Is touch really that important? An analysis of the business opportunity of haptic technology in online shopping

Henrique Agostinho

Dissertation written under the supervision of Gonçalo Saraiva

Dissertation submitted in partial fulfilment of requirements for the MSc in Business, at the Universidade Católica Portuguesa, 16 September 2020.

ABSTRACT

Title: Is touch really that important? An analysis of the business opportunity of haptic technology in online shopping

Author: Henrique Leitão Agostinho

Commerce and consumer experience have entered a new reality with the rise of the Internet and the digital age. People are becoming dependent of online shopping due to the convenience of shopping while sitting at home, which saves both time and money. The online environment lacks the sense of touch and this might pose a challenge to online shoppers.

The rise of haptic technology could be the answer for lack of touch within online consumer experience. Sensorial technology can give to our digital lives a more realistic experience.

This exploratory study aims to analyse the opportunities that haptic technology could generate in online shopping. Therefore, the research problem was examined from two different perspectives. Firstly, from the e-commerce side, in which the purpose was to gain insights about the current state of online business, and the main obstacles that consumers face when shopping online. Secondly, from haptic experts' side, understand what the current status of haptic technology development is and if the haptic technology can improve online business.

Findings reveal that haptic technology is going to play an important role in the gaming industry, medical training, education, and other industries within the next years, but for e-commerce purposes, not in the short time. Findings also report that there are a few other challenges in online shopping and touch is not consider as a priority. The development and implementation of this technology are also considered a brick-wall to implement in a short time.

Keywords: haptic technology; e-commerce; touch, business opportunity

SUMÁRIO

Titulo: Será o toque assim tão importante? Uma análise da oportunidade de negócio das tecnologias hápticas no setor do comércio online

Autor: Henrique Leitão Agostinho

A experiência do consumidor entrou numa nova realidade com o surgimento da Internet e da era digital. Os consumidores tornaram-se dependentes das compras online devido à conveniência de fazer compras em casa, o que economiza tempo e dinheiro. O ambiente online não inclui a experiência do toque e isso pode representar um desafio para os consumidores.

O surgimento da tecnologia háptica pode ser a resposta para a falta de toque na experiência online do consumidor. A tecnologia sensorial tem a capacidade de tornar a nossa vida digital uma experiência mais realista.

Este estudo exploratório visa analisar as oportunidades que a tecnologia háptica pode gerar nas compras online. A questão foi abordada de duas perspetivas. Numa primeira fase, obter insights sobre o estado atual do negócio online e os principais obstáculos que os consumidores enfrentam na hora de comprar online. Numa segunda fase, verificar qual o status atual do desenvolvimento da tecnologia háptica e se esta tecnologia tem a capacidade de melhorar a experiência de uma compra online.

Os resultados revelam que a tecnologia háptica desempenhará um papel importante na indústria dos jogos, na medicina, educação e outras indústrias nos próximos anos, mas para fins de e-commerce, não num curto espaço de tempo. Os resultados indicam também que as plataformas de e-commerce enfrentam ainda muitos desafios e o toque não é considerado uma prioridade. O desenvolvimento e a implementação da tecnologia háptica são considerados também uma barreira para a implementação num curto prazo de tempo.

Palavras Chave: toque; tecnologia háptica; oportunidade de negócio; loja online

ACKNOWLEDGMENTS

This dissertation closes my 4-year cycle at Católica Lisbon School of Business and Economics. It was a demanding but satisfying journey. At this point I would like to express my sincere thanks to the people involved in this work:

Firstly, I would like to express my gratitude to Gonçalo Saraiva, who supervised my thesis, critically and pragmatically.

Second, I want to express my gratitude to the interviewers for their contribution to this dissertation by providing their valuable time and insights.

Finally, a special word of appreciation to my girlfriend who always provided unconditional support during this last phase of the master and to my beloved parents, who supported me throughout all my life.

TABLE OF CONTENTS

GLOSSARY

Haptic technology - HA

Online Shopping – OS

Virtual Reality – VR

Augmented Reality - AR

INTRODUCTION

The world of business is changing – that is a given fact we have been living in the past decades. New disruptive technologies, the rising of the digitalisation and the Internet have come to change the landscape and bring new concepts to the field. Retail stores are now replaced by online platforms and e-stores, whereas the regional and local customer segment become global (Sergi, Esposito, & Goyal, 2019).

Commerce and the consumer experience have entered a new reality with the rise of the Internet and the digital age. The consumer journey was affected and redefined by new technologies, from the awareness to the buying process (Kim & Lennon, 2008).

Hence, the Internet has an exponent potential in this sector, as the fastest-growing retail channel, according to J. Clement in "Statista" (2019). The same author explains that this channel's sales volume is increasing, being nearly six times higher when compared to 2014. In 2018, global e-retail sales grew by 22.8% when compared to the previous year. Additionally, in the same year, 12.2 % of global retail sales came from retail e-commerce. When looking into the future, online retail sales are expected to account 6.542 billion US dollars by 2023, meaning 22% of total global retail sales (Clement, 2019).

The massification and globalisation of the Internet use imply a direct increase of this tool also in the retail business, as consumers are buying more through this channel (Joachim Zentes, Dirk Morschett, 2017). However, there are still challenges that this channel faces, despite its promising future, that need to be tackled to make headway in the business.

One of the struggles faced is the high abandonment of the shopping cart, according to Barilliance, the average cart abandonment rate for 2016 was 77.24%. This number rose slightly in 2017 to 78.65% (Serrano, 2020). The conversion of online browsers into actual buyers has remained low, ranging between 1.53% and 4.14% of Web site visitors depending on the device used (Statista, 2020a), compared to nearly 67% of mall visitors who purchase during their visit as reported by Soriano (Soriano, 2006). In fact, as much as an average of 75% of online shoppers will abandon their purchases before checking out (Baymard Institute, 2020). Such phenomena imply that some factors keep Internet shoppers from buying via the Internet.

Even though the impressive growth rate and optimistic outlook, as noted before, there is compelling evidence to suggest that many consumers are still reluctant to purchase via the

Internet. Several authors have come across a few reasons why this still happen and why e-commerce is not more successful.

The consumer's insecurity towards online buying can arise from several causes, such as fear of security breaches (Tarafdar & Zhang, 2007), lack of confidence or even to buy in the website due to its content and design (Shobeiri, Mazaheri, & Laroche, 2015; Singh, Malik, & Sarkar, 2016; Sohrabi, Mahmoudian, & Raeesi, 2012). This lack of confidence justifies the fact that consumers often feel reticent to buy high priced products (Grewal, Iyer, & Levy, 2004).

Another limitation faced by consumers in e-commerce, according to several authors is the possibility of examining the products while buying online. This constitutes a problem since physical contact, also known as the need for touch, is a relevant aspect of the buying process and consumer journey, when analysing different options, choosing a preference and finally making a choice (S. H. Lee, Workman, & Jung, 2017; Peck & Childers, 2003b).

This challenge is also addressed in the Retail Dive's Consumer Survey, cited by Skrovan (2017), a study focusing on the American market that concludes that one of the reasons that make consumers prefer to shop in stores instead of online is because the later does not allow them to see, touch or feel the products, as well as the impossibility of bringing the products with them at the moment. Moreover, 62% of the participants of this study say that their primary motivation for shopping in stores is to have contact with the product, by trying and seeing it (Skrovan, 2017).

Another study conducted by Forrester Research shows that more than 50% of the consumers that do not end their purchase online is due to the impossibility of check the state of the product before buying it. This demonstrates the importance given by consumers to have a satisfactory amount of information about the product they intend to buy. And much of this information is acquired through *in loco* assessment (Kim & Lennon, 2008).

A discussion with retail futurist Doug Stephens points that retails stores will not disappear but projections for 2033 suggests that the majority of our daily consumption will be transacted online (Howland, 2020). Dolliver, eMarketer 2020, adding that more than 8 in 10 Millennials will be digital shopper (Dolliver, 2020).

To overcome the challenges that arise from the need for touch, retailers have started to look for technological solutions that might improve the customer experience and journey. One of the innovations used nowadays is the online and virtual recreation of the in-store experience, in

which the product inspection is possible using 3D images, digital images, zooming technology, VR and AR (Kim & Lennon, 2008). Another alternative that has not been widely explored, for this purpose, is the use of Haptic technology.

