind of thing."* Participant from Odour 7 "*When I go to outer hotel, this is good hotel. I feel, this is the same perfume. Maybe. I guess it made me feel like home. It is not too much but feels just right."* Participant from Odour 3 "*Um, one is um, I liked the landscape when I just came in and I liked the, some sort of, um, hopefully it doesn't sound weird…um..like it had a good smell from you. ….I think so. Yeah, I definitely see. So, and the landscape,*

	smell, and yourself and the brightness. And I think that, or somehow triggered, yeah." Participant from Odour 1
Theme 2: **The participants think that interactive dialogue with an AI chatbot is the most important design material that directly affects their emotional response, the quality of interaction with an AI chatbot, and their decision to continue to use the chatbot.**	*"I think 70% was the content and 15% was the smell."* Participant from Odour 1 *"It is mainly his reply…feedback…his way of saying. He speaks really like a person like where real man*." Participant from Odour 3 *"I was annoyed because I was thinking how do I say about service design*?" Participant from Odour 6 "*So I think at first I was relaxed, but when I asked, are you a real squirrel? He said yes as if he was trained by AI. I felt a little tensed*." Participant from Odour 7
Theme 3: **A machine can offer a better psychological safety than a human therapist in this use context**.	**"***If it is not a real person, I do not have to worry about whether I would get along well with it, so I feel psychologically more safe with a chatbot*." Participant from Odour 1. "*Not that I can trust, but I know it's anonymous, so it's not like I'm thinking like X is going to feel this way by my response."* Participant from Odour 3 *"If it has a human face, I think it would be scary. I won't tell any secrets. It is a cartoon face. Squirrel, so I know that this is just a machine. Animal."* Participant from Odour 6.

The first theme emerged in almost every single odour group, except in the odour 6 group. The participants who quickly established an association between ambient odour they sensed in the room and other sensory stimuli, physical space, other people, and their prior experiences went through the aesthetics of experience enabled by the effect of olfactory stimulus in the room. Although many of these participants were able to make sense of the aesthetics of experience enabled by the olfactory stimulus and how it affected their emotions and the quality of the interaction in general, many of them also added that the effect of the olfactory stimulus was relatively subtle in comparison to the visual and sound stimuli that were present in their surroundings. These participants easily picked up noisy traffic from the outside and trees and the park seen from the window, but for the ambient odour, some of them were able to sense it only when they were waiting for a response from the chatbot and when they were explicitly asked about the effect of the olfactory stimulus. This finding suggests that the odour was most likely processed at an unconscious level first, which was then brought to the consciousness of the participants when they were asked about it and when they were paying attention to the surrounding environment whilst waiting for a response from the chatbot.

The participant from the odour 7 group made an association between the olfactory stimulus and another sensory modality – sound – and explained how the interplay between these two senses positively affected her emotions and the overall quality of the interaction with an AI chatbot. Similarly, the participant from the odour 3 group vividly described the association she made between the ambient odour of the experimental room and that of the hotel lobby floor she had been in the past. She was lost three times on the way to the experimental room and was already very exhausted from spending her entire day in the studio, finalising her painting; therefore, her stressful feelings were aggravated by the time she entered the experimental room. But the ambient odour of the room helped her quickly relieve this stress, as the odour retrieved her memory of a nice hotel lobby floor she found relaxing in the past. A feeling of relaxation immediately triggered in her which then changed her initial negative emotions into positive ones. Her narrative reveals that a positive association established between the olfactory stimulus and users' previous experience can retrieve positive memories, which trigger positive emotions in users. This process ultimately helps users quickly make sense of the effect of the olfactory stimulus on their emotions and influence their decision to continue to use an SSP, such as an AI chatbot.

In a similar vein, the participant from the odour 1 group made an interesting relationship between the ambident odour of the experimental room, the urban view from the window of the experimental room, and the attractiveness of the experimental researcher. He emphasised how the relationship between these three stimuli helped him realise a positive change in his emotional response during the interaction with an AI chatbot and made his overall interactive experience engaging and enjoyable. An additional participant from the odour 7 group described the odour of her home as a sense of security. She thought that the association she makes between home and the odour of her home would let her reveal about herself more to the AI chatbot.

The meta-level theme 1 clearly supports the body of the extant literature, which claims that humans make sense of the olfactory stimulus through a powerful association they make with other sensory stimuli, especially visual and taste stimuli (Spence, Obrist, Velasco, and Ranasinghe, 2017; Gilbert, Martin, and Kemp, 1996). At the same time, it sheds light on the potential role played by a positive association established between the olfactory stimulus and other sensory modalities in enabling the value co-creation process between the user and an AI chatbot. Similarly, physical space, such as hotel lobby and home to which participants have established certain meanings in the past repeatedly came out during the interviews. When designers aim to choreograph the aesthetics of experience with an AI chatbot, they may think about the types of space where their users are likely to interact with it more frequently and identify the types of associations their users are likely to establish between this specific space and the olfactory stimulus they plan to use for design.

Retrospectively, designers could also first think about what kind of olfactory stimulus may help users to build a positive association with the physical space where their users frequently interact with an AI chatbot. By doing so, they could align the olfactory stimulus, a physical space, and an association between the olfactory stimulus and a physical space towards an intended experiential design goal for the user interaction with an AI chatbot.

The second meta-level theme refers to the participants' appreciation of AI intelligence that allows the chatbot to comprehend and follow the flow of the conversation. The data gleaned from both the interviews and the maps of emotions clearly indicate that the participants' emotional responses during the interaction with the chatbot were significantly influenced by an interactive dialogue exchanged between the participants and the chatbots. Most participants highly praised the intelligence of the chatbot that can hold the conversation with the participants as if humans do. The participant from the odour 3 group specifically noted that how the chatbot responded to him and drove the conversation affected his emotion and his continued intention the most, and he appreciated the intelligence of the chatbot that showed its capability to hold the conversation as humans do. Another participant from the odour 1 group pointed out that the content of the conversation contributed approximately 70% to a change in his emotional responses and the overall quality of the interaction with an AI chatbot. It was also very clear from the participants' testimonies during the interview in the post-engagement stage that difficult questions asked by the chatbot triggered negative emotions, such as anxiety and irritation.

As already noted earlier, most participants of the second-round experiment were attending the intensive academic English course offered by the RCA prior to the new academic year. During the interview, some of these students seemed frustrated when they could not find the right vocabulary to articulate their thoughts. This observation indicates that the chatbot's questions may not have been the difficult one, but the participants' lack of prior exposure to the English language could have contributed to causing irritation in them, as they found some areas of complex subjects challenging to articulate in English fluently. Most participants also highlighted that since AI chatbot is a screen-based interaction, the content is the key for user engagement and satisfaction. They added that if the content does not serve the purpose of their use, they will be less likely to engage with a chatbot in the long haul.

The last theme was derived from the observation that many participants appreciated anonymity guaranteed by the AI chatbot. The data sets from the interviews with these participants allude to the participants' psychological burden when they interact with another human, as it requires the ability to empathise with others. But the chatbot enabled by AI is merely a machine trained by large sets of data. The participants liked the fact that they do not need to worry about what they

say when they interact with the chatbot, because it does not possess complex human emotions and cognitive ability in their view. The participant from the odour 1 group shared his feeling of relief from chatting with a chatbot rather than with a human therapist because he does not have to worry about whether he would get along well with the chatbot. The participant from the odour 3 group also raised a similar example as a reason and pointed this out as one of the key reasons that determines her decision to continue to use the chatbot.

6.4.6 No Odour

During the data analysis process, three emergent themes were identified in the interview transcripts from the group of participants who were not exposed to any odours during the experiment. Table.6.7 summarises these three themes and raw data from the interview transcripts which support each theme.

TABLE 6. 7: CONTROL GROUP (NO ODOUR) EMERGENT THEMES

Theme 1: **The users experienced negative emotions and thus negatively reacted to the interaction with the AI chatbot when the response from the chatbot was either too slow or too fast.**	"*I had to wait for his response for a very long time."* Participant 21 "*Because sometimes I need the waiting, waiting moment. So it was a bit distressful."* Participant 23
Theme 2: **AI intelligence that allows the AI to understand and follow the flow of the conversation is the most important element of the interaction.**	"*I think I'm very focused on the conversation. I ignore any other things*." Participant 22. "*I'm focused on the conversation, and I want to keep going in this conversation, so I don't care about others*." Participant 20
Theme 3: **The interaction with the AI chatbot was mechanical, which made it different from human-to-human connection**	"*Sometimes you can feel that you are talking to AI. Um, like the sentence, the way of answer, um, is a bit uh, not like a human. I typed something and uh, it replied to me immediately, and uh, people sometimes don't do that."* Participant 22. "*Sometimes when chatting, you don't have to be very logical, or you don't have to be. It's kind of random when you chat with your friend, but the chatbot asked questions and replied like the formula*." Participant 21

The first theme that emerged in the control group that was not exposed to the olfactory stimulus refers to negative emotions triggered in the participants caused by either a slow or a fast response from the chatbot. Some participants shared a similar view in the odour 7 group. Two participants in the control group specifically mentioned that the chatbot took too long to respond to them after the first message. As explained earlier, this experiment was designed, based on the Wizard of OZ approach; therefore, I acted as a Wizard in another room next to the experimental room to mimic the intelligence of the AI chatbot behind the curtain. Although it took only about a

minute for me to move to the next door after I briefed each participant in the experimental room, Participant 21 described this brief waiting moment as 'very long', which made her bored. Similarly, Participant 23 expressed her impatience with the chatbot in the beginning. She responded that she likes an instant reply, and this waiting moment made her distressed. Observing the same theme that emerged in both the treatment and the control groups suggests that a speed of messages exchanged is a non-negotiable design element for designers to orchestrate the aesthetics of experience for users in the context of human-AI chatbot interaction.

The second theme which highlights the importance of AI intelligence that allows it to understand and drive the flow of the conversation was also observed in the control group. Some participants specifically pointed out that because they focused on the screen-based chat conversation, they often forgot about the surroundings, and therefore, any environmental cues did not affect their emotions, nor did they affect the quality of the interaction with the chatbot. This theme appeared in every single group observed so far, regardless of the exposure to odours. It clearly conveys that a seamless interactive dialogue enabled by the intelligence of AI is a critical design element for the aesthetics of experience that leads to value co-creation between the user and the chatbot. There was one participant who was aware of sensory stimuli, such as the natural odour of the room, the space where she was in, and distracting noise from the outside. Furthermore, she added that she was able to closely sense the ambident odour of the room. She felt that the odour of the room resembles a wooden-based odour. In combination with this odour, the small space where she was in made her nervous, while she was waiting for a response from the chatbot, but once she re-immersed back into the conversation with the chatbot, she forgot about her surroundings again.

The last theme is based on the participants' narratives which claim that the chatbot was not intelligent enough to hold the conversation as humans do. Some participants explicitly stated that they could tell they were talking to the AI chatbot, because of unnatural flow of the conversation. One of them described the nature of the interaction with the chatbot as mechanical, and she felt that the flow of the conversation was controlled by some types of the formula behind it. This finding from the control group is in stark contrast to how the participants from the treatment group described the intelligence of AI chatbot, because most participants from the treatment group highly praised the intelligence of the chatbot they interacted with. Some of them even described their interaction with the chatbot as equivalent to human-human interaction.

Even Participant 2 from the odour 6 group who argued that the chatbot failed to pass the Turing test also acknowledged that the chatbot demonstrated a high level of intelligence in comparison to any other chatbots he had interacted with in the past.

These findings reveal that the olfactory stimulus prompted participants in the treatment group to quickly establish an association between the olfactory stimulus and their past experiences, which helped them easily assign relevant meanings to the olfactory stimulus they were exposed to during the interaction with the AI chatbot. It appears that this information-processing fluency helped the participants to experience the aesthetics of experience, which translated into an enhanced engagement and satisfaction.

On the contrary, the control group participants who interacted with an AI chatbot in the absence of the olfactory stimulus had not experienced the aesthetics of the experience. Their negative evaluation of their interaction with the chatbot appears to be linked to the lack of their ability to process information fluently, as they were single-blinded by the fact that they were talking to an AI chatbot. The chatbot's interaction with each participant was controlled by human behind the curtain through the Wizard of OZ approach, and the chat with each participant did not have any prescriptive guideline, other than the fact that the chat should be tailored towards the purpose of an AI chatbot – a social companion that provides emotional support to the users who are interested in looking after their mental well-being proactively. As a result, the flow of the conversation was as natural as any conversations that may happen between humans. This contrast observed between the participants from the treatment group and the control group suggests that the control group's biased view towards their interaction with an AI chatbot can be understood as the lack of their ability to process information fluently during the interaction with the chatbot.