Traditional technologies for virtual reality and augmented reality create human experiences through visual and auditory stimuli that replicate sensations associated with the physical world. The most widespread VR and AR systems use head-mounted displays, accelerometers and loudspeakers as the basis for three dimensional, computer-generated environments that can exist in isolation or as overlays on actual scenery. In comparison to the eyes and the ears, the skin is a relatively underexplored sensory interface for VR and AR technology that could, nevertheless, greatly enhance experiences at a qualitative level, with direct relevance in areas such as communications, entertainment, medicine and online shopping experience (Yu et al., 2019).

Several authors point as top trends for e-commerce for the next decade the use of technologies that allow consumers to approximate to reality, such as AR, VR, etc. (Chen, Tilley, Jones, & Rapp, 2019; Lindberg, 2020; Mary Meeker, 2019; Meyer, 2020; Mohsin, 2020). In this line of increasing appetite of consumers to have a closer relationship with machines to obtain the most realistic sensations possible, sensorial technology can play a vital role.

Accordingly to Ovum (Ovum, 2016), consumers expect shopping to be a fully interactive experience by 2026. An interactive retail experience would include technologies that allow the consumer to engage in a mix of real and virtual reality, such as augmented reality, Virtual reality and Haptic Technology. This unification of both worlds in an OS experience will be important tools to create relevant brand's value proposition.

In studies reported to date, there is minimal empirical research regarding the assessment of the business opportunity of HT in OS and thus very little is known about how this technology could improve the OS experience and its consequent influence on business success. Therefore, to address this research gap, this study seeks to examine: (1) if touch is an essential factor on the decision buying process in OS and, additionally, (2) determine if haptic tech could diminish the lack of touch in an online shopping experience, and for this reason improve the online shopping experience itself.

Problem Statement

The current online shopping paradigm dictates a need for retail stores to distinguish from competitors to conquer the market. In order to do so, it is essential to listen to the consumer and understand their pain points and what is holding them back when it comes to OS and what is lacking in their purchase experience.

One of the main reasons why consumers are still unsatisfied is the lack of touch. Thus, bring new technology to the table that allows consumers to "approximate" more to the products they desire; it will create a competitive advantage against those who not have this sense of touch technology.

The scope of this study is to evaluate the business opportunity of HT in online shopping. Therefore, this study seeks to understand if touch is an important factor in the decision buying process in OS and the business opportunity that this technology could generate in OS. To address this problem statement, the following research questions will be examined:

RQ1: What are the current challenges in the online shopping decision process?

RQ2: Is it touch an important factor in online shopping?

RQ3: What is Haptic Technology?

RQ4: What are the opportunities that haptic technology generates in online shopping?

Relevance

By answering these questions, this study makes several contributions to the existing literature and industry knowledge. Namely, it clarifies if touch is an important factor in the consumer decision process in online shopping. Furthermore, it provides an initial step to evaluate the business opportunity of haptic tech in the OS market by analysing the need for touch that some consumers show when buying online and the mechanism of action that this tech can provide to eliminate this lack of touch.

By doing so, this study provides a conceptual framework that takes into account both the consumers' perspective and the businesses' perspective for HT adaptation in some electronic devices that can give a sense of touch when consumers are searching for products online to buy.

Research method

In order to answer the research questions, a qualitative, exploratory research approach was used, including both primary and secondary data, due to the novelty of the topic. Both, primary and secondary data, were used to investigate the topic: Secondary data was mainly applied to define a literature review about the key topics of the research topic - the current state of e-commerce and forecasts for the coming years, constraints that the sector still faces, the introduction of HT, the current state of this tech in the markets and forecasts - with the goal to build a theoretical foundation for further primary data investigation. Additionally, primary data was used to justify the data collection method and to sustain the results´ analysis. Primary data was collected through the conduction of 4 semi-structured interviews, between March and July of 2020 to generate in-depth knowledge about the current use of haptic tech and to verify if there is a business opportunity to introduce these technologies in electronic devices and diminish the lack of touch in online shopping experience. Two different groups of stakeholders (retailers, HT-expert). Thereby, this work tries to present a comprehensive potential of HT to reduce the lack of touch in OS experience.

Dissertation Outline

The next chapter presents a literature review and describes the research context, which guides this study. The literature review assembles previous relevant studies and empirical evidence. First, how online business is performing, forecast and the most significant challenges this business is facing, following the research on HT and his applications. Finally, the status of the global HT market. The third chapter presents the methodology of this study, data collection and research procedure for this study. Further, the sample is characterized. The fourth chapter contains an analysis of the collected data and demonstrates the results. Finally, the fifth chapter, based on the results, concludes and points out the limitations of this research as well as indications for further research.

LITERATURE REVIEW

This chapter presents a review of the existing literature regarding the study background and research questions. Previous studies, industry reports, as well as empirical evidence from various academic journals, are studied and summarised.

Online shopping

Ecommerce 2020, the past, the present and the future

E-commerce has become an important slice in the world's economy. In 2017, the value of B2B and B2C e-commerce surpassed 25.3 trillion US dollars (UNCTAD, 2017). Its weight in the global economy has led to its acknowledgement and consequent growth. In the 2017 edition of the United Nations Conference On Trade And Development (UNCTAD), it was shared data regarding the e-commerce growth in different regions. Asia-Pacific is the region with the highest market growth, followed by Europe, North America, Latin America and the Middle East. (UNCTAD, 2017).

More recent studies point out that the business paradigm in the USA makes it, accordingly to the eshopword 2019 report, the main e-commerce market in 2018. Its logistics infrastructure and high exportations in the e-commerce market lead to the rising of a market that is worth 504.58 billion US dollars in revenues.

Although there is a growing trend in this market, studies indicate there are differences between regions when it comes to the adoption of e-commerce. For example, India and China, the two fastest-growing and populous economies have responded quite differently to it. In 2012, the first registers B2C e-commerce sales around 10.7 billion US dollars, which represents only 3.3% of China's B2C e-commerce sales - 328.4 billion US dollars. This difference demonstrates that the success of e-commerce is connected with internet use by the population. While China had, in 2014, 641 million internet users, India had 243 million users, according to the 2015 PWC Report noted by Sergi et al., 2019 (Sergi et al., 2019).

The 2015 UNCTAD report establishes a set of three indications that would shape by then the B2C e-commerce. Firstly, it indicates that it will grow faster than B2B e-commerce, secondly that developing economies across Asia and Africa will play a central role in its growth and adoption, rather than the developed countries, and lastly that China and India will be the leading economies in the e-commerce growth attracting a lot of focus from the global economies and businesses in these regards (Sergi et al., 2019).

Throughout the last years, several studies and reports predict a prosperous future for OS. Anis et al (2018), explain an example of this, focusing on the online purchase behaviour of American consumers in one of the most relevant shopping moments of the country, the Black Friday. According to a survey led by this author, 54% of the consumers were planning to shop more online in that year, compared with previous years, and one of the reasons pointed is to escape the chaos that this happening usually means to the traditional retail shops (Anis, Elliott, & Koestler, 2018).

Nevertheless, other researchers are still firm believers of the physical stores. Bill Fisher, eMarketer senior editor, defends that physical retail sales continue to represent the most significant share of total sales. This publication reveals that the value of retail sales in in-store in 2019 represents representing 89.3% of total retail sales (1.8% growth), in a total of 4,888.04 billion US dollars, whilst e-commerce represents 10.7% of total retail sales, in a total of 586.92 billion US dollars and a growth of 14% (eMarketer, 2019). "Habits may be changing, and fast, but the high street still appears to have some life left in it," says Fisher.

This trend is confirmed by a survey conducted by eMarketer in 2019 and published in their 2020 report, regarding the United Kingdom market, that claims that 60% of UK internet users ages 18 to 75 claimed to prefer to shop in-store for Christmas gifts, whereas 37% chose to shop on websites via desktop/laptop or mobile of stores with a physical location. This shows an interesting trend identified in the UK consumers who like to shop at digital stores that also have a physical one. eMarketer predicts that 66.8% of e-commerce buyers in the UK chose the click-and-collect delivery option in 2019. This practice is known as "buy online, pick up in-store" (BOPUS).

Hence, accordingly, to this report, consumer digital shopping habits will evolve further, but evolution will be less revolutionary and more evolutionary (eMarketer, 2020).

Generation Y (also known as millennials, born between 1980 and 1994) and Z (born between 1996 and 2015) are the age groups that represent the most significant share of e-commerce consumers. These age groups can have low buying power, given that they can be either too young to have an income or can be too old to understand the latest technologies (Sky Potential, 2020).

According to Business Insider Intelligence, Gen Z will represent up to 82% of the online consumer market by 2026, and Gen Y accounts for 80% of the online sales. These generations have strong online potential, especially Generation Z, that spend between 5 to 6 hours browsing

the Internet per day. 80% of them have more than one device, and 26% use smartphones for more than 10 hours a day. Millennials are also more enthusiasts about the convenience of online buying and the ones that make more impulse purchases (Pandey, 2020; Sky Potential, 2020). Gen Y and Gen Z represent 24 and 21%, respectively, of the global population with a purchasing power of 40% (3.3 Trillion US Dollars) and 32%, respectively (Sky Potential, 2020).

E-commerce, as a trend has been growing globally. In 2017, 1.3 billion people, representing one-quarter of the world's population aged 15 years and older, shopped online (more 12% than in the previous year). Online shopping is more spread among countries with higher levels of income. In Denmark, Germany, Netherlands, Norway, Sweden and the United Kingdom more than 80% per cent of Internet users make purchases online. However, there are over 24 low and lower middle income countries which e-commerce accounts for less than 10 per cent of Internet users (UNCTAD, 2019).

COVID-19 impact

COVID-19 pandemic represents a real challenge for traditional retail and an e-commerce opportunity. It became more urgent to digitalise businesses (Derow, 2020).

According to a recent National Retail Federation (NRF) survey, since the beginning of the pandemic, 9 in 10 consumers have purchased products online they had previously only bought in store. Delivery mobile applications have also increased to more than the double and consumers find it an "easy" experience and "something they would try again" (NRF, 2020).

This crisis has changed buying habits across the globe. In Italy, for example, according to the Financial Times (March 20), Carrefour doubled its online sales after one week of confinement, whilst in the USA, application downloads from the three largest retailers more than doubled when compared to 2019, in March, according to data from Apptopia. This new reality also led to new behaviours. A survey by the Wall Street Journal on April 20, says that about a third of respondents did grocery shopping through digital channels for the first time during the Covid-19 pandemic (Pereira, 2020).

This awakening to digital retail led to a 6% global traffic increase in retail platforms between January and March 2020. Retail websites had 14.34 billion visits in March 2020, whilst 12.81 billion in January 2020 (Statista, 2020b).

Moreover, in terms of revenue growth, the United States online retailers' year-over-year (YoY) revenue growth is up 68% as of mid-April and online conversion rates increased by 8.8% in February. These rates are equivalent to the ones experienced in Cyber Monday, which shows the level of effectiveness of OS during this crisis. Physical stores also have a new challenge ahead that arise from Covid-19: the fear of returning to stores due to the risk of getting the virus. A recent Morning Consult study, based on surveys with 2,200 US adults between April 7 and April 9, concluded that 24% of consumers said they wouldn't feel comfortable returning to shopping malls for the next six months or more, and 16% said they would return in doing so in the next three months. This shows that consumers are more motivated to stay home and shop online (Columbus, 2020).

A study performed by Bloom Partners in Germany with 502 participants, in 2020, concludes that digitisation is the big winner of the corona crisis, since its full potential will be supported more broadly (72%) and not only limited to e-commerce (Bloom Partners, 2020).

Factors influencing online consumer behaviour

The purchase behaviour in OS is a phenomenon that has many factors and variables which can influence it. The consumer decision making, online or in-store, as part of the purchase behaviour, has been an area of interest for the ones doing consumer research and "will continue to be critically important" (Bettman, Luce, & Payne, 1998).

Online shopping behaviour (or online buying behaviour and Internet shopping/buying behaviour) is "the process of purchasing products or services via the Internet". It consists of five steps that are similar to those associated with traditional shopping behaviour. The first step includes the recognition of a need and search for a solution, secondly evaluation of the different alternatives, then making a choice that fits the criteria for meeting the need. Finally, the transaction is handled and then the after-sales services provided (Liang & Lai, 2000).

Regarding online shopping, the purchase decisions are determined by many factors such as the interactions of consumers with the Internet and the online environment. To understand online decision-making processes, it is crucial to recognise the process in which the consumers are involved in and the actions they make until they reach a decision (Karimi, 2013). What triggers the consumer to make a purchase, what affects their decision-making processes and what leads to different choices and processes in various contexts and for distinct individuals are important questions to ask.

There have been identified several factors that can influence OS, and different aspects have a distinct level of importance in various stages of decision making (Karimi, 2013).

For example, Court et al. (2009), believe that company-driven marketing is more important in the development of the initial consideration, while consumer's information and knowledge are more relevant during research and evaluation (Court, Elzinga, Mulder, & Vetvik, 2009).

Besides consumer characteristics and environmental influences, the characteristics of the product or service, medium and distributor also define the context of the decision (Constantinides, 2004), as well as the maturity of the market, the sellers' reputation and information asymmetry and quality (Clemons et al., 2016)(C. H. Park & Kim, 2003).

When comparing physical and online stores, the latest has several advantages. They allow the consumer to save time, with no travelling associated or waiting in lines; they are available 24/7 in anywhere in the world with the Internet; allow the consumer to have more detailed information about the product that is being sold and offers more interactivity between consumers and product/service. These characteristics give the buyer a bigger sense of control (Moshrefjavadi, Rezaie Dolatabadi, Nourbakhsh, Poursaeedi, & Asadollahi, 2012).

Nevertheless, online stores also have disadvantages when compared to physical stores. In online stores, customers cannot experience the product with their physical senses - seeing, touching, tasting, smelling, and hearing.

This absence of physical interaction is one of the main characteristics of the online environment and is considered central constraint of OS (E. J. Lee & Park, 2014; Overmars & Poels, 2015).

This impossibility of feeling and touch the products leads to the hesitation of buying online in detriment of buying in-store, even if the consumers have some level of experience as internet users or are familiarised with the websites (Verhoef, Neslin, & Vroomen, 2007) (Cho, Kang, & Cheon, 2006). Although recent research reveals that OS figures are growing, there is a behavioural trend that consists of searching for information regarding the product online and then make the purchase in stores afterwards.

This same trend is confirmed by Tom Popomaronis, through his research published in Forbes in 2016, in which he accounted "12 Astonishing Shopping Facts that sum e-commerce in 2016". During this study, he collected data that pointed that 60% of consumers have done an online buy to "pick up in-store" via mobile, 88% % of e-commerce users found detailed product content extremely important. Ratings have also shown to be very relevant since more than 90%

of consumers buying on Amazon wouldn't purchase an item with less than three stars (Popomaronis, 2016).

The eMarketer report from 2014 analysed a survey made by the consulting firm Accenture about how digital shoppers made their purchases in the United States. 78% claimed to do "webrooming,", which means to research online before heading to a store to make a purchase. In some cases, the respondents said that store trips eventually led to a digital purchase. This Accenture study also found that 72% of respondents "showroomed", which means that these consumers bought online after seeing a product in a store. This shows that consumers have combined both online and offline to create a unique shopping experience (eMarketer, 2014).

An experiment by Flavián, Gurrea & Orús (2017) shows that product presentation videos have positive effects in consumers, as they are more likely to buy after seeing one when compared to the ones that didn't see any video. This result explores the persuasion power of realistic online product information. The same research shows that displaying a realistic and objective video has a strong influence on purchase intentions and on the consistency between attitudes and intentions. However, in regards to individuals with a high need for touch (NFT), results show that when confronted with vivid information on the computer screen through audio-visual content, these individuals may develop a greater desire for to experience the physical aspects of the purchase, leading them to prefer the brick-and-mortar setting for a more direct experience (Flavián, Gurrea, & Orús, 2017).

When an individual is in the information search stage of the decision-making process, they actively collect and incorporate information from several sources before making a choice, in order to satisfy their need for information (Bettman et al., 1998; Court et al., 2009; Darley, Blankson, & Luethge, 2010; C. H. Park & Kim, 2003). Then, the consumer compares sellers based on this information to make the best purchase decision (J. K. Park, Chung, & Yoo, 2009).

In an online purchase, when consumers are interested in a specific product, they look at different sources of information in order to compare until feeling they have enough knowledge to make a thoughtful decision. Hence, the importance of information richness and easy access to it in order to quicken consumers' purchase decisions. (Chiu, Lo, Hsieh, & Hwang, 2019).