6.5 Discussion

The findings from the treatment and the control groups present original insights on human's interactive experience with an AI chatbot for designers, marketers, and HCI researchers. The emergent themes discussed in the preceding sections present the common themes that emerged across the participants in the treatment and the control groups. The emergent themes examined in each of the four odour groups were further clustered into meta-level themes through an additional analysis and synthesis process.

The similarities and differences observed between the treatment and the control groups can be summarised into the categories as follows respectively: 1) The Dynamics of Interaction; and 2) Information-Processing Fluency (Schwarz, 2004). The category – the Dynamics of Interaction – that describes the common theme observed in both the treatment and the control groups reinforces the early findings further, which illustrate that the first requirement towards enabling the aesthetics of experience is to make sure that the content of the conversation serves the purpose of the interaction between the user and an SSP, especially when an SSP is a text-based object like a chatbot. The findings from the second-round experiment further reinforced the fact that the participants who experienced the aesthetics of experience explained that they were

engaged during the interaction with the chatbot and expressed their desire to interact with it again in the future, which confirms the aesthetics of experience as a driver that enhances user engagement, satisfaction, and continued intention for a chatbot. Also, it means that the aesthetics of experience that results in an enhanced user engagement, satisfaction, and continued intention for an AI chatbot is an enabler for value co-creation between the users and an AI chatbot. These findings shed new light on the secondary role played by the olfactory stimulus for the aesthetics of experience design in human-AI chatbot interaction in a smart service system. At the primary stage, the users' utilitarian value must be well served by an AI chatbot, which is the dynamics of the interaction served by the content of the chat in this experiment. As demonstrated by the result of the experiment, without meeting the user's utilitarian value-in-use, smart service providers are less likely to bear fruit on the use of the olfactory stimulus as a design material for the aesthetics of experience design. At the secondary stage, the user's emotional value-in-use, which is enabled by the aesthetics of experience, further promotes value co-creation that takes place between the user and an AI chatbot.

The key difference observed between the treatment and the control groups is the level of information-processing fluency. It refers to the observation in which the participants in the control group interpret an interactive dialogue exchanged with an AI chatbot as mechanical, which made them think that they were talking to a machine. These participants pointed out the sentence as unnatural, as the chatbot seemed to detect certain words within sentences and drove the conversation by simply building upon these words. In contrast, most participants in the treatment group appreciated the intelligence of the chatbot, as they felt that interactive dialogue which they had with the chatbot was certainly on par with any conversations they could have with humans. They also often complimented the chatbot's superior human-like intelligence relative to any other AI chatbots they had used in the past. These participants often used the word 'natural' and 'I felt that I was talking to a human'. Also, it is noticeable that the participants from the treatment group found it easy to access their memories and past experiences and quickly establish an association with the olfactory stimulus they were exposed to, which positively influenced their emotions and the overall quality of the interaction with the chatbot.

This result offers clear evidence which shows the effect of the olfactory stimulus on participants' processing fluency. According to the processing fluency theory, conceptual fluency refers to the ease of mental operation, which is enabled by the memories that assign the meanings to the stimulus (Graf, Mayer, and Landwehr, 2017). The olfactory stimulus is well known to be a good trigger for long-term memories stored in humans' brains. As demonstrated by the experimental result from the treatment group, the participants were able to quickly establish an association between the olfactory stimulus and their past experiences, such as the participant's previous experience at a hotel lobby floor that had a similar ambient odour and the odour of home that

reminded the participant of a sense of security. The presence of the olfactory stimulus seems to have enhanced the conceptual fluency in participants, which then positively influenced the overall quality of the interaction with an AI chatbot (Schwarz, 2004; Lee and Labroo, 2004).

6.6 Self-Reflection on Interpretive Phenomenology Data Analysis

Interpretive phenomenology research appreciates the knowledge researcher brings to the data interpretation. Unlike descriptive phenomenology that promotes the researcher's strict separation from data through bracketing, Heideggerian's interpretive phenomenology approach acknowledges the difficulties in a complete separation of researcher from datasets (Horrigan-Kelley, Millar, and Dowling, 2016; Noon, 2018; Tuffour, 2017). In interpretive phenomenology, the challenge of complete bracketing is instead integrated into the data interpretation process; therefore, the meanings distilled from the data interpretation process are co-constructed by both researcher and the research participants (Hefferon and Ollies, 2006; Wojnar and Swanson, 2008).

Given the nature of the data interpretation process in interpretive phenomenology research, Smith and Osborn (1999) encourage including the section for self-reflection to give readers an opportunity to learn about what prior knowledge and experiences the researcher brought to the data interpretation process and how she or he contributed to new knowledge co-creation with the participants. Reflecting on how the world I have been exposed to has influenced my data interpretation process, I was able to identify three points as below that could have directly affected how I made sense of the data.

First, I have realised that I have brought a certain level of a biased perspective from years of previous research and work experiences in marketing. I have noticed that I tried to make sense of the data through how marketers approach customer data. For example, when I saw the patterns of varied reactions from the participants with respect to the dynamics of interaction between them and the AI chatbots, I tried to understand this variation from the perspective of the user segment, according to their demographic profiles. This is a very common practice used by marketers, and if I were to come from a different background such as physics or computer science, I might have taken a different approach to understand this variation observed in datasets.

Secondly, the purpose of qualitative research methods such as interpretive phenomenology is not to make a generalisation. Instead, its aim is to build a thick description of each participant's experience in order to understand the phenomenon and the situation under study through the eyes of research participants. But constantly I have come to realise that I was trying to make generalisations out of higher-level themes and emergent themes manifested in the datasets. My

intention to distil higher-level themes was to understand similar patterns observed across the participants who were exposed to the odours in a given experimental context. This intention was motivated by my interest in building original and new insights that may help other design researchers who are interested in advancing the current thinking in how to use the olfactory stimulus to design for the aesthetics of experience, which enables value co-creation between the user and an AI chatbot to enhance user engagement and satisfaction. Making generalisation is a typical approach used in social science research where ensuring external validity of research is considered critical, as scientific research findings must be replicated in other contexts to make knowledge contributions to the scientific academic research community. I felt that my previous exposure to the academic consumer research at a Ph.D. level has been still lingering in my head, which intervened my data interpretation process occasionally.

Lastly, I thought that when I was immersing myself in the interview transcripts, I found myself using the term, touchpoints, interchangeably with design material. Although a clear origin of the term, touchpoint, remains unclear, it is known to be first used by the services marketing discipline (Howard, 2007; Bitner, Ostrom, and Morgan, 2008). Prior to the widespread of the use of the term, touchpoints, the services marketing and its adjacent disciplines used the term service encounter, which they describe it as where service providers and consumers interact with each other through the point of contact (Solomon, Surprenant, Czepiel, and Gutman, 1985; Bitner, Booms, and Tetreault, 1990). Recently, the term, touchpoints, have received a lot of tractions in the design discipline, especially in the service design community (Sanders and Stappers, 2012). As I am bringing design and marketing exposure to the data interpretation process, I considered every touchpoint as a potential design material for the aesthetics of experience design for human and AI chatbot interaction. Touchpoints are a disciplinary jargon that is new to most scholars coming from non-marketing and non-design disciplines. Also, even among marketers and designers, marketing researchers coming from operational research and design researchers coming from product design background are not entirely familiar with the term, touchpoints. Because of my preconception formulated through my previous exposure, I think that without knowing, I constantly searched for touchpoints in the interview transcripts and sought the ways to leverage touchpoints as a design material to enhance user engagement and satisfaction in a given interaction context.

As a result of this self-reflection, I was able to bring an integrated view from the design and the services marketing disciplines towards the data analysis process. Looking back, it was an added benefit, because this doctoral research is an interdisciplinary study that has adopted the theoretical foundation – SDL – from the services marketing discipline and a research through design methodological approach from the design discipline. Keeping the perspectives of both the design and the services marketing disciplines during the data analysis process allowed me to

make sense of the data from both a design researcher and a service marketing researcher standpoint. By doing so, I was able to make sure that the meanings emerged through the data analysis process either offer new information or reinforce existing knowledge of the research streams in SDL in the services marketing discipline and the research streams in service design in the design research discipline. Therefore, the final outputs from the data analysis process were moulded into a new knowledge that forms an integrated view that reflects the interdisciplinary perspective.

6.7 Conclusion

The purpose of this chapter was to scale up the first-round design experimental process to delve deeper into the preliminary findings from the first-round design experiment and explore the olfactory stimulus as a design material and its effect on the participants' emotions and the quality of the interaction with the chatbot through a more robust approach. To that end, two specific areas of the design experimental process were refined in the second-round experiment.

First, the same size of the experiment was scaled up from ten students from the RCA and Imperial College London to twenty-seven students from the same institutions. In the first-round design experiment, the total of ten participants joined the experimental sessions, and they were randomly allocated to the treatment and the control groups. The treatment group was exposed to the odour 8 which was rated as the most pleasant and familiar odour by the participants during the odour category development exercise. By increasing the same size of the experiment, the second-round experiment was aiming to look at whether emergent themes observed in the first-round experiment are also supported by the findings from the second-round experiment.

Secondly, the second-round experiment introduced additional odours that were identified as pleasant during the odour category development exercise into the experimental process. The ultimate purpose of introducing additional pleasant odours to the second-round experiment was to understand whether variations in odours influence how participants make sense of their emotions and evaluate the quality of the interaction with the AI chatbot. Also, as stated previously, there is a paucity of literature that examines the olfactory stimulus as a design material for experience design in the design research discipline. By integrating additional four odours that were identified as pleasant during the odour category development exercise, the second-round experiment was able to generate insights on whether different types of odours that are identified as pleasant make significant differences to how participants make sense of their emotions and evaluate the quality of the interaction with the chatbot. With these insights, the second-round experiment result contributes to answering the first subset question of this doctoral research – How could service designers use the olfactory stimulus as a design material to design for the olfactory-enabled aesthetics of experience in human-AI chatbot interaction?

The result shows that despite different types of odours were used in the experiments, participants in the treatment group showed similar reactions in terms of how they described their emotions through drawings and during the interviews and how they evaluated their interaction with the chatbot. The differences in the result were rather observed between the participants who were exposed to the odours during their interaction with the chatbot versus the participants who interacted with the chatbot in the absence of the odours. The insights from this observation assure service designers that they can use any of these four odours used in this experiment to design for the aesthetics of experience for human-AI chatbot interaction. However, they will need to keep in mind that they should think ahead what types of associations their target user group is likely to make between the olfactory stimulus they intend to use and the physical space where the user group is likely to frequently interact with an AI chatbot.

Lastly, the second-round experiment replaced a self-report questionnaire used in the first-round experiment in the pre- and post-engagement stages of the user journey with a phenomenological interview. The rationale behind this change was based on the reason that the philosophical foundation and the purpose of interpretive phenomenology is more closely aligned to the purpose of this research, which is to capture the essence of the users' lived experience that can be translated into new knowledge. The level of granularity exhibited in the data sets collected from this experiment confirmed that the replacement of a self-report questionnaire with a phenomenological interview enhanced the robustness of the data collected.

The self-reflection on the interpretive phenomenology data analysis process made me realise that my data interpretation process was heavily influenced by my prior exposure to the consumer research at a Ph.D level at the department of marketing at the business school. But it was a positive influence, because it allowed me to keep the perspectives of both the services design and marketing disciplines during the data analysis process. As a result, the meanings emerged through the data analysis process formed an integrated view that reflects the interdisciplinary perspective.

The general discussion on the findings from both the first-round and the second-round experiments are presented in Chapter 7 in the section 7.2.