Court et al., 2009 research found that merchandising and packaging have become crucial selling factors since more consumers choose to make their final purchase decision once they are in a store. And this decision can be highly influenced by the visual dimension since up to

40% of them change their decision because of the packaging, placement, or interactions with salespeople (Court et al., 2009).

Rathee & Rajain (2019) recognised, through their research that OS is a common practice in the current market, but it does not offer a complete sensory experience bearing in mind the lack of touch which is crucial in some categories of products (Rathee & Rajain, 2019).

With the growing questions that arise from the lack of touch, customer-focused haptics research also grew. It investigates how individuals use information gained via their hands, like product softness, texture and quality, while shopping. Until now, this research investigated topics such as the reaction to products touched by others and the individual trait need for touch, amongst others (Peck & Childers, 2003b). These studies show that touch increases the feeling of ownership when compared with the ones who didn't touch, which showed that it has a significant main effect (Peck & Shu, 2009). Research in this regards also show an increase in confidence in product judgments (Peck & Childers, 2003b), which result in more positive product evaluations (McCabe & Nowlis, 2003; Peck & Wiggins, 2006) and lead to an increase in spontaneous buying (Peck & Childers, 2006).

In 2003, (McCabe & Nowlis, 2003) confirmed through their research that consumers have more favourable purchase intentions if they are allowed to touch products, whilst Peck and Childers (2003a) found the need for touch was a problem in online buying. Consumers who have a need for touch in the moment of purchasing are more inclined to choose brick-and-mortar stores for shopping instead of using the Internet. Thus the importance to investigate the need for touch as a variable potentially related to Internet shopping trends and habits (Peck & Childers, 2003a).

Hence, the same authors Peck and Childers (2003a) developed the Need For Touch (NFT) scale to "measure preference for acquiring and using information obtained through the haptic sensory system". The scale measures two dimensions: the utilitarian goal-directed NFT (instrumental) and pleasure-seeking hedonic NFT (autotelic). The NFT scale has high reliability and has been validated, thereby is easy to apply and appropriate for quantitative analysis (Peck & Childers, 2003b, 2003a). The authors separate the products between low-touch and high touch. While computer software is considered low touch, clothing stands in the high touch category. Taking the example of clothing, the authors compared the NTF related to a diversity of physical objects, one of them being a sweater. In this case, touch played a crucial role because it revealed the texture and quality of the fabric and demonstrated characteristics such as softness and

warmth. The main feature of physical objects is the texture – they can be hard, rough, warm, cold, heavy or light); therefore, evaluation of such objects necessarily entails the use of touch (McCabe & Nowlis, 2003). This can be a deal-breaker, according to Grewal et al., 2004, since customers may choose not to purchase products such as apparel over the Internet because of the need to touch, feel, and try on products. The impossibility to inspect the products physically before buying is also one of the demonstrations of the need for touch, according to (S. H. Lee et al., 2017), in which researchers concluded that among the five most important reasons for not purchasing products online was the lack of opportunity to touch the products before buying.

Bearing this in mind, the need for touch is a challenge that online retail faces (Grewal et al., 2004).

Haptic Technology
Haptic technology is a technology also known as kinaesthetic communication or 3D touch. It describes any technology that "can create an experience of touch by applying forces, vibrations, or motions to the user". They can have different uses such as create virtual objects in a computer simulation, control virtual objects or even enhance the remote control of machines and devices. (Bermejo & Hui, 2017; El Saddik, Orozco, Eid, & Cha, 2011).

Concerning VR and human-computer interaction, humans trust on visual and auditory feedback to get information. Visual feedback is acquired through a display, and auditory feedback is displayed through headphones, speakers, or other devices (Dangxiao et al., 2019). According to several authors (Bermejo & Hui, 2017; El Saddik et al., 2011; Sreelakshmi & Subash, 2017), haptic feedback will soon assume a crucial role in computer-human interaction through different haptic devices with other uses, such as:

- A feedback user interface, such as buttons, pull-down menus
- Gaming
- Multi-media publishing with immersive media through VR and AR mobile platforms
- Vehicle industry, for better interfaces to control the vehicles without losing the visual sense
- Telerobotic and Teleoperation, with high-quality manual controllers such as The Da Vinci surgical system
- Education and training, simulated training, and innovative passive learning methods
- Rehabilitation, for example, improving living conditions for visually impaired people

- A scientific study of touch
- E-commerce

This technology is characterized by the diversity of existing devices. Some authors try to group the different gadgets in order to be more noticeable. Dangxiao et al., 2019, divide haptic tech into three main paradigms: desktop haptics, surface haptics, and wearable haptics.

Regarding desktop haptics, the user's hand is holding the stylus of the gadget and controls a virtual tool such as a surgical scalpel, mechanical screwdriver etc. There are six simulated motion/force dimensions in desktop haptics: three translations and three rotations of the virtual tool. A desktop haptic device is "a multi-joint robotic arm with a stylus that held in user's hand, and the device can track the movement of the stylus and provide force feedback on the stylus". Usually, the tool is installed on a table-top or the ground (Dangxiao et al., 2019).

Surface haptics is applied in mobile phones when the user touches the screen with his fingertip and slides along with typical gestures such as panning, zooming and rotating etc., and consequently controls a finger avatar to sense the texture and/or shape of virtual objects. The simulated motion/force elements in surface haptics are two in the planar surface of the touchscreen. Unlike desktop haptic devices that simulate indirect contacts between hands and objects (i. e., tool-mediated interaction), surface haptics has the objective to replicate direct connections between bare fingers and objects. In this case, users can, for example, touch and feel the shape or the roughness of an image displayed on the screen of a mobile phone (Dangxiao et al., 2019).

Finally, in wearable haptics, the user's hand is wearing a haptic glove and that allows the user to control a virtual hand-shaped avatar with various simulated movements such as grasping, pinching, lifting etc. Twenty-two motion dimensions are related to the DoF (degree of freedom) of human's hand, and the force dimensions are actively changing, varying on the number and topology of contact points between the virtual hand and the controlled objects (Dangxiao et al., 2019).

In addition to the previous technologies presented, emerging tactile representation technologies include air film tactile representation, electrostatic tactile representation, and ultrasonic tactile representation. Air film tactile representation or air bearings are fluid bearings that use a thin film of pressurised gas to provide a low friction load-bearing interface between surfaces.

Electrostatic tactile representation is built around the measurement of the electric current generated by electrostatic induction. The sensor can detect contact between two objects that are not in contact with it. When the human body gets in contact with an object, the electrostatic charge is produced in the body due to tribological interactions. Then, an instantaneous change is observed in the electric potential of the human body. Therefore, contact can be detected via the difference in the electric potential of the human body (Kurita, Fujii, & Shimada, 2011; Mallinckrodt, Hughes, & William Sleator, 1953).

Unlike other technologies mentioned, which include a touch screen or a wearable device, ultrasonic tactile representation is a noncontact haptic rendering technology that creates tactile sensations in free space using an ultrasound transducer display and an ultrasonic haptic rendering algorithm.

Ultrasonic haptic rendering uses ultrasonic focusing technology and modulation to operate the desired tactile sensory stimulus to a certain point in mid-air by managing the phase and intensity of the ultrasound pulses produced by each ultrasound transducer. When used on a user's skin surface, ultrasound creates a tactile sensation that can be felt by the user. Typical ultrasonic rendering methods consist of amplitude modulation and spatiotemporal modulation (Chongyang, Weizhi, & Xiaoying, 2019).

Another research by Bermejo and Hui (2017), suggest an extended classification of haptic devices. During their study, the authors divided the technology in cutaneous tactile and kinaesthesia, based on the principle operation of haptics sensation. Cutaneous/tactile is related to the skin, whereas kinaesthesia/proprioception/force is a sense mediated by the end sensory organs located in muscles, tendons and joints. It is associated with the capabilities of sensing the relative position of the body's parts and strength. The tactile receptors vary significantly with the body parts they cover. During their research, they reference several authors that developed numerous essential technologies that are connected with the different type of haptic tech (Bermejo & Hui, 2017).

Regarding **cutaneous sensory,** there are three types of cutaneous devices:

Cutaneous sensory technology	Example
Vibration	Smartphone vibration device
Fingertip	Hapthimble, 3 RRS
Skin	Skin displacement and wristband

The cutaneous/tactile approach is presently one of the most used haptic feedback devices. It works through vibration on our smartphones or games controllers, enabling cutaneous perception on the user's hand when we type or crash a car in a videogame. This is a cost-effective and feasible implementation of HT due to its miniaturisation and simple design of vibration motors. Still, vibration patterns are difficult to distinguish in many situations, such as walking, and offer limited information (i.e., duration, strength, and vibration pattern).

Regarding active surfaces**, there are three types of devices:**

Active surfaces Technology	Example
Pin array	Smartphone pin array
Multicell array	Multi-array cell
Finger based	Normal/texture touch

Active surfaces feature the best performance for rendering surfaces, with excellent resolution and accuracy. However, many of the devices lack portability due to the haptic design.

Regarding mid-air haptics**, there are three types of devices:**

Mid-air technology	Example
Ultrasound	SkinHaptics, Ultrahaptics
Air jet	Aireal
Laser-based	LaserStroke

Mid-air haptic devices have the main advantage of not covering the user's skin. Therefore, they allow several possibilities for mobility, free movement and touch experiences in the real world (Frier, Pittera, Ablart, Obrist, & Subramanian, 2019).

Regarding **Kinaesthetic sensory** haptics**, there are four types of devices:**

Mid-air technology	Example
Manipuladum	PHANToM, Omega, Haplet, Wolverine
Grasp	PHANToM

Exoskeleton	Rutgers Master II, Smart Glove, Jointless Glove
Other kinaesthetic	Electro Muscle Stimulation (EMS)

Other kinaesthetic approaches use electro muscle stimulation (EMS) to display force feedback. Even though the portability and autonomy of these electronic devices are demonstrated, the rendered force lacks continuity and can be violent in some situations.

Global Haptic Technology market

The global haptic technology market is continuously growing and is estimated to expand at a compound annual growth rate (CAGR) of 14.44% from 2020 to 2028. Regarding revenue, HT is expected to generate a revenue of about 3.9 billion US dollars by 2028.

The increasing adoption of haptics in electronic devices has been the primary motivation for the market to continue to invest in it, is the highest revenue source for haptic tech. Its most effective implementation on a large scale was done by smartphone manufacturers, more specifically in their touch screens.

The application of the technology has evolved and there has been a continuous transformation from traditional uses, through gaming effects and message alerts to more visual and audio feedback that is integrated into smart devices. This technology is also being used in retail to give the buyer a better customer experience by using, for example, smart wearables with haptics (INKWOOD Research, 2020).

The market of haptic technology will increase, according to research, through its application in industries such as the automotive, telecommunications, and IoT appliances, to improve product design and operating precision. The technology can also benefit sound, touch, and visual effects in devices which are contributing to its wide adoption in the electronics sector. On the other hand, the vibration feedback feature improves touchscreen accuracy. In gaming, the trend is to incorporate HT as well as AR. All in all, the capability of haptic to simulate the user's sense of touch by generating mechanical signals is one of the major factors that are boosting the market demand. (Hayward, 2020; Wadhwani & Saha, 2020).

In 2019, the tactile feedback segment dominated the global HT market with the largest market share (97.51%). This research also points out that it will be the fastest-growing feedback type with a CAGR of 14.48% during the forecast period. It has been used so far in smartphones and

tablets over the past five years. The increased demand for these gadgets translates into an increase in the market for haptic. The force-feedback haptic has been used in surgical and other simulation applications for more than a decade and has been growing at a constant rate. Its market is expected to grow after 2025 due to several new developments (INKWOOD Research, 2020).

Although this is a growing market, there is some resistance in adoption force-feedback HT, mainly because of its high cost, high power consumption and technical challenges related to product design. The major restraint identified by INKWOOD research is high-power consumption. Almost all haptics-enabled devices are battery-powered and when incorporating this technology in devices, engineers and designers are more concerned about the power consumption of HT in battery-critical applications (INKWOOD Research, 2020). One other factor slowing down the market growth is the high implementation cost of the technology. Integration of haptic in consumer electronics or gaming consoles increases the overall cost of these devices, which can harm its demand (Wadhwani & Saha, 2020).

METHODOLOGY

This chapter presents and explains the methodology used to answer this dissertation's research questions. Firstly, it will unveil the general research approach, followed by clarification of the sample selection, the process of data collection and lastly the process of data analysis.

Research approach

This research aims to analyse the opportunities that haptic technology could generate in online shopping. The research questions were addressed through a qualitative, exploratory approach. Qualitative research, focusing on non-statistical data, analyses the meanings attributed by participants and the relationships between them, using a variety of data collection techniques and analytical procedures (Flowerdew & Saunders, Mark; Lewis, Philip; Thornhill, 2008)

Within qualitative research, an exploratory approach is useful when no theory and no formulated hypotheses are available in advance (Stebbins, 2001). By doing exploratory research, it was possible to gain insights about the chosen area and clarify the knowledge about a problem. In order to conduct this exploratory research, and as suggested by Saunders (2013), a search of the literature; interviews to 'experts' in the subject; and in-depth individual interviews were performed.

As the dissertation aims to understand the potential that could come from the use of haptic tech for e-commerce purposes, an area where there is a lack of scientific research and clear hypotheses, the chosen qualitative, exploratory approach is appropriate.

This research followed a case study strategy, by exploring a research topic within its context and with the goal of the answer to the 'why?', 'what?' and 'how?' questions, being then the most used in exploratory research.

Sample Selection

The sample used in this research is non-probabilistic as its goal is to collect information from specific actors that are specialist in the haptic area and e-commerce. This study also has a heterogeneous sampling, since the researcher used his judgment to choose the participants that fit better into the investigation, aiming to answer the research questions.

Therefore, the research problem was examined from two different perspectives. Firstly, from the e-commerce side, in which the purpose was to gain insights about the current state of the online business, what are the main forecasts for the coming years, as well as to identify what are the main obstacles that consumers face when shopping online, and what strategies are used by companies to remove these obstacles. Secondly, to understand if the introduction of technology such as HT can help to improve the business. To find a relevant sample of e-commerce specialists, the following criteria were applied: the interviewees had to be part of leading digital businesses and this business's strategy had to reveal a certain degree of innovativeness to fit into this study sample.

Several individuals were selected, meeting the criteria mentioned above, but just two were interviewed due to the availability of respondents. In the end, the researcher interviewed a key account manager for e-commerce in one of the biggest FMCG in the world; and a digital consultant from a relevant European consultancy company, that is specialised the digital area and has clients such as Nike, Beiersdorf, Nestlé, Porsche, Volkswagen. The interviewees asked not to be identified for a matter of confidentiality. Hence, they were given fictitious names, Vanessa and Mariana, respectively.

The perspective of haptic technology experts was also evaluated. The goal was to get a clearer understanding of the technology usage at each stage and the requirements necessary for successful adaptation and implementation for e-commerce purpose. To select the sample, a LinkedIn and Google search was undertaken with the aim to identify experts in this field, preferably with a focus on the gadgets industry. Two experts accepted the invitation to participate in this research, namely the researcher Hugo Alexandre Ferreira, an expert in HT, that holds a bachelor in Medicine and Physics, as well as a PhD in Physics and work in the fields of neurosciences, neuromarketing and brain-computer interfaces, among others; and PhD professor Oliver Schneider, assistant professor at Waterloo University (Canada) of Human-Computer Interaction in the Department of Management Sciences. His research interests include human-computer interaction, haptics, and creativity-support systems. In his biography, in the universities website one can read that his "long-term goal is a suite of haptic computing tools to assist the creation, deployment, and study of haptic technology".

Data collection

Primary data

For this dissertation, semi-structured, in-depth interviews were conducted. These interviews were beneficial for qualitative research to explore a participant's thoughts and behaviours (Boyce & Neale, 2006). There were some constraints in terms of availability from the representants of all the actors from the e-commerce ecosystem. The pandemic crisis that occurred during the time frame of this research can be one of the reasons why there were not many accessions to this inquire given that the specialist in e-commerce in different industries was tackling the challenge of digitalising their companies, in a time when this meant the survival of many companies. Nevertheless, according to Patton (2002), cited by Saunders et al. (2013), although the sample is small, it has different perspectives which makes it relevant since if a pattern is detected it is likely to be representative.

The data collection method chosen was the semi-structured interview, bearing in mind the exploratory nature of this study (Flowerdew & Saunders, Mark; Lewis, Philip; Thornhill, 2008). Although there was a script, the interview was adapted according to the context and the previous answers. Through this data collection, it was possible to analyse the current status of haptic tech and e-commerce business.