Chapter 7: General Discussion and Conclusion

Aesthetics of Experience Design Framework for Human-AI Chatbot Interaction

7.1 Introduction

Chapter 6 explored the second-round design experiment that scaled up the first-round experiment conducted in Chapter 5 by increasing the sample size and introducing additional

odours (Odour 1,3,6, and 7) that were identified as pleasant during the odour category development exercise. A total of twenty-seven students from the Royal College of Art (RCA) and Imperial College London participated in the second-round experiment. In the second-round experiment, the self-report questionnaire was replaced by a phenomenological interview, which was held in both pre- and post-engagement stages of the user journey. The second-round experiment adopted an interpretive phenomenology approach to interpreting the data collected from the interviews. The rationale behind choosing this approach over a descriptive phenomenology approach lies in a close alignment between the philosophical foundation of interpretive phenomenology and the purpose of this doctoral research and of the chosen method - design experiment. The design experiment welcomes prior knowledge and experiences researchers can bring into the research scene. In the same way, interpretive phenomenology's philosophy encourages researchers to co-construct the meanings that emerge through the data with research participants (Frechette, Bitzas, Aubry, Kilpatrick, and Lavoie-Tremblay, 2020; Lopez and Willis, 2004).

The findings from the second-round experiment further reinforced some aspects of the preliminary findings uncovered in the first-round experiment and revealed some new information that sheds light on the effect of the olfactory stimulus on user emotions and the user's perceived quality of the interaction with an AI chatbot.

First, the result of the second-round experiment further highlighted the importance of AI intelligence, which allows the chatbot to comprehend the content of the conversation accurately and either drive or follow the flow of the conversation with a user flawlessly. The participants' responses clearly show that the chatbot's intelligence that underpins interactive dialogue significantly affected a change in participants' emotional responses, participants' level of engagement, satisfaction, and thus their decision on whether to continue to use the AI chatbot.

Secondly, the participants from the second-round experiment also expressed their appreciation for the chatbot's non-human condition that guarantees anonymity and therefore psychological safety for users. Some participants explicitly shared their concerns over having a human therapist or a counsellor, because given that they are humans, the participants thought that human therapists and counsellors may be more likely to influence participants with their own personalities.

Lastly, the result of the second-round experiment also uncovered new information that may help designers who are interested in leveraging the olfactory stimulus as a design material for the aesthetics of experience design in human-AI chatbot interaction context. The result that was compared between the treatment group and the control group in the second-round experiment

presents that the participants from the treatment group were able to quickly establish a positive association between the olfactory stimulus used in the room and other sensory stimuli, physical space, or another person to make sense of their interaction with the chatbot. By doing so, participants were able to experience the olfaftory-enabled aesthetics of experience that led to an enhanced engagement, satisfaction, and continued intention to use the chatbot.

This Chapter is the final chapter of this doctoral research. The purpose of this chapter is to introduce the framework that has emerged through the findings from the first- and the second-round design experiments. The first section in this Chapter closely discusses the findings from the first- and the second-round design experiments in response to the research questions put forward in Chapter 2. This section intends to help readers to build a good understanding of how each round of the design experiment led to the next and the final research output – *the framework for the olfactory-enabled aesthetics of experience design in human-AI chatbot interaction.*

Following on the general discussion, the second section of this Chapter introduces the Olfactory-enabled Aesthetics of Experience Design Framework for Human-AI Chatbot Interaction. Not only does it present a theoretical stance of the framework, but also the framework in service design practice to help both academics and practitioners with the operationalisation of the framework in real life context.

It then discusses the theoretical contributions from this doctoral research and the implications for design practice. Finally, in concluding remarks, it shares with the research community the limitations of this research and the guidance for future research direction for those who may be interested in further expanding the findings from this doctoral research.

7.2 General Discussion

The data collected through several methods – a self-report questionnaire, the mapping of emotions, and an exit interview – in the first-round experiment were analysed, focusing on two specific categories: the emergent themes for engagement with the chatbot and the emergent themes for disengagement from the chatbot. The emergent themes discussed did not necessarily focus on the treatment group versus the control group in order to first build a broader understanding of enablers that enhance user engagement and detractors that disengage users from chatbots. Two emergent themes from the engagement category – the content of the conversation and psychological safety guaranteed by non-human condition – were further reinforced by the findings from the second-round experiment where the meta-synthesis of the treatment group data clearly demonstrated that AI intelligence that underpins the content of the conversation is the most important design material for the engaging interaction with the chatbot.

Also, the participants from the second-round experiment expressed their carefree attitude towards the chatbot because of a psychological safety guaranteed by it, given that it is a non-human actor and thus it is not able to judge or influence the participants in the way human counsellors or therapists do.

These findings suggest that the content of the conversation which is driven by AI intelligence must meet the users' expectations first, and most participants think that utilitarian value-in-use is the baseline user value that needs to be in place when they interact with an AI chatbot. However, most chatbots which the participants interacted with in the past had not met this requirement to date; therefore, the chatbot that was controlled through the Wizard of OZ approach in the experiments delighted the participants with the machine intelligence that parallels that of humans. One participant from the second-round experiment made an exclamation that the chatbot he interacted with in this experiment is much smarter than other similar types of chatbots he used in the past. This finding confirms that the aesthetics of experience enabled by the olfactory stimulus is unlikely to be activated unless utilitarian value-in-use enabled by the content of the conversation is in place first.

The perceived effect of the olfactory stimulus on participants' emotions and the perceived quality of the interaction with a chatbot discussed in the first-round experiment revealed that the treatment group is categorised into two camps: those who recognised the ambient odour in the room and articulated its effect on their emotions and the quality of the interaction with the chatbot, and those who recognised the ambient odour in the room but were not able to articulate any effect on their emotions and the quality of the interaction with the chatbot. The participants who sensed the odour in the room and experienced the aesthetics of experience described the sensory experience they had as the soothing effect of the ambient odour on their emotions, as it helped them to relax when they felt nervous and tired at the start of the experiment. These insights further bolstered the empirical evidence where the participants from the treatment group who carried initial negative emotions into the experiment were able to turn these emotions into positive ones, with the aid of the olfactory stimulus they were exposed to in the experimental room.

Also, it is imperative to note that the participants who experienced the transition of their initial negative emotions into positive ones benefitted from quickly establishing an association between the olfactory stimulus they were exposed to and their prior experiences and knowledge. The olfactory stimulus is known to trigger memory easily because odour-related memory is often encoded and stored in long-term memory, which users can use to retrieve related information (Morrin and Ratneshwar, 2003). The participant from the odour 3 group in the second-round experiment associated the olfactory stimulus she was exposed to with a nice hotel lobby floor

she had been in the past. She responded that the ambient odour of the room reminded her of the ambient odour in the hotel lobby floor she had been before. She even questioned whether the ambient odour of the experimental room was the same type of odour she experienced in the hotel lobby floor she had been. She also emphasised the fact that she came to the experimental session, feeling exhausted and stressed as she spent entire day painting in her studio and was lost on the way to the experimental room. However, as soon as she entered the experimental room and sensed the ambient odour in the room, she felt that her stresses were quickly waning, and she was able to find herself staying calm and relaxed again.

Similarly, the participants from the treatment group who were able to quickly establish an association between the olfactory stimulus and other sensory stimuli, object, physical space, and another person in the same space showed that they experienced the aesthetics of experience that enables value co-creation with a chatbot. For example, the participant from the odour group 7 in the second-round experiment usually finds a quiet space extremely isolating, as it gives her a feeling of loneliness, but despite the space where she interacted with the AI chatbot was awfully quiet, she rather found the quiet space and its interaction with odour 7 enjoyable. She further explained that the combination of the ambient odour of the space and the quietness in the space kept her feel at ease, and she enjoyed the overall interaction with the chatbot. Participant 10 from the odour group 1 associated the olfactory stimulus with the experimental researcher, as he thought of the ambient odour of the room as soft feminine perfume worn by the researcher. Furthermore, he pointed out that the sensory experience and his interaction with the researcher contributed to having a positive interaction with the chatbot.

These examples clearly demonstrate that a positive association made between the olfactory stimulus and other sensory stimuli, physical space, and another person in the same space enables the aesthetics of experience, which prompts participants to co-create value with a chatbot better. A value co-creating interaction between the user and a chatbot appears in form of an enhanced user engagement, satisfaction, and user's continued intention to use the chatbot, which leads to reduced abandonment of chatbot by users. The extant literature in retail context already presented empirical evidence, which confirms that pleasant odour can positively influence customer emotions, satisfaction, and behavioural intention (Roschk, Loureiro, and Breitsohl, 2017).

Another observation is that in both the first- and the second-round experiments, the participants in the control group had more scepticism towards the chatbots' intelligence. Some of them also explicitly expressed their disappointment with their interaction with the chatbot because they felt that they were talking to the machine. In their view, the chatbots were responding to their messages, based on the algorithmic formulas. Unlike the control group participants, the

treatment group participants explicitly expressed their pleasant surprise by AI intelligence that allowed the chatbot to interact with them as seamlessly as humans do. This opposing view observed between these two groups can be explained by the effect of the olfactory stimulus. The cognitive process of the olfactory stimulus often takes place unconsciously (DeLuca and Botelho, 2021). Regardless of whether the participants were able to make sense of their aesthetics of experience enabled by the olfactory stimulus, the treatment group participants went through the aesthetics of experience which helped them seamlessly process the information during the interaction with the chatbot. As a result, they positively reviewed their interaction with the chatbot and expressed their desire to chat with it again in the future. In the absence of the olfactory stimulus, it is clear from the findings that the participants in the control group could not demonstrate the ability to process information fluently that parallels that of the treatment group, because the participants from the control group found the dynamics of the interaction with the chatbot flawed, based on man-made algorithmic formulas.

Also, the aesthetics of experience that positively influenced participants' emotions helped them retrieve information stored in their long-term memory to establish an association between the olfactory stimulus and other subjects. In contrast, the participants from the control group were not able to demonstrate this ability during the experiment, which made it clear that the aesthetics of experience did not take place during their interaction with the chatbot; as a result, the value co-creation process was not prompted, which resulted in a subpar user experience.

One last important observation that needs to be addressed here is that the participants from the treatment group who went through the aesthetics of experience were better at value co-creation with the chatbot. This user behaviour is caused by the participants' tendency to linger onto the stimulus that helps them maintain or augment a positive emotional experience. Cirricione, Estes, and Caru (2014) demonstrated in their study that their study participants focused on positive ambient odour rather than painting to maintain their positive mood. The findings from the second-round experiment of this doctoral research reveals a similar observation. The participants from the treatment group focused on the positive aspects of the interaction with the chatbot, such as its superior intelligence that made their interaction seamless and natural, and the positive association the participants made between the olfactory stimulus and other objects that augmented their overall positive interaction with the chatbot. This is an indication that the participants' positive emotional experience is the outcome of emotional and hedonic value co-creation with a chatbot, by suppressing negative association whilst expanding positive association.

In value co-creation literature, scholars take a processual approach to define how customers or users carry out the value co-creation process. Ranjan and Read (2016) defined the antecedents

and the outcome of value co-creation, while Yi and Gong (2013) introduced a customer value co-creation behaviour scale that measures the value co-creation process. In this doctoral research, however, the value co-creation process between the participants and the chatbots was observed in a more abstract manner, because the participants' shared feelings, thoughts, and observed interactive behaviour with the chatbot showed that they process the olfactory stimulus intuitively and unconsciously.

The findings from the odour category development exercise, the first-, and the second-round experiments conducted in this research have become the building blocks of the Olfactory-Enabled Aesthetics of Experience Design Framework introduced in the next section.

7.3 Olfactory-Enabled Aesthetics of Experience Design Framework

"*Emotional quality is probably one of the reasons why experiences are chosen to be beautiful.*" (Maattanen, 2017, p.9).

The Olfactory-Enabled Aesthetics of Experience Design Framework in Figure. 7.2 is distilled from empirical evidence generated from the odour category development exercise and two-rounds of design experiments conducted as part of this doctoral research. Given that this doctoral research is an interdisciplinary study that is situated at the intersection of design research and services marketing, the framework that emerged throughout this research embodies a strong interdisciplinary perspective on human-AI chatbot interaction in a smart service system. The review of the extant literature in sensory marketing confirms that the use of the olfactory stimulus for improving customer or user engagement and satisfaction has been explored for some time, but specifically in a retail context. To the best of my current knowledge, exploring the olfactory stimulus as a design material for the aesthetics of experience design for human-AI chatbot interaction in a smart service system is initiated by this doctoral research for the first time.

Table.7.1 on page 164 presents the odour palette from the odour category development exercise. Although seven odours out of ten odours selected by the CenSes Lab perfumer were identified as pleasant by the study participants of this research, the odour palette in Table 5.1 represents the top five odours with a mean score of greater than 6.50 on the scale of pleasantness. Its superior score on the parameter of pleasantness reassures service designers that they can safely experiment with any of these odours to design for olfactory-enabled aesthetic experience in human-AI chatbot interaction context. The odour palette can also serve as a point of reference that guides designers to choose the relevant context-specific odour to accomplish their design goal for aesthetic experience design for human-AI chatbot interaction.