This data, when confronted with the secondary data, gave a wide overlook of the e-commerce opportunity that could come from the use of haptic tech.

Due to the novelty of the topic, it was not possible to adapt any interview guidelines from previous research. It was designed by themes according to the issues that were intended to be discussed. The interview was divided into two big groups: e-commerce and haptic tech experts. With an average duration of one hour each, the interviews were made between July and August of the current year, by videoconference. The interviews were recorded for posterior transcription and all interviewees were informed of the recording and assured that the data given is protected by confidentiality if it was their wish.

Regarding the structure of the interview, an effort was made to follow guidelines in order to reflect the theme of the dissertation. In the case of e-commerce intervenient, the guideline was structured in 4 sections: a) status of e-commerce, b) factors that influence an online buyer c) how companies are fighting against these factors d) will be haptic an alternative. In the case of HT experts, the guideline was structured in 4 sections: a) definition of haptic technology b) the

current state of technology c) what are the different technologies currently available d) can haptic tech be adapted to improve the online experience?

Secondary data

Secondary data, as data already gathered by third parties about the topic (Flowerdew & Saunders, Mark; Lewis, Philip; Thornhill, 2008), was used to enrich and support findings previously obtained through interviews and to increase the reliability and accuracy of the analysis. In this study, secondary data includes journal and media articles, case studies, reports, and information obtained from websites providers of haptic tech.

Data analysis

The applied methodology is split into primary and secondary research for a complete understanding of the defined research questions (Valentine, 2005). In the first part of the analysis, secondary data in the form of academic literature was collected. Most of the sources consist of journal articles combined with reports from important institutions. The second part of the analysis is based on primary research, namely, expert interviews.

The interviews were first recorded and transcribed. After read in detail, the most relevant inputs were summarised and grouped in categories in order to find trends and shared ideas. The analysis was done manually, given the small number of interviews, and helped the researcher to compare, detect differences, patterns, themes, and trends (B.Miles & Huberman, 1994). Finally, the most relevant information taken from the interviews was confronted with the themes explored by the current dissertation.

RESULTS

Online shopping

During the period of 2000-2015, the value of e-commerce has increased significantly resulting in dramatic growth and acceptance worldwide. In 2015, this market reached the value of 25.3 trillion US dollars according to UNCTAD report (UNCTAD, 2015). The potential of the online market for the coming years is still massive, since the largest countries in population, China and India, still have an extremely low internet penetration. Tremendous growth is pointed out by the indicators, followed by the gradual increase in the populations of these countries with regard to internet access (Sergi et al., 2019). Regarding mature markets (Europe and USA), growth is expected to remain at a good level. Although e-commerce is already familiar to people, penetration rates in some countries are still very low (eshopworld, 2019).

The interview with a key account manager for e-commerce, Vanessa, points to a 5% penetration rate for the online business in Portugal. A low figure when compared to countries like the United States, England, and Germany, where the penetration rate is around 50%. She says that the forecasts for Portugal are super interesting, "it is expected that this market will continue to grow at very significant levels". Who will also contribute to this expected growth will be the arrival of generation Y and Z when it comes to online shopping. With the adulthood of these generations, it is expected for 2026 a contribution of 82% and 80% respectively of the total purchases made online (Sky Potential, 2020).

In addition to the reasons stated above, COVID-19 pandemic came to stir the waters even more. In her interview, Vanessa indicates that the closing of physical stores during the lock-down period allowed many Portuguese consumers to make their first online shop. And those who already did so frequently, intensify their online shopping even more and bought even more products and more product categories in the online space. The studies also help to understand how the market has behaved since the virus appeared. A study carried out in the United States indicate that 9 out of 10 consumers bought at least one product online that they usually bought offline before the crisis (NRF, 2020). In Italy, according to The Financial Times, the country doubled its online sales after one week of confinement (Pereira, 2020). From the market point of view, the Key Account manager for e-commerce says "I can almost say that we have advanced 2 or 3 years in relation to the projections that existed about e-commerce for the future. At the end of the first half of 2020, we believe we are living the reality expected for the years 2022/2023". Even with this abrupt growth, she says that this behaviour will not be reversed, "it

is to be maintained", as she believes that "many Portuguese have broken the barrier of their first purchase".

The interview with the digital consultant, Mariana, also helps to prove that the effect of the pandemic on the online business was brutal. "In the projects in which I am involved, I can tell you that brands that had already an online platform grew three times more. So those brands that were more prepared, focused in digital, were the winners of these last months", adding that "in the projects that were meant to be for offline purposes, the clients asked us to freeze them, as they are currently reconsidering the business model."

Factors influencing online consumer behaviour

Despite being the fastest growing business globally, it is still a big challenge for both brands and e-retailers. When asked about what are the main factors that determine buying online, both interviewees referred to the complexity of analysing a customer journey in an online purchase. Internet shopping behaviour overall is a very complex phenomenon that covers several features and is influenced by many factors, says Vanessa. She complements that "the process takes many turns, has many entry points and many exit points". Mariana, in order to exemplify the difficulty and diversity that is an online purchase, leaves an example of two products that she worked in. One had two touchpoints until the conversion was verified, and another had between six to eight touchpoints until the conversion occurred. In sum, they indicate the following factors that influence online shopping: price, retailer trust, payment method, delivery fee, quality and quantity of the product description, referrals, reviews and delivery time.

The literature review, in addition to the factors mentioned above - price, payment method, retailer confidence, delivery rate, delivery time, product comparison, referencing, quality of information about the product (Chiu et al., 2019; Clemons et al., 2016; Constantinides, 2004; Court et al., 2009; C. H. Park & Kim, 2003) - also consider lack of touch as a factor of enormous importance (Grewal et al., 2004; S. H. Lee et al., 2017; McCabe & Nowlis, 2003; Peck & Childers, 2006; Peck & Shu, 2009). It was important to note that several authors consider the lack of touch as one of the important factors when a consumer chooses whether to buy online or offline, but on the other side, both interviewees indicated that companies today adopt strategies such as quality of information, type of content, design of the platform so that consumers do not feel the need to really touch the product, and for that reason, touch doesn't easily come to their minds.

Touch as an important factor for e-commerce platforms

It was interesting to note that after analysing important studies regarding online shopping process, those present, among other factors, touch as one of the influencing factors. However, in the interviews, this was not the answer found. Vanessa replied "without a doubt, I would say that at this moment, in addition to the experience that a physical store can provide, the only difference between the two channels is the question of touch", clarifying that "when I say touch I mean experimenting and trying, and not physical touch". She adds that "transversally I believe that it is still a factor of valorisation, but I'm not sure if in the future it will be" and that " in the future this can change". Mariana's answer is also interesting because she shares that touch is not the essential point, and more the trying and checking the product's dimension "is it suitable for me? Am I wearing the correct size?".

When questioned specifically about touch as a differentiation factor, both interviewees state that it is imperative to analyse the subject according to the category of the product itself. The type of product defines the need for touch.

This last statement of the interviewee confirms the theory developed by Pecks and Childers in 2003. These authors created a scale for "measure preference for acquiring and using information obtained through the haptic sensory system". The authors separate the products between low-touch (ex: electronic devices, computer software) and high touch (ex: clothing). In the end, the category where the product falls reflects the preference for consumers whether to buy online or offline.

What is our interviewees' knowledge concerning haptic tech?

Both interviewees on the e-commerce side showed no knowledge about the studied technology. Mariana indicated that she had already heard somehow about the use of this technology in the sex toys industry, for long-distance devices, but she did not show knowledge in what the technology was or how it worked.

Haptic Technology and the different devices available in the market today

"I define haptic tech as anything that engages the sense of touch," Oliver said. He also says that "there is a lot of things that qualify as haptic tech, but the uniting factor is that all feel like something in the sense of touch, but they manifest in different ways. They could be wearable,

they could be into a mobile device, they could be in a VR, they could be purely visual but all comes together in HT." Hugo, in his interview, answers, "Haptic technology is about modelling / interacting with the organ of touch. A set of technologies that somehow interact, translate the touch into action or can modulate the sensation of touch." He adds that "it is a human-computer interaction". The studied literature completes these by saying that these technologies can be used to create virtual objects in a computer simulation, to control virtual objects, and to enhance the remote control of machines and devices (Bermejo & Hui, 2017; El Saddik et al., 2011).

The sense of touch can now be felt in different ways. Several branches of research are underway to obtain the best sense of touch. In general, the studied authors identify the following technologies: Desktop haptics; Surface haptics; Wearable haptics; Air film; Electrostatic; Mid-air; Electrostimulation

Current status of HT. Is this technology close to a product for the final consumer?
Analysing literature on HT is very difficult due to its recent life. A report by INKWOOD, 2020, indicates that the main driver of this market is the adoption of this technology in electronic devices (INKWOOD Research, 2020). In the interview with Oliver Shneider, specialist and researcher in the area of haptic technologies, he points out that this technology is still in a very embryonic phase when we think from the point of view of a possible product for the final consumer or even for a company. Oliver says in the interview that he believes we are experiencing a turning point in haptic technology. "The last 30 years of research in HT have brought us to a point where for the first time we have very interesting technology available that can be reproduced in the mass market". Oliver even says that "HT is already available in our homes on many devices without we realize", and gives examples such as vibrating buttons, touchscreens on mobile phones, touch screens and virtual buttons on high-end segment cars. He also points out that at this moment, many start-ups have appeared and started individual projects to make this technology scalable.

"Many of the haptic technologies were born from gaming, today the research is in the area of medical training, in the future it will reach the consumer in other ways, I have no doubt", says Hugo in his interview. "At the moment, it is not mainstream, it is not yet attractive either from the point of view of the final consumer or from the business point of view. This device costs around 5000 euros. To develop a technology like this today you need around 80-100 million euros, and all of this amount just to reach a product".

The reasons why this technology is not considered mainstream are raised by the articles studied and by the researchers interviewed. Studies report that key restraints are the extremely high costs of producing this technology, high energy consumption, the production circuit, design of the devices and, finally, the combination of these technologies makes the final electronic device very expensive (INKWOOD Research, 2020; Wadhwani & Saha, 2020). Interviewees point for similar reasons. Oliver indicates three major reasons. "The first is full-stack. For this technology we must think about hardware, software, design, psychology and the individual, all of that collides to make a certain sense of touch, and if you change one part of the stack, it influences the others. So, in the end, to develop this technology, we must have a team with engineers, software developers, designers and they must be familiar with all fields and the field of sense of touch". The second big challenge pointed by him was the variety of different devices. "You may know how to design surface haptic for touch screens, but you may not know how to design mid-air sensations or force feedback". Finally, he identifies the third challenge, as probably the most important nowadays. There is very limited information about this technology. Developers of this technology are not sharing knowledge and that decreases the speed of development.

Is there any business opportunity for haptic tech in OS?

For this question we have two points of view—the point of view from the online side and the point of view from haptic experts' side.

On the e-commerce side, the digital consult Mariana says that inside the product categories that require more touch, e-retailers are already working on strategies to get around the problem, strategies that are less expensive and easier to apply. For products that require experimentation and testing, Mariana believes that they will continue to have their space in a physical store. She says that she does not believe that this technology will solve the issue but adds that the previous answer is based on the fact that she has very little knowledge about Haptic technologies. She also concludes that the example of the "Try free" strategy, already used by some brands, removes all space for the introduction of this new technology itself. Mariana concludes by saying "I honestly think we are moving more towards Augmented Reality". She believes that the introduction of haptic tech at this time is not a priority for e-retailers. "The tools that currently exist still have a very high progression margin" and she considers, for example, artificial intelligence as "sexier" to invest. She considers that "the problem with consumers when buying online is the result, not the texture of the product."

In the interview with Vanessa, the challenge was similar. The key account manager for e-commerce answers in four very different points.

1-Reports that the current gadgets, such as virtual try-on and augmented reality, have very low penetration rates, very low conversion rates. This data frightens e-retailers about investment in new technologies.

2-She believes that e-retailers still have many challenges to explore - omnichannel perspective, virtual try-on, etc. She also believes that major players may come to think about these new technologies, not for reasons of conversion but for reasons of differentiation.

3-Lack of knowledge about the technology does not help to answer the question. However, she believes that the introduction of these sensory technologies will never be transversal to all types of products and gives an example of why. (1) Perishables and the real importance of touch; (2) shoes – would touch help with questions like the size, if it hurts when walking, if the sole is hard; (3) furniture – would touch help the consumer to figure out how well it if in a room, if it fits well with the rest of the furniture and rugs. The key account manager believes not.

4-Finally she points out that the fast transformation of the business in recent months and in recent years does not help to define what will be a trend or a business opportunity. E-retailers believe that online shopping is becoming internalized in the consumer mind and it will quickly become a daily habit. But they are not sure about the right path in terms of technologies adaption.

The experts' side is not as consistent as occurred in the interviews. Professor Oliver says "this tech just passes embryonic, is at the point where hardware is reliable for engineers to put into a device, but it's still isolated for specific senses" adding that "we only get one or two types of stimulation". He says, "it's incredible anyway", but there is still many years ahead for researchers to come up with a scalable consumer product. He also mentions that the priority must be the evaluation of cost but there is very little information about it. The technology that is available today has a high value for specific tasks, like medicine, rehabilitation, gaming, and there the investments is evident. For e-commerce is hard to say, because the technology today only gives texture, or a sense of touch with a wearable or the filling of grabbing. Altogether, it is not possible to give a realistic experience with the technology available today. He finishes

the answer pointing three fields where he sees this tech being used in the short term: personal wearables, medical training and surgeries and automotive industry.

On the other side, Professor Hugo shows more enthusiasm around the future of this tech for e-commerce purpose. When asked about if companies could invest in this technology for their online platforms, he answers, "I would say yes, I believe that they can introduce these technologies as a factor of differentiation, as a factor of innovation. I think they only need to understand if their sales would increase after adopting these technologies". He says "the price of the technology is proportional to the absorption of the market. At the moment, this absorption does not yet exist, but I believe that in the future things will be reversed. I believe with the recent advances in this technology and what will be the major advances in the coming years, companies will already be able to look at it in a different way."

Regarding the question what are the haptic technologies more suitable for e-commerce purposes, Professor Hugo says "I would say that it will be the technology that I call the sixth sense, through neuro-modelling, by activating circuits that are related to the sense organs. "The brain has already created reality, now we just need to help it to create the sensation of touch". He points out that electrostimulation is the most interesting prospect, or the closest to reach the consumer. He says that the existing technology is not far from what would be needed to create a gadget with the capacity to "trick" the brain.

CONCLUSION

This paper provides, to the best of my knowledge, the review of the emerging opportunity for haptic technology in online shopping. The review highlights the potential benefit for this technology within the e-commerce market and outlines the challenges which currently exist for widespread adoption.

People nowadays are becoming dependent on online shopping sites due to the convenience of shopping while sitting at home, which saves both time and money. The online environment lacks sensory cues, in particular, the sense of touch. The lack of touch might pose a challenge to online shoppers as compared to in-store shopping. Thus, the present study was conducted to find if the adoption of haptic tech for e-commerce purposes could diminish this lack of touch and for this reason, turn into a big business opportunity for online shopping platforms.

Main findings

The literature recognizes the touch as an extremely important factor for the consumer, however in the interviews this factor is not valued. Both interviewees, from the e-commerce side, believe that touch can indeed be a factor to take into account, however companies have already adopted strategies to reverse it. Factors such as, price, payment method, retailer trust, delivery fee, referrals, reviews, delivery time, above others, are considered as the most important for a successful online shopping experience.

Haptic technology does produce incredible sensations and creates enthusiasm, but is still in a very embryonic state, and this is verified by the difficulty in finding literature and in the interviews with researchers. The technology is not yet ready to be applied or reproduced in a final product for the consumer. At this moment only manages to emit isolated and not a full complete sensation. It also features a variety of devices that do not yet work together. Finally, the industry of haptics implies a large investment in both research and product development.

The technology will be introduced in the short term in fields such as medicine, education, and gaming, and will continue to be present in our smartphones and probably in other devices even though we don't know. The path to online platforms is not certain. Most respondents are reticent. On the e-commerce side, this technology is not seen as the solution for the problem, and on the scientific side, haptic technology is still a long way from reaching a product and for these reasons is difficult to predict where it will be applied.