TABLE 7. 1: ODOUR PALETTE FROM THE ODOUR CATEGORY DEVELOPMENT EXERCISE

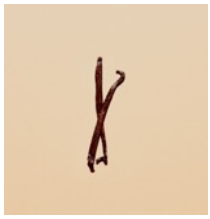
Odour 1	Odour 3	Odour 6	Odour 7	Odour 8
				
Grapefruit	**White Musk**	**Herbal**	**Rose**	**Vanilla**

FIGURE 7. 1: THE VALENCE, INTENSITY, AND FAMILIARITY OF THE ODOUR PALETTE

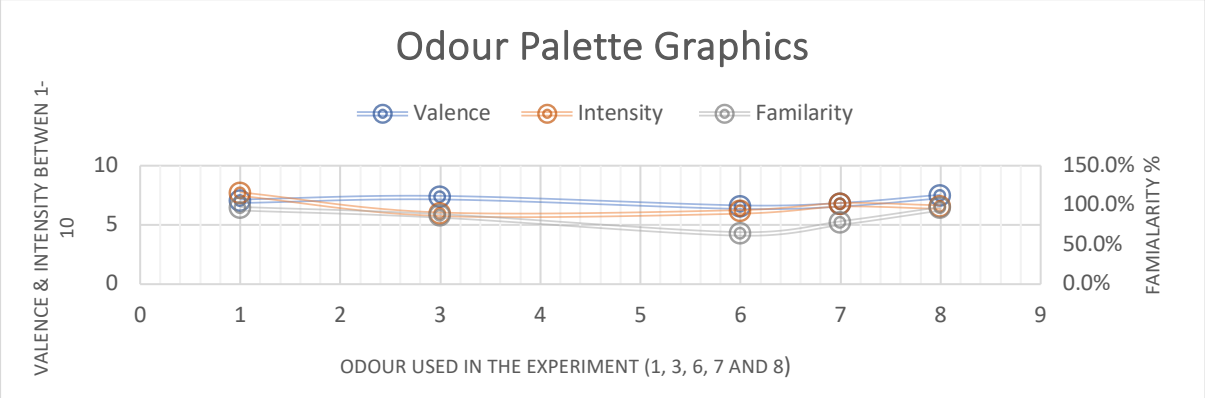


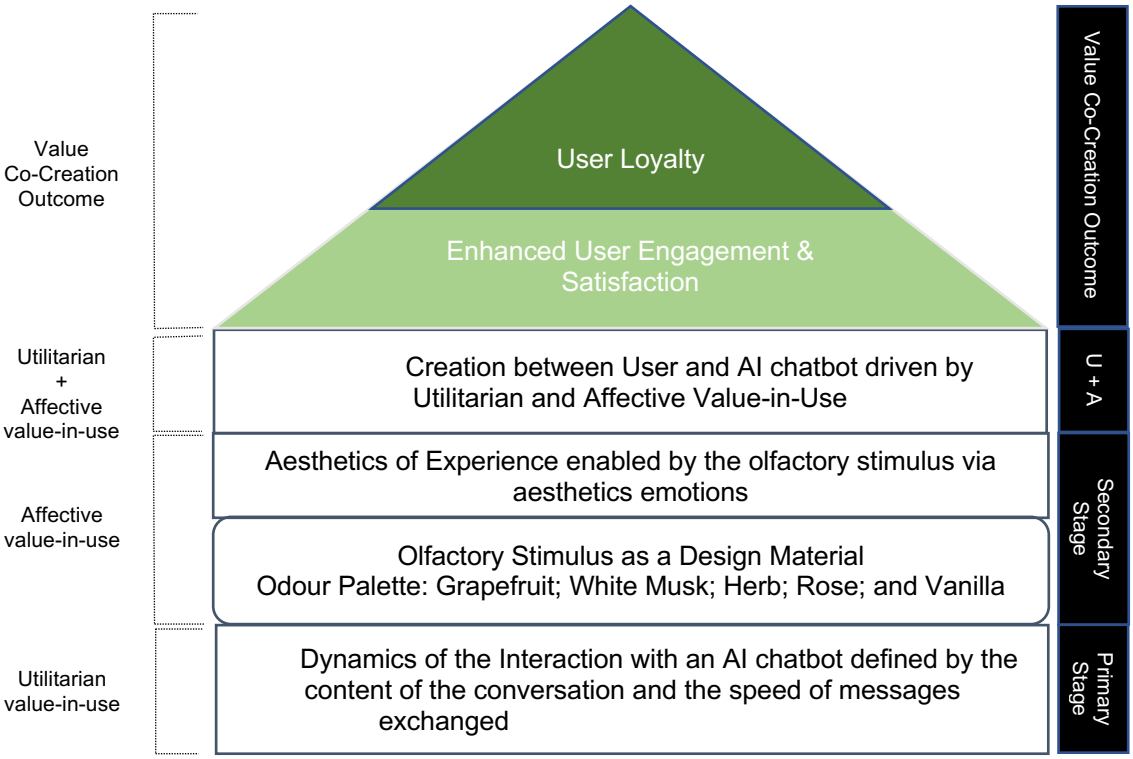
Figure. 7.1 above illustrates the variations in the valence, the intensity, and the familiarity of odours across all 5 odours that are part of the odour palette. As discussed in Chapter 5, the participants rated pleasant odours as less intense in comparison to the odours they found unpleasant during the odour category development exercise. It is also noticeable that most participants found pleasant odours somewhat familiar. The odour palette graphs could serve as the guideline for the olfactory stimulus selection for experience design, as the graphs offer a holistic view on each odour of the odour palette from the valence, the intensity, and the familiarity perspective.

The result of the second-round experiment reveals that the majority of the participants were not able to discriminate odours accurately. Regardless of five different types of the odours used for two-rounds of the experiments conducted for this research, most participants described the odour as sweet female perfume or odours similar to flowers. This finding contradicts the finding from the odour category development exercise in which participants showed their ability to discriminate the odours and share odour-related memories, emotions, and thoughts. This contradiction can be explained by the need for the participants to make conscious efforts to smell each odour and make sense of it during the odour category development exercise, whilst in the

first- and the second-round experiments, the odour was diffused across the room prior to each experimental session. Given the nature of subtle olfactory cues, the participants might have not been able to discriminate the ambient odour accurately. Their focus on chatting with the AI chatbot during the experiment could have also contributed to the lack of participants' ability to discriminate odours accurately, as most of their conscious efforts were spent on the chat screen rather than on their surroundings. This research controlled the potential confounding effects that may be caused by the inconsistent intensity of the odours across the experimental sessions by keeping the intensity of each odour at three drops of each odour into 30ml of water. In addition, no more than two experimental sessions were scheduled per day to make sure that the odour in the room after the first experimental session in the morning was completely ventilated before the second experimental session scheduled for the afternoon begins.

Figure 7.2 illustrates a theoretical framework that emerged throughout the findings from the odour category development exercise and two-rounds of design experiments discussed in Chapters 4, 5, and 6.

FIGURE 7. 2: OLFACTORY-ENABLED AESTHETICS OF EXPERIENCE DESIGN FRAMEWORK



The bottom layer of the framework represents the foundation of the aesthetics of experience. As shown by the first- and the second-round experiments, ease of use is conceived as taken-for-granted by many users. Enabling utilitarian value-in-use for users has been the focus of design for many decades. Whether it be products or services, they need to help users meet their goals, and enabling this process has been the job of designers. The findings from two-rounds of design experiments discussed in depth in Chapters 5 and 6 make strong empirical evidence that the

content of the conversation underpinned by the AI intelligence of chatbots must enable users to fulfil the purpose of their use first.

But it is imperative to note that one of the challenges many designers and SSP makers face these days is that they can no longer delight their users with ease of use that meets the user's utilitarian value-in-use alone. If designers want to help AI chatbot makers to engage with their users and develop a long-lasting relationship, they will need to help users to connect with the chatbot on an emotional level (Wensveen, Overbeeke, and Djajadiningrat, 2000; Chaturvedi, 2016). In order to help users connect with a chatbot on an emotional level, designers can leverage the olfactory stimulus. Human's olfactory sense directly controls the human emotions. By using the olfactory stimulus as a design material, designers can orchestrate the aesthetics of experience by inducing aesthetic emotions in users (Menninghaus, Wagner, Wassiliwizky, Schindler, Hanich, Jacobsen, and Koelsch, 2019). The users who have experienced the aesthetics of experience are prompted to co-create value with a chatbot better because the aesthetics of experience augments a positive interaction with a chatbot. During the experiments, the participants demonstrated that those in the treatment group who experienced the aesthetics of experience focused on the positive aspect of the interaction rather than the negative one, which, as a result, further prompted the value co-creation process but minimised value co-destruction. More specifically, the treatment group participants were not easily disengaged by either a fast or a slow pace of the messages exchanged with the chatbot, whereas the control group participants explicitly expressed their frustration and anger when the chatbot responded to them either too fast or slow, depending on each of their own perception of how soon the message should be sent from one to the other. Also, the treatment group participants demonstrated a superior information-processing fluency, as most of them found the interaction with the chatbot as seamless and frictionless that resembles the conversation with humans.

The value co-creation process prompted by the olfactory-enabled aesthetics of experience is driven by both utilitarian and affective value-in-use, which then results in an enhanced user engagement and satisfaction shown by the results of the experiments in this research. A similar result was also demonstrated by previous empirical studies (e.g. Ranjan and Read, 2016; Cossio-Silva, Revilla-Camacho, Vega-Vazquez, and Palacios-Florencio, 2016). It may still be early to make a definitive conclusion that an enhanced user engagement and satisfaction observed in the experiments in this research will lead to user loyalty, provided that each participant interacted with the chatbot for 15 minutes only; however, all participants who experienced the aesthetics of experience evaluated positively about the engagement with the chatbot and overall satisfied with the interaction with the chatbot, and more importantly, they all expressed their desire to interact with the chatbot again in the future. This observation suggests that the aesthetics of experience that prompts value co-creation, which results in an enhanced

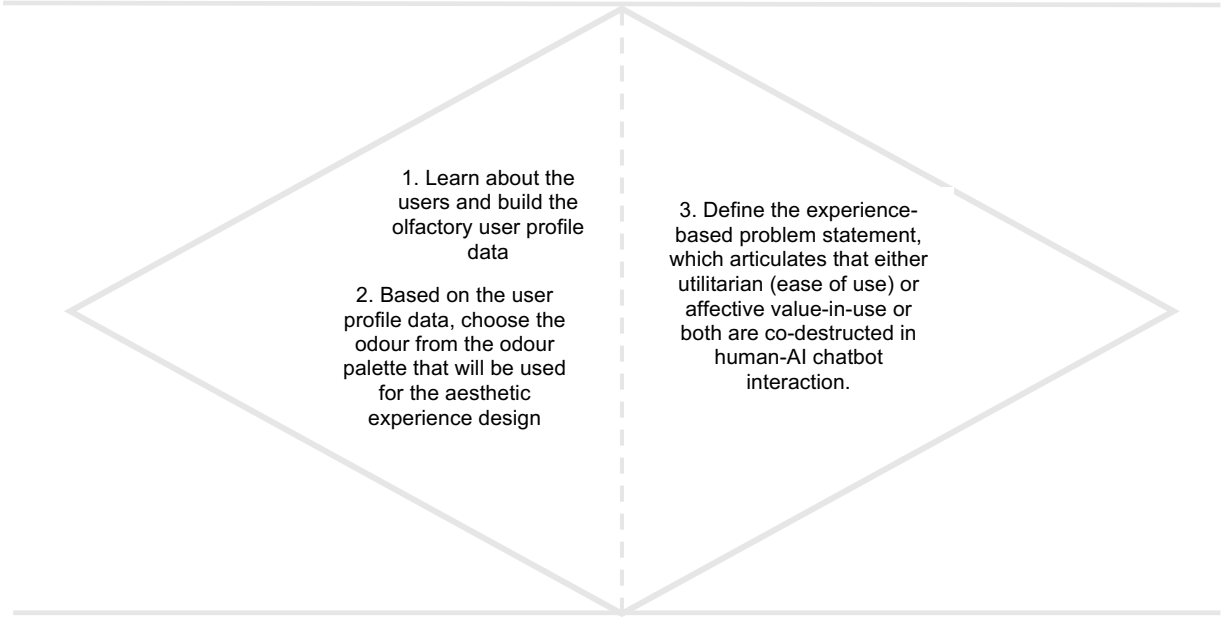
user engagement and satisfaction in human-AI chatbot interaction is likely to lead to user loyalty. Therefore, this finding supports the view that the olfactory-enabled aesthetics of experience that prompts value co-creation between the user and an AI chatbot will likely reduce the user abandonment rate in a smart service system.

This doctoral research observed the linkage between the aesthetics of experience and value co-creation between the participants and the chatbots in an abstract manner to allow a phenomenological interpretation of lived experience captured in each experimental session. In order to provide designers with more tangible design guidelines, Figure.7.3 below illustrates how designers can adopt the olfactory stimulus in design practice to design for the olfactory-enabled aesthetics of experience in human-AI chatbot interaction. The purpose of the process introduced in Figure 7.3 is not to provide prescriptive guidelines for designers but to close the knowledge gap between the frameworks that emerged out of the academic design research and design practice carried out by design practitioners. In doing so, this research aims to operationalise the framework in design practice context more effectively and maximise its potential impact on current design practice and the design outcome.

FIGURE 7. 3: OPERATIONALISING THE OLFACTORY-ENABLED AESTHETICS OF EXPERIENCE DESIGN FRAMEWORK IN SERVICE DESIGN PRACTICE

Design Stage: Discovering Problem (First Diamond)

Design Objective: To explore the problem space from an experiential perspective while learning about the target user groups to build the olfactory user profile data.



Design Stage: Framing Solution (Second Diamond)

Design Objective: To leverage the olfactory stimulus as a design material to orchestrate the olfactory-enabled aesthetics of experience in human-AI chatbot interaction and prompt the value

co-creation process between the user and an AI chatbot to enhance user engagement and satisfaction.

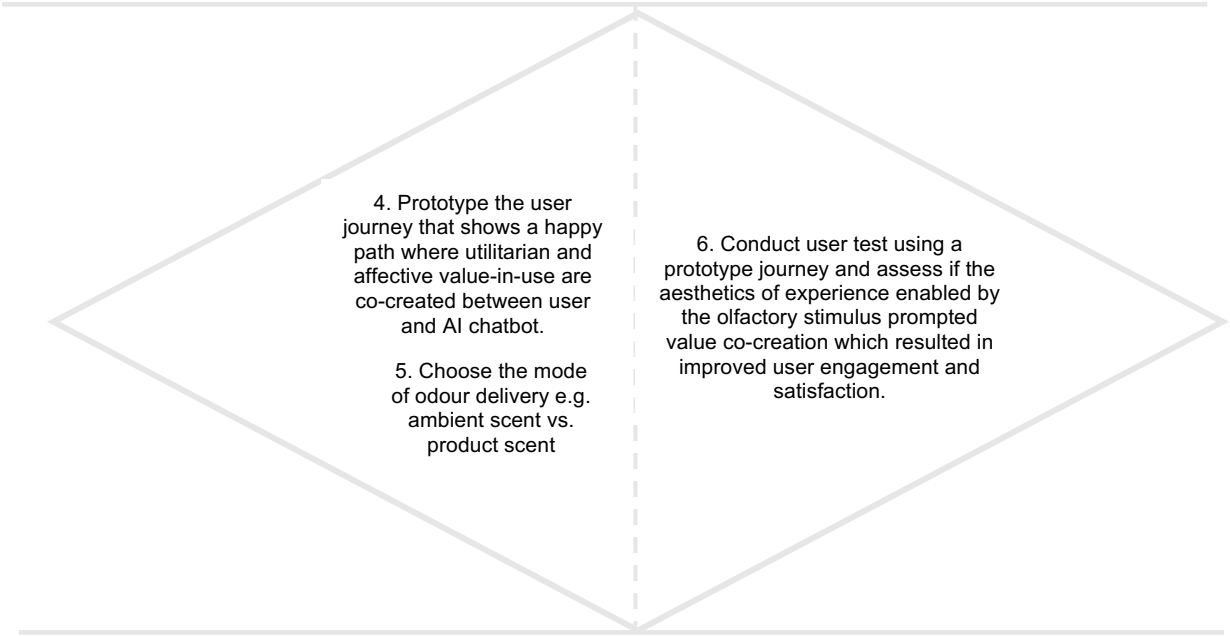


Figure.7.3 showcases how the use of olfactory stimulus as a design material can be integrated into the double diamond design process and enable the aesthetics of experience that prompts value co-creation in human-AI chatbot interaction from a practitioners' standpoint. By integrating the olfactory stimulus as a design material into the double diamond design process, Figure. 7.3 helps service design practitioners to operationalise the olfactory-enabled aesthetics of experience design framework in their design context.

7.4 The Relationship between the Aesthetics of Experience and Value Co-Creation

Once the value co-creation process is accelerated between the user and an AI chatbot through the emergence of the aesthetics of experience, the aesthetic experience and the value co-creation are expected to become interdependent with each other, which will form a non-linear relationship. As introduced in the review of the literature section in Chapter 2, the concept of aesthetics is no longer understood in a static term such as a physical appearance of an object. Instead, the concept has largely shifted towards an experiential-centric view, which has also introduced many new terms, namely the aesthetics of experience and the aesthetics of interaction. Building on the commonalities exhibited in the conceptual understanding of the concept of aesthetics as experience in the extant literature, this research defines the aesthetics of experience as '*value-in-use emerged through a sensory experience'*.

The findings from this doctoral research demonstrate that the participants who experienced the aesthetics of experience were able to better engage with the AI chatbot and their overall satisfaction of the interaction with it was higher; these participants also wanted to speak with the

chatbot again in the future, which supports a linear relationship between the user engagement, the user satisfaction, and the user's continued intention to use (user loyalty). This finding indicates that the aesthetics of experience that emerges throughout the interaction with the AI chatbot prompted value co-creation between the participants and the AI chatbots, given that the enhanced user engagement, the user satisfaction, and the user's continued intention to use are the outcome of value co-creation. The body of extant literature in the marketing discipline already confirms this relationship (e.g Rosck et al 2017; Ranjan and Read, 2016). Previous studies that examined the relationship between engagement, satisfaction, and future intention heavily relied on statistical results to determine the relationship between these constructs. As a result, messy social elements that make human life complex and idiosyncratic were absent in the analysis of these studies. In this research, it takes account of complex details of human emotions and human behaviour through a research through design approach, and its findings reinforce further the linear relationship between engagement, satisfaction, and continued intention defined by previous quantitative studies.

7.5 Concluding Remarks

7.5.1 How this Doctoral Research Answers the Research Questions

The answers to the research questions of this research are discussed throughout the results and the discussion sections in previous and current chapters. This section provides a summary of how the findings from this research answer the research questions.

Based on the knowledge gaps identified in Chapter 2, this doctoral research put forward the research questions as follows: *1) How could service designers use the olfactory stimulus as a design material to design for the olfactory-enabled aesthetics of experience in human--AI chatbot interaction? 2) Could the olfactory-enabled aesthetics of experience emerged in human-AI chatbot interaction enable value co-creation between the user and an AI chatbot that enhances user engagement?*

The review of extant literature reveals that previous empirical studies that examined the phenomenon of lack of user engagement in the HCI discipline explored the phenomenon through the human sensory modalities, specifically the visual, auditory, and haptic senses. But more recent studies (e.g. Obrist et al, 2014) recognised that although the human's olfactory sense has the closest linkage to the areas of the human brains that directly control human emotions, it has been under-explored by the HCI researchers that examine the HCI challenges. In response to this knowledge gap, this doctoral has chosen the olfactory sense as a potential design material for service designers to inquire into olfactory-enabled aesthetic experience design for human-AI chatbot interaction. Chapter 4 introduced how this research executed the odour category development exercise in collaboration with the perfumer from the CenSes Lab at the Institute of

Philosophy, the University of London. The output from this exercise was to create a palette of odours that can be used throughout the design experiments in this doctoral research, given that the olfactory sense lacks the standardisation in odour-related vocabularies in comparison to other dominant senses, such as visual stimulus, which already has a highly established standardised visual-related vocabularies like colour.

The odour category development exercise discussed in Chapter 4 not only identified the odours that will be used throughout the design experiments as a design material, but also introduced the sets of the odours that can be used as preliminary guidelines for service designers to choose the relevant context-related odour when they use the odour as a design material to design for the aesthetics of experience in human-AI chatbot interaction. As a result, the findings from the odour category development exercise partially answers the first research question – *how could service designers use the olfactory stimulus as a design material to design for the olfactory-enabled aesthetics of experience in human-AI chatbot interaction?*

The series of design experiments introduced in Chapter 5 and 6, and the outputs from these experiments – the Olfactory-Enabled Aesthetics of Experience Design Framework for Human-AI Chatbot Interaction, provide answers to the second research question – *Could the olfactory-enabled aesthetics of experience emerged in human-AI chatbot interaction enable value co-creation between the user and AI chatbot that enhances user engagement*? The findings from the design experiments demonstrate that the participants who were exposed to the odours showed several characteristics, which enabled them to co-create value with the AI chatbots more effectively. In comparison to the participants in the control group who interacted with the AI chatbot in the absence of the odour, the participants from the treatment group showed their tendency to linger onto the positive aspect of the interaction with the chatbot, which led to the positive evaluation of the interaction with it. Their positive evaluation of the interaction also resulted in their desire to interact with the chatbot again in the future. The ambient odour in the experimental room appeared to have induced aesthetic emotions in these participants, which enhanced their information-processing fluency that helped them quickly establish a positive association between the olfactory stimulus and other sensory stimuli, physical space, and another person in the same space.

The control group participants, however, showed during the interaction with the chatbot that they became easily irritated if they found the chatbot responding either too fast or slow to their messages. Some participants from the control group also expressed that the nature of the interaction with the chatbot was mechanical, which discouraged them from interacting with the chatbot again in the future.

The key findings from the experiments also pointed out the importance of the content of the conversation as the enabler for the utilitarian value-in-use from the interaction with the chatbot. The findings confirmed that without co-creating utilitarian value-in-use first, service designers are expected to see that the users' emotional value-in-use enabled by the olfactory stimulus would be less likely to generate an intended experiential design outcome.

The Olfactory-Enabled Aesthetics of Experience Design Framework for Human-AI Chatbot Interaction illustrates the relationship between the olfactory stimulus, the aesthetics of experience, and value co-creation between the user and the chatbot concisely. The framework conveys the key message of the findings from these experiments, which showed that the effect of olfactory stimulus on user emotions and the users' perceived quality of the interaction with the chatbot enhanced user engagement, satisfaction, and continued intention for an AI chatbot, because the aesthetics of experience that emerged during the interaction with the chatbot enabled users to co-create value with the chatbot more effectively. As a result, an effective use of the olfactory stimulus could improve user engagement, which, as a result, reduces the abandonment rate of chatbot in a smart service system. However, the framework also conveys an important message that this empirical relationship supported by these experiments will bear fruit only when the users' utilitarian value-in-use has already been fulfilled.

7.5.2 Theoretical Contributions

The knowledge contributions from this doctoral research are as follows. First, this research is an interdisciplinary study that situates at the intersection of design and services marketing; therefore, it directly responds to the call from the service research community that has called out for further contributions from interdisciplinary studies to advance the current knowledge in complex service system (Gustaffson and Bowen, 2017), especially for building a better understanding of actor-to-actor interaction within a complex smart service system. Previous studies in SDL observed a gap between the general theory and an empirical study, because the construct such as value co-creation and SDL as a theoretical concept and, more recently, as a meta-theory exhibit a higher level of abstraction, which make them difficult be operationalised empirically (Storbacka, Brodie, Bohmann, Maglio, and Nenonen, 2016). Some studies in SDL discourse noticed this challenge early on and called out for the development of a mid-range theory that can fill this gap (Brodie, Saren, and Pels, 2011; Lusch, Vargo, and Gustafsson, 2016). This doctoral research contributes original and new knowledge, which demonstrates how service design can be used as a mid-range theory to operationalise SDL and empirically observe the challenge of the lack of user engagement observed at micro-level of smart service system.

Secondly, this research explores the olfactory stimulus as a design material that has been under-explored in the design discipline. Although the olfactory stimulus in marketing strategy (sensory marketing) has been extensively studied in the marketing discipline (e.g.Krishna, 2011; Roschk

et al, 2017), especially within the circle of sensory marketing scholars, design researchers have not actively explored the olfactory stimulus as a potential design material within their design practice. As a result, there is a missing knowledge that serves as the building blocks of the olfactory stimulus as a design material for the aesthetics of experience design, specifically in the context of human-AI chatbot interaction. This doctoral research fills this gap of knowledge in the current literature by presenting the odour palette that was developed through the odour category development exercise, and the findings from two-rounds of design experiments, which explored the effect of the olfactory stimulus on the participants' emotions and their perceived quality of interaction with the chatbot.

Lastly, this research examines the lack of user engagement and the user retention problem in a smart service system through the theoretical lens of SDL, while it takes a research through design approach to explore rich details of human emotions and behaviour in the context of human-AI chatbot interaction. Its hybrid approach in combining the theoretical foundation from the services marketing discipline and a methodological approach from the design discipline is original, and it introduces a design experiment as a legitimate research method for exploratory research to scholars from non-design disciplines. Also, it explicitly introduces service design as a mid-range theory that can effectively operationalise a high-order construct, value co-creation in the context of human-AI chatbot interaction.

7.5.3 Design Practice Implications

With the result from this doctoral research, designers can have more confidence in using the olfactory stimulus in their design practice to accomplish their intended design goals. To date, the body of extant literature in design discipline that examines sensory stimuli significantly focused on visual, haptic, and auditory senses, despite the human's olfactory sense, having the most intimate relationship with the areas of the human brain that directly control human emotions. I am hoping that the findings from the odour category development exercise, such as the odour palette and the variations between the odours in terms of the valence, the intensity, the familiarity, and the participants' general thoughts and feelings associated with each odour would guide service designers on how to select the odour to achieve an intended design goal, especially for the olfactory-enabled aesthetics of experience design in human-AI chatbot interaction. Also, the Olfactory-Enabled Aesthetics of Experience Design Framework can be a generic guideline which designers can use as reference to align its use of the olfactory stimulus to its design goals. Similarly, a linear relationship between the key constructs, the aesthetics of experience, value co-creation, the user engagement, the user satisfaction, and the user's continued intention to use an AI chatbot, further reinforced from the findings from this research could help designers to design with a clear intent in each phase of the design process to fulfil their design goals.

While the olfactory stimulus is proven to be an effective experiential design material to design for the aesthetics of experience that prompts the emotional value co-creation process between the user and an AI chatbot, designers need to be reminded that ease of use is a taken-for-granted attribute that needs to be met first and foremost. With the absence of utilitarian value-in-use in the user's interaction with an AI chatbot, the use of olfactory stimulus is unlikely to bear fruits on the aesthetics of experience design and thus its efforts are unlikely to turn into improved user engagement, satisfaction, and user's decision to continue to use an AI chatbot.

7.5.4 Research Limitations

Although the odour category development exercise and two-rounds of design experiments conducted in this doctoral research generated some novel and original knowledge contributions, this research is also not without any shortcomings. The five points stated below concisely summarise the limitations of this research.

First, this research explored the olfactory stimulus as a design material specifically within the context of human-AI chatbot interaction. As a chatbot is a screen-based SSP, the effect of the olfactory stimulus on user emotions and user's perceived quality of interaction may be different if the user had interacted with an SSP that possesses an interaction modality other than screen, such as voice or touch. The findings from this research can be explored further in the research context, in which users interact with a chatbot that is voice-enabled or touch-enabled, in order to build a holistic understanding of the olfactory stimulus as a design material for engaging user interaction for human-AI chatbot interaction in a smart service system. Some participants from this doctoral research who expressed their insensitivity towards the olfactory stimulus often pointed out their focus on the chatbot screen as the key reason for their inability to perceive the olfactory stimulus. Observing the participant's interaction with a voice-based or a touch-based chatbot will validate whether screen-based efforts minimised the participants' ability to detect the olfactory cues and thus the ability to make sense of the aesthetics of experience if they have experienced it.

Secondly, each participant was given a complete freedom to interact with the chatbot of their choice in a way that they would like to. They were all informed in advance that the chatbot was built for the purpose of supporting users' emotional well-being; therefore, the majority of the conversation was very much focused on each participants' life in general and any challenges they were going through. The chat script was not pre-determined, but the general structure of the chat content stayed identical across all participants, which started with a simple introduction and the chatbot asks the participants about any challenges the participants are facing in their life where they may need some emotional support from the chatbot.

Since the participants had a full control over the conversational flow, the flow of conversation with the chatbot was not entirely identical across the participants, although the general structure remained the same across all participants. As a result, there are possibilities that the flow of conversation driven by a complete freedom given to each participant for the chat interaction with the chatbot might have influenced the reliability of data collected from each experiment.
Thirdly, the chatbot was built for the purpose of serving as a social companion for users to provide emotional support. In doing so, the chatbot is trying to help users to proactively look after their emotional well-being. This specific use case given to design experiments conducted in this doctoral research could have contributed to the findings from experiments, which may not be applicable to other use scenarios. Any design researchers who are interested in taking this study result to the next level may want to conduct an experiment under a different use scenario. In doing so, further research that supports the findings from this research will improve the rigour of the olfactory-enabled aesthetics of experience design framework for human-AI chatbot interaction.

Fourthly, as a human relationship evolves over time, so does human's interaction with an AI chatbot. The effect of olfactory stimulus and its effect on users' emotions and how users make sense of their interaction with an AI chatbot will evolve as they develop a relationship with it. The data collected for this research relies on a cross-sectional study that does not offer a complete picture of how users' relationship with an AI chatbot affects the way users make sense of the effect of the olfactory stimulus on their emotions and the quality of the interaction with an AI chatbot. A longitudinal study may improve the rigour of the research findings.

Lastly, this research further reinforced the fact that the more users become familiar with the odour, the less sensitive they become to the odour, but it did not explore further when to replace the olfactory stimulus in use during the design process to ensure that it makes an intended impact on user emotions and the quality of the interaction. As the result of this research demonstrates that sensitivity towards the olfactory stimulus is highly individual-specific, it will be challenging for design researchers to uncover a specific point within the user's journey of the interaction with an AI chatbot where the olfactory stimulus in use needs to be replaced with another type of odour to enable the aesthetics of experience. However, a longitudinal study might be able to reveal some patterns that could serve as useful preliminary insights, which design researchers can build on for future research.

7.5.5 Future Research Direction

The limitations of this research already point out some of the areas that require further investigation by future research. In this section, it will not repeat what was already discussed under the section of the research limitations. Instead, it introduces three specific areas of research that may significantly help advance the current knowledge in how the olfactory stimulus

can be leveraged in service design practice to make positive differences to human-AI chatbot interaction in a smart service system.

One area to be explored further is whether the medium of odour delivery will bring about a different result on the relationship between the key constructs observed in this research. The medium of odour delivery was often described as a notoriously tricky part by previous research that examined the olfactory stimulus (Brewster, McGookin, and Miller, 2006; Obrist, Gatti, Maggioni, Vi, and Velasco, 2017; Spence, Obrist, Velasco, and Ranasignhe, 2017). Because of this challenge, the olfactory stimulus has been under-explored in the body of the extant literature compared to any other human senses that can be easily explored, especially visual and auditory senses. In this research, the odour was diffused by an ambient diffuser, which was used as the medium of odour delivery to create ambient odour in the experimental room. However, there are many other ways to deliver odour. For example, an odour scratch paper was often used by perfume makers to let the magazine readers sample new fragrances launched by the makers. Similarly, the olfactory image was used by previous study (e.g. Krishna, Morrin, and Sayin, 2014). As shown by the result of this research, olfactory stimulus retrieves human memory that evokes previous experiences. By taking advantage of the association human makes between the olfactory stimulus and their previous exposure, future research may experiment with the olfactory images that evoke odours in users through an object, colour, or their past experiences. By doing so, users' brains will evoke the odour that is conveyed through the olfactory image. To enhance the validity of the result of this research, future research may go beyond ambient odour and explore another medium of odour delivery to inquire into whether any different results are achieved for the effect of the olfactory stimulus on user emotions, engagement, satisfaction, and continued intention to use, and therefore the relationship between the key constructs, the aesthetics of experience and value co-creation between the user and an AI chatbot.

Another area that may need further exploration by future research is the lack of a cohesive view on the aesthetics of experience measurement scale. This research conceptualises the aesthetics of experience as 'value-in-use emerged through a sensory experience'. The conceptual definition of the aesthetics of experience denotes an implicit relation between aesthetic emotions and user (or customer) value. Extant literature produced the plenty of scholarships on the measurement scale for user (and customer) value for many decades, and most recently, the aesthetic experience (e.g. Schindler, Hosoya, Menninghaus, Beermann, Wagner, Eid, and Scherer, 2017; Blijlevens, Thurgood, Hekkert, Chen, Leder, and Whitfield, 2017). The key weakness of the extant literature that developed the aesthetics of experience scale is their distinct view towards aesthetic emotions. These studies separated the concept of aesthetics emotions from everyday emotions, and their scales heavily focused on visual aesthetics measurements. As a result, these

scales are not robust enough in the research context that explores the aesthetics of experience that was enabled by other sensory modalities.

The current literature in aesthetic experience measurement is fragmented, and in order to help designers to continuously refine the rigour of their approach to the olfactory-enabled aesthetics of experience design, the academic research community will need to develop a more cohesive conceptual approach to the development of aesthetics of experience design scale and explore the sensory modality that goes beyond visual aesthetics.

Lastly, the finding from olfactory category development exercise demonstrated that there was no significant cultural effect on participants' perception of odour awareness and odour-related meanings. This result contradicts most studies that examined the effect of gender, culture, and individuals on humans' perception of odour meanings and odour awareness. Although the effect of gender was observed in this research, the effect of culture and age in this research was minimal. As the sample of twenty-two study participants for the olfactory category development exercise was represented by sixteen different nationalities, the sample itself was highly diverse, and this research interpreted the minimal effect of culture as the outcome of globalisation that has brought the world together and created mass production of homogenised youth pop culture across the world. But this area needs to be further explored in future studies in order to understand whether the result from this research is an isolated case.

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Appendix

1. A Self-Report Questionnaire (Pre-Engagement)

Please consider yourself in a talking therapy with AI bot. We often get to experience a certain level of a mood swing and depression, especially during the journey of postgraduate study and research. But most of us tend to avoid seeking professional help in such situations to maintain the good quality of life. AI bot can be a mediator and a self-care companion who could help you regulate your emotions better on a daily basis. Imagine yourself in a talking therapy with an AI bot and answer the questions below.

1. Participant Number: [ ]

2. AI bot's visual attractiveness is one of the most important factors that influences my decision to continue to engage with the bot and its talking therapy. *

Strongly Disagree 1 2 3 4 5 Strongly Agree

3. AI bot's ability to interact with me through voice in addition to online messaging will engage me with a talking therapy better. *

Strongly Disagree 1 2 3 4 5 Strongly Agree

4. If AI bot can lighten up the candle of my flavour scent during the talking therapy, I could engage with the bot and the therapy session better. *

Strongly Disagree 1 2 3 4 5 Strongly Agree

5. I think having a talking therapy with an AI bot will help me regulate my emotional well-being. *

Strongly Disagree 1 2 3 4 5 Strongly Agree

6. I think having a talking therapy with an AI bot is simpler and easier than talking to a professional psychologist. *

Strongly Disagree 1 2 3 4 5 Strongly Agree

7. I think I will enjoy having a talking therapy with an AI bot. *

Strongly Disagree 1 2 3 4 5 Strongly Agree

8. I think I will enjoy having a talking therapy with an AI bot. *

Strongly Disagree 1 2 3 4 5 Strongly Agree

9. I will likely continue to use the AI bot for talking therapy or other purpose in the future. *

Strongly Disagree 1 2 3 4 5 Strongly Agree

10. I think I would be happy using AI bot for the purpose of talking therapy. *

Strongly Disagree 1 2 3 4 5 Strongly Agree

2. A Self-Report Questionnaire (Post-Engagement)

Yes, you have already answered most of the questions below before you start chatting with a bot. But once more, please do answer these questions. Thanks :)

1. Participant Number: [ ]

2. AI bot's visual attractiveness is one of the most important factors that influences my decision to continue to engage with the bot and its talking therapy. *

Strongly Disagree 1 2 3 4 5 Strongly Agree

3. AI bot's ability to interact with me through voice in addition to online messaging will engage me with a talking therapy better. *

Strongly Disagree 1 2 3 4 5 Strongly Agree

4. If AI bot can lighten up the candle of my flavour scent during the talking therapy, I could engage with the bot and the therapy session better. *

Strongly Disagree 1 2 3 4 5 Strongly Agree

5. I think having a talking therapy with an AI bot will help me regulate my emotional well-being. *

Strongly Disagree 1 2 3 4 5 Strongly Agree

6. I think having a talking therapy with an AI bot is simpler and easier than talking to a professional psychologist. *

Strongly Disagree 1 2 3 4 5 Strongly Agree

7. I have enjoyed talking to AI bot. *

Strongly Disagree 1 2 3 4 5 Strongly Agree

8. I will continue to use this bot in the future for talking therapy or other purposes. *

Strongly Disagree 1 2 3 4 5 Strongly Agree

9. I will continue to use this bot in the future for talking therapy or other purposes. *

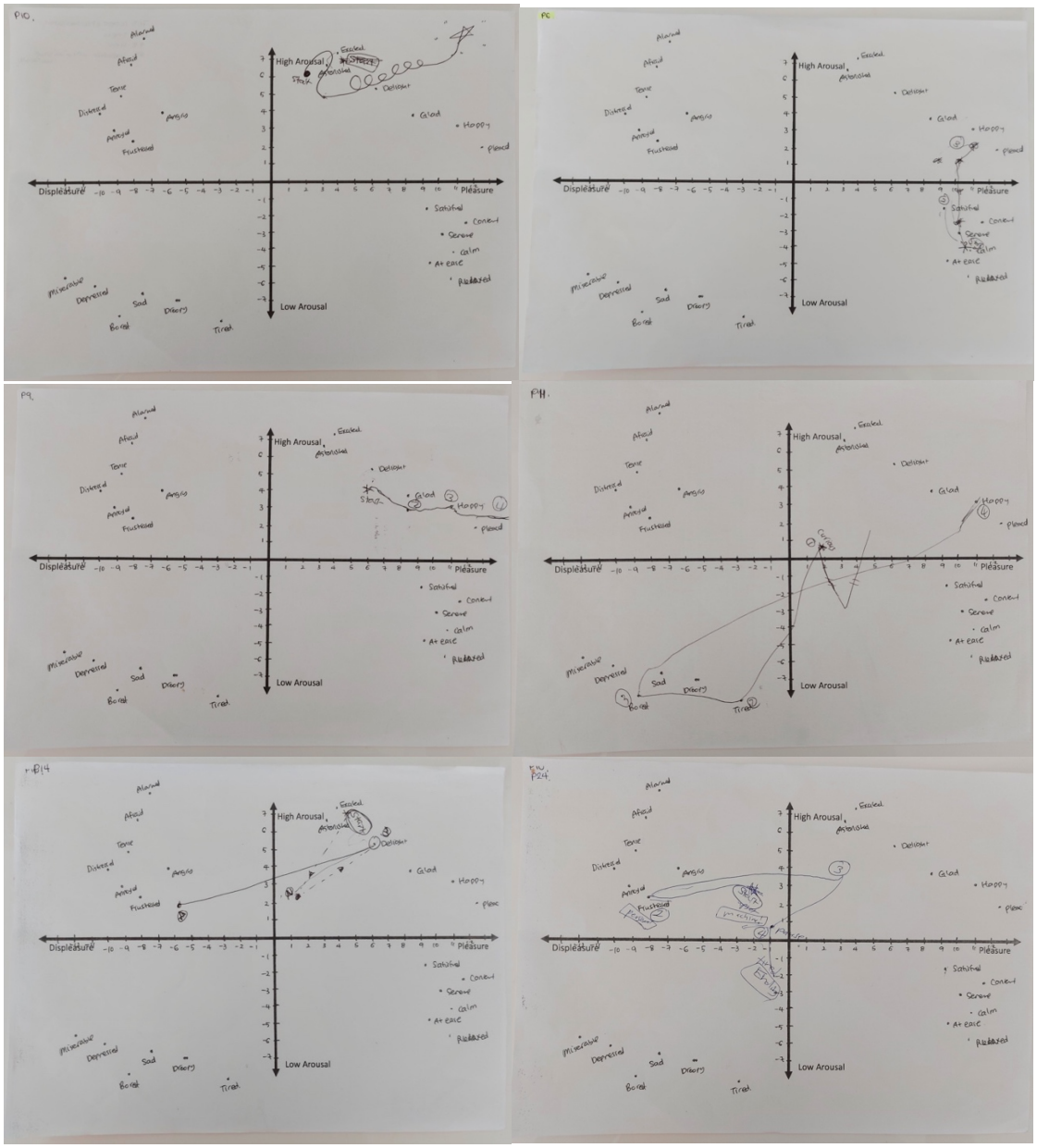
Strongly Disagree 1 2 3 4 5 Strongly Agree

10. I am happy with the quality of talking therapy services offered by the bot. *

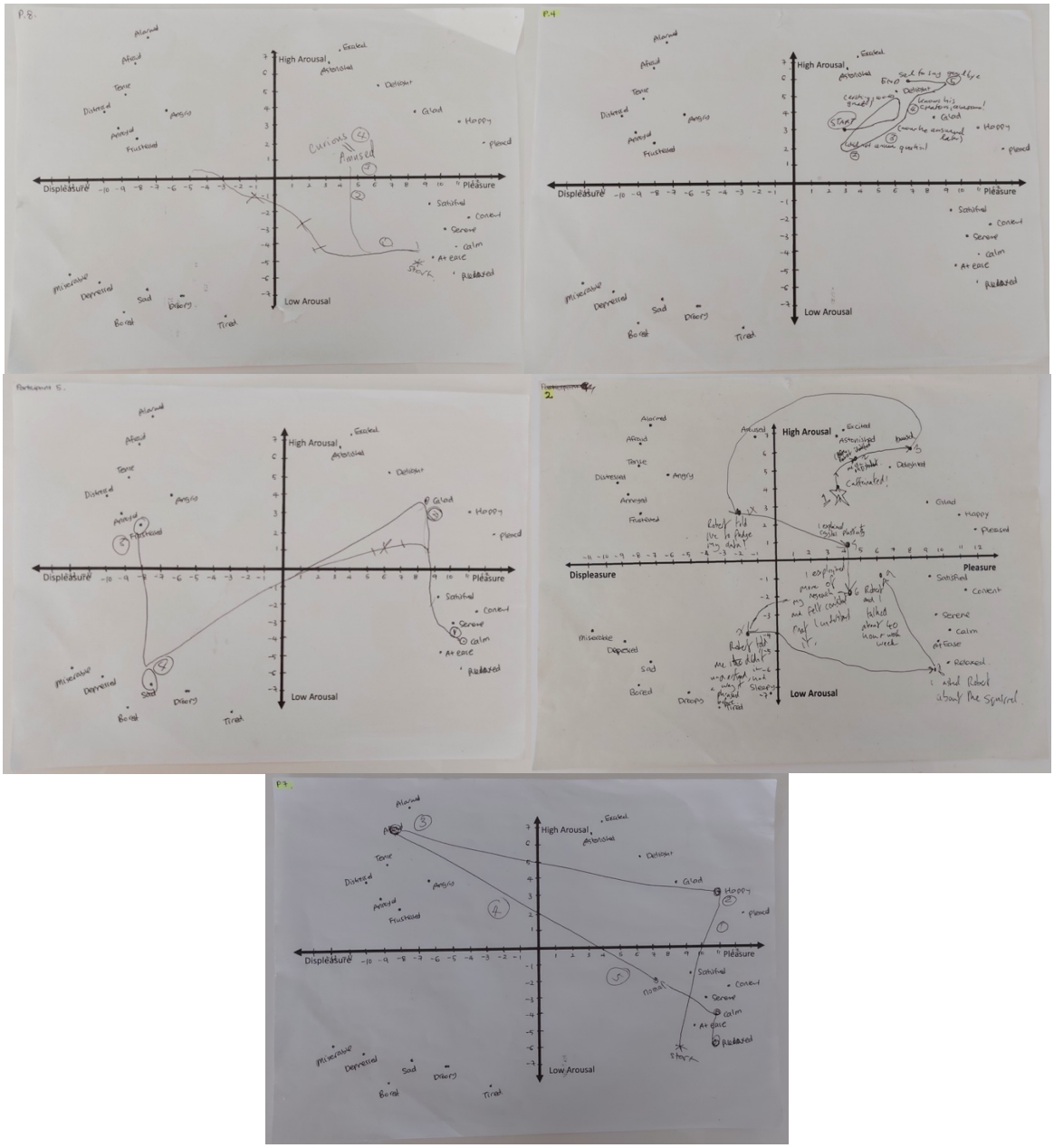
Strongly Disagree 1 2 3 4 5 Strongly Agree

3. The Maps of Emotions

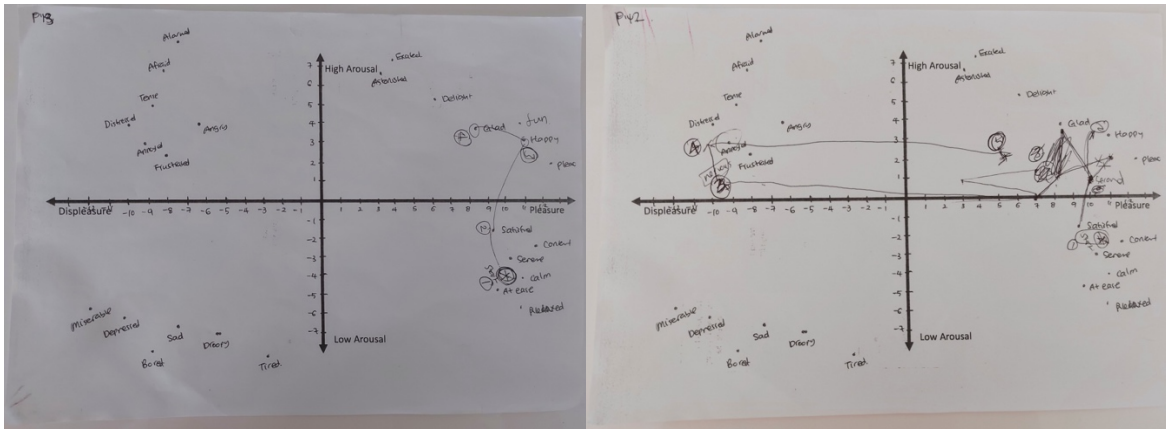
Odour 1



Odour 3


High Arousal
Low Arousal
Displeasure
Pleasure
Alarmed
Afraid
Tense
Distressed
Angry
Annoyed
Frustrated
Excited
Astonished
Delighted
Glad
Happy
Pleased
Satisfied
Content
Serene
Calm
At ease
Relaxed
Miserable
Depressed
Sad
Bored
Droopy
Tired

Odour 6


High Arousal
Low Arousal
Displeasure
Pleasure
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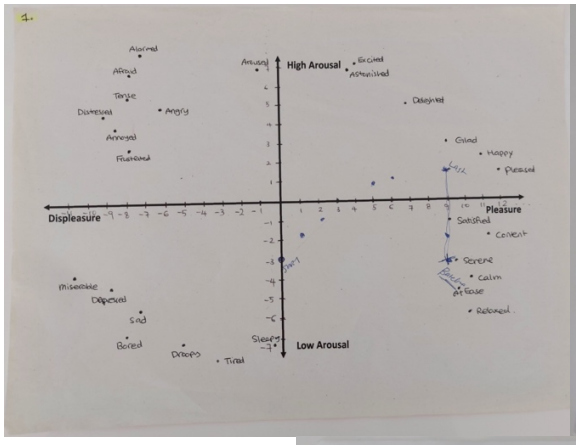
Distressed
Angry
Annoyed
Frustrated
Excited
Astonished
Delighted
Glad
Happy
Pleased
Satisfied
Content
Serene
Calm
At ease
Relaxed
Miserable
Depressed
Sad
Bored
Droopy
Tired


1.
High Arousal
Low Arousal
Displeasure
Pleasure
Alarmed
Afraid
Tense
Distressed
Angry
Annoyed
Frustrated
Excited
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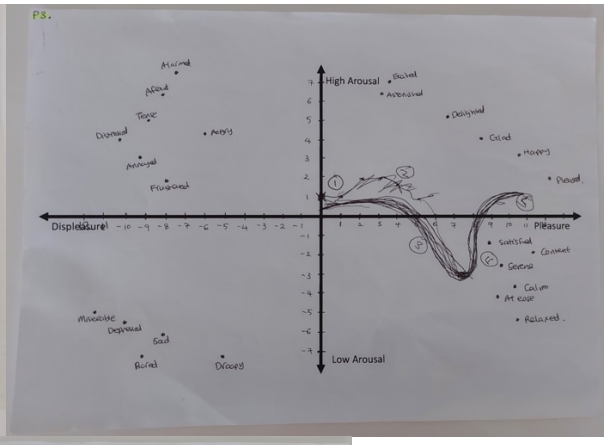
Delighted
Elated
Happy
Pleased
Satisfied
Content
Serene
Calm
At ease
Relaxed
Miserable
Depressed
Sad
Bored
Droopy
Tired
Sleepy


P3.
High Arousal
Low Arousal
Displeasure
Pleasure
Alarmed
Afraid
Tense
Distressed
Angry
Annoyed
Frustrated
Astonished
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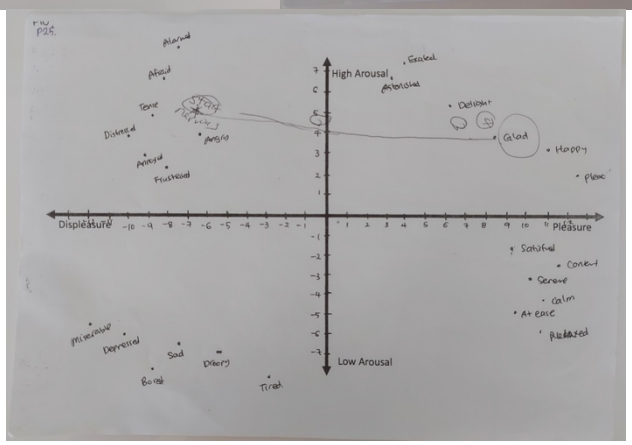
Miserable
Depressed
Sad
Bored
Droopy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High Arousal
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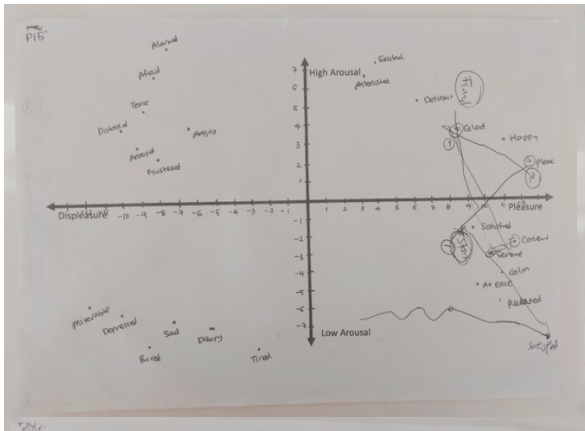
Odour 7


P15.
High Arousal
Low Arousal
Displeasure
Pleasure
Alarmed
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Bored
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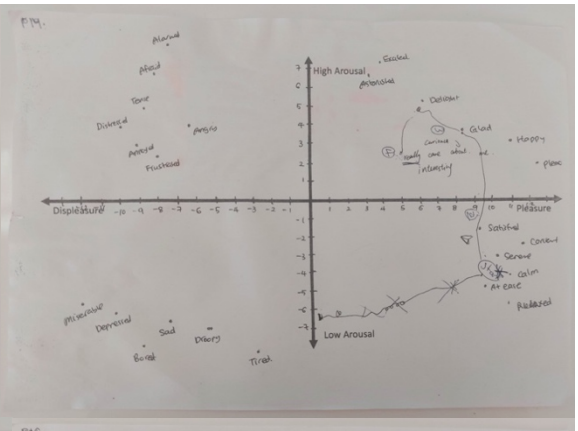
P14.
High Arousal
Low Arousal
Displeasure
Pleasure
Alarmed
Afraid
Tense
Distressed
Angry
Annoyed
Frustrated
Astonished
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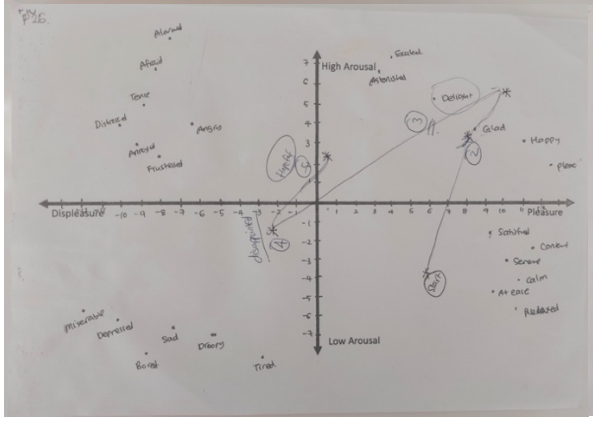
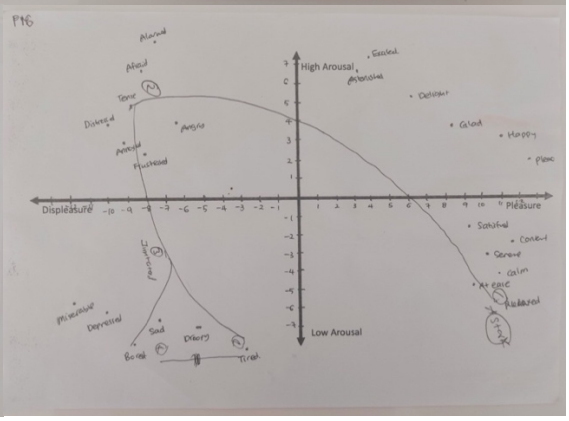
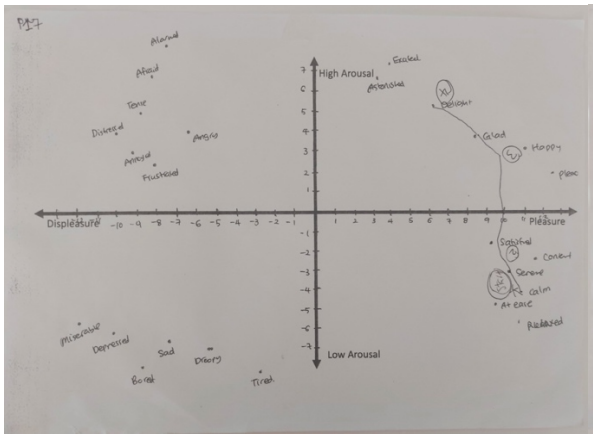
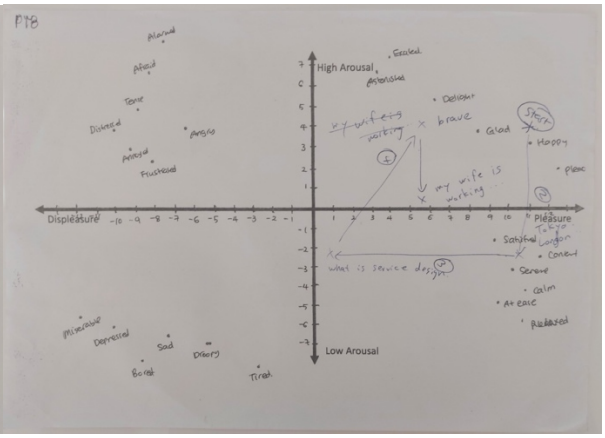
Elated
Happy
Pleased
Satisfied
Content
Serene
Calm
At ease
Relaxed
Miserable
Depressed
Sad
Bored
Droopy
Tired

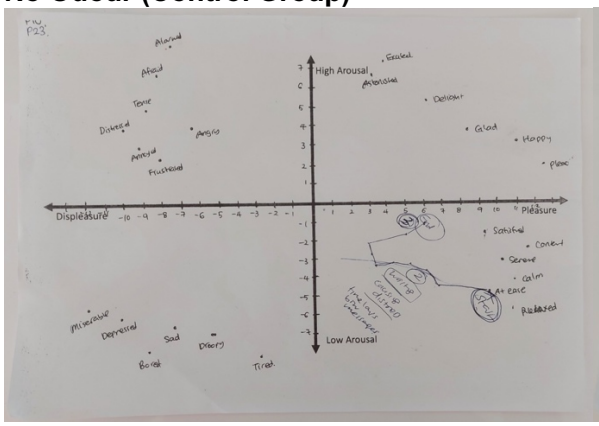

P16.
High Arousal
Low Arousal
Displeasure
Pleasure
Alarmed
Afraid
Tense
Distressed
Angry
Annoyed
Frustrated
Astonished
Delighted
Elated
Happy
Pleased
Satisfied
Content
Serene
Calm
At ease
Relaxed
Miserable
Depressed
Sad
Bored
Droopy
Tired

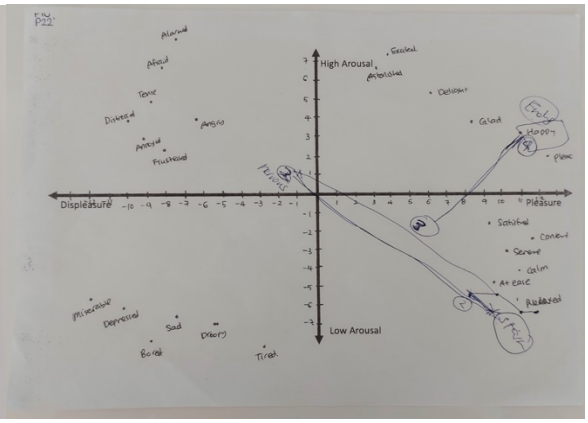

P16.
High Arousal
Low Arousal
Displeasure
Pleasure
Alarmed
Afraid
Tense
Distressed
Angry
Annoyed
Frustrated
Astonished
Delighted
Elated
Happy
Pleased
Satisfied
Content
Serene
Calm
At ease
Relaxed
Miserable
Depressed
Sad
Bored
Droopy
Tired

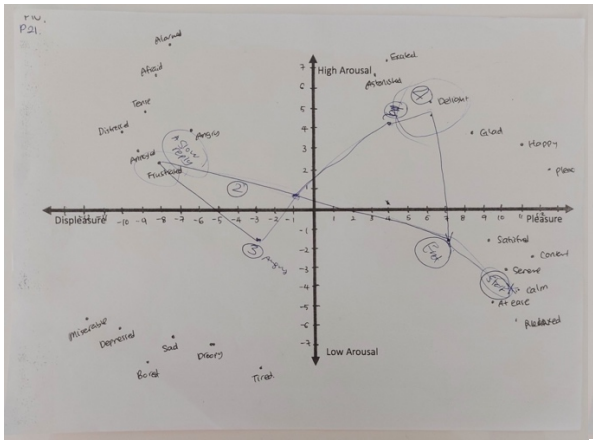


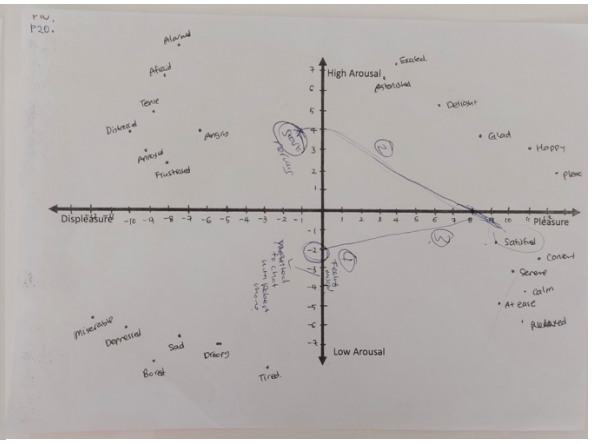


No Odour (Control Group)






P21.
High Arousal
Low Arousal
Displeasure
Pleasure
Alarmed
Afraid
Tense
Distressed
Angry
Annoyed
Frustrated
Astonished
Excited
Delight
Elated
Happy
Pleased
Satisfied
Content
Serene
Calm
At ease
Relaxed
Miserable
Depressed
Sad
Gloomy
Bored
Tired
1
2
3
4
5


P20.
High Arousal
Low Arousal
Displeasure
Pleasure
Alarmed
Afraid
Tense
Distressed
Angry
Annoyed
Frustrated
Astonished
Excited
Delight
Elated
Happy
Pleased
Satisfied
Content
Serene
Calm
At ease
Relaxed
Miserable
Depressed
Sad
Gloomy
Bored
Tired
1
2
3