Limitations and further research

Due to the time and budget constraints of a master dissertation and COVID-19 situation, this research has to be seen in the light of some limitations: (1) It is important to note that, in spite of the diverse of the interview participants, the sample size is not big enough to ensure the completeness of the outcomes presented, and may not be considered as very representative; (2) Although a great deal of existing literature was covered regarding Haptic Technology, this technology is in a very embryonic state and due to this fact, the data collected has limited the nature of its conclusion; (3) COVID-19 situation certainly made it impossible for more people to have accepted the invitation for the interview. One of the selection criteria for the sample was work in e-commerce platforms or directedly involved in online business. During this period, I believe these individuals faced great challenges, and for this reason, due to the lack of time, they did not show interest in the interview. A survey should be considered for further research to obtain greater participation.

In summary, the underlying study makes a unique contribution to the academic literature by examining the previously unexplored opportunity of HT to improve the customer experience in online shopping and offers some indications for future research. HT is going to play an important role in the gaming industry, medical training, rehabilitation, education and several other industries within the next years, but for e-commerce purposes, not in the short time. There is a long way in e-commerce business to arrive in the use of this tech. There are a few other challenges in online shopping to fulfil before this big step. Further studies will show if the insights generated in the underlying study are part of a long-term trend, or if HT will be able to provide sustainable advantages to e-commerce in a short time.

REFERENCE LIST

Anis, B. Y., Elliott, B., & Koestler, C. (2018). *Black Friday 2018 : Consumers are eager, more digital, and willing to spend*. Retrieved from https://www.mckinsey.com/business-functions/marketing-and-sales/our-insights/black-friday-2018-consumers-are-eager-more-digital-and-willing

B.Miles, M., & Huberman, A. M. (1994). *Qualitative Data Analysis* (Second). SAGE Publications.

Baymard Institute. (2020). Cart Abandonment Rate Statistics. Retrieved May 16, 2020, from https://baymard.com/lists/cart-abandonment-rate

Bermejo, C., & Hui, P. (2017). *A survey on haptic technologies for mobile augmented reality*. Hong Kong University of Science and technology. Retrieved from http://arxiv.org/abs/1709.00698

Bettman, J. R., Luce, M. F., & Payne, J. W. (1998). Constructive Consumer Choice Processes. *Journal of Consumer Research*, *25*(3), 187–217. https://doi.org/10.1086/209535

Bloom Partners. (2020). *The New Normal of Food Habits*.

Boyce, C., & Neale, P. (2006). Conducting in-depth interviews: A Guide for designing and conducting in-depth interviews for evaluation input. *Pathfinder Internationall*, *Monitoring*(May), 1–16.

Chen, M., Tilley, M. S. E. C. S., Jones, M. P. N., & Rapp, J. (2019). *the Future*. *Wunderman Thompson Intelligence*.

Chiu, Y. P., Lo, S. K., Hsieh, A. Y., & Hwang, Y. (2019). Exploring why people spend more time shopping online than in offline stores. *Computers in Human Behavior*, *95*(September 2018), 24–30. https://doi.org/10.1016/j.chb.2019.01.029

Cho, C. H., Kang, J., & Cheon, H. J. (2006). Online shopping hesitation. *Cyberpsychology and Behavior*, *9*(3), 261–274. https://doi.org/10.1089/cpb.2006.9.261

Chongyang, S., Weizhi, N., & Xiaoying, S. (2019). Tactile sensitivity in ultrasonic haptics: Do different parts of hand and different rendering methods have an impact on perceptual threshold? *Virtual Reality & Intelligent Hardware*, *1*(3), 265.

https://doi.org/10.3724/sp.j.2096-5796.2019.0009

Clement, J. (2019). Retail e-commerce sales worldwide from 2014 to 2023. Retrieved March 26, 2020, from https://www.statista.com/topics/871/online-shopping/

Clemons, E. K., Wilson, J., Matt, C., Hess, T., Ren, F., Jin, F., & Koh, N. S. (2016). Global Differences in Online Shopping Behavior: Understanding Factors Leading to Trust. *Journal of Management Information Systems*, *33*(4), 1117–1148. https://doi.org/10.1080/07421222.2016.1267531

Columbus, L. (2020). How COVID-19 Is Transforming E-Commerce. Retrieved June 10, 2020, from https://www.forbes.com/sites/louiscolumbus/2020/04/28/how-covid-19-is-transforming-e-commerce/#134cd8af3544

Constantinides, E. (2004). Influencing the online consumer's behavior: The Web experience. *Internet Research*, *14*(2), 111–126. https://doi.org/10.1108/10662240410530835

Court, D., Elzinga, D., Mulder, S., & Vetvik, O. J. (2009). *The consumer decision journey*. *McKinsey & Company*.

Dangxiao, W., Yuan, G., Shiyi, L., Yuru, Z., Weiliang, X., & Jing, X. (2019). Haptic display for virtual reality: progress and challenges. *Virtual Reality & Intelligent Hardware*, *1*(2), 136. https://doi.org/10.3724/sp.j.2096-5796.2019.0008

Darley, W. K., Blankson, C., & Luethge, D. J. (2010). Toward an Integrated Framework for Online Consumer Behavior and Decision Making Process: A Review. *Psychology & Marketing*, *27*(2), 94–116. https://doi.org/DOI: 10.1002/mar.20322

Derow, R. (2020). Why Retail Needs a Digital Strategy — Fast. Retrieved June 2, 2020, from https://medium.com/bcg-digital-ventures/why-retail-needs-a-digital-strategy-fast-b2b03086c35f

Dolliver, M. (2020). US Millennials 2020. So, How's that Adulting Thing Going—in Digital Usage, Shopping, Finances and Homeownership? Retrieved March 25, 2020, from https://www.emarketer.com/content/us-millennials-2020

El Saddik, A., Orozco, M., Eid, M., & Cha, J. (2011). Haptics Technologies: Bringing Touch to Multimedia. *Haptics Technologies*, 1–21. https://doi.org/10.1007/978-3-642-22658-8

eMarketer. (2014). *Retailers Look to Merge Offline and Online Shopping Experiences in*

2014. Retrieved from http://www.emarketer.com/Article/Retailers-Look-Merge-Offline-Online-Shopping-Experiences-2014/1010812

eMarketer. (2020). *The New Realities of Retail in the UK*.

eshopworld. (2019). *GLOBAL ECOMMERCE MARKET RANKING 2019*.

Flavián, C., Gurrea, R., & Orús, C. (2017). The influence of online product presentation videos on persuasion and purchase channel preference: The role of imagery fluency and need for touch. *Telematics and Informatics*. https://doi.org/10.1016/j.tele.2017.07.002

Flowerdew, R., & Saunders, Mark; Lewis, Philip; Thornhill, A. (2008). *Research methods for business students*. *International Journal of the History of Sport* (Vol. 30). https://doi.org/10.1080/09523367.2012.743996

Frier, W., Pittera, D., Ablart, D., Obrist, M., & Subramanian, S. (2019). Sampling strategy for ultrasonic mid-air haptics. *Conference on Human Factors in Computing Systems - Proceedings*, 1–11. https://doi.org/10.1145/3290605.3300351

Grewal, D., Iyer, G. R., & Levy, M. (2004). Internet retailing: Enablers, limiters and market consequences. *Journal of Business Research*, *57*(7), 703–713. https://doi.org/10.1016/S0148-2963(02)00348-X

Hayward, J. (2020). *Haptics 2018-2028 : Technologies , Markets and Players*.

Howland, B. D. (2020). The future of retail: What 2020 and beyond will bring to the industry. A discussion with retail futurist Doug Stephens as a new decade dawns. Retrieved March 25, 2020, from https://www.retaildive.com/news/the-future-of-retail-what-2020-and-beyond-will-bring-to-the-industry/569615/

INKWOOD Research. (2020). *GLOBAL HAPTIC TECHNOLOGY MARKET FORECAST 2020-2028*. Retrieved from www.inkwoodresearch.com

Joachim Zentes, Dirk Morschett, H. S.-K. (2017). *Strategic Retail Management: Text and International Cases* (3rd Editio). Springer Gabler.

Karimi, S. (2013). *A purchase decision-making process model of online consumers and its influential factor a cross sector analysis*. Manchester Business School.

Kim, M., & Lennon, S. (2008). The Effects of Visual and Verbal Information on Attitudes and Purchase Intentions in Internet Shopping. *Psychology & Marketing*, *25*(2), 461–

146–178. https://doi.org/DOI: 10.1002/mar.20204

Kurita, K., Fujii, Y., & Shimada, K. (2011). A new technique for touch sensing based on measurement of current generated by electrostatic induction. *Sensors and Actuators, A: Physical*, *170*(1–2), 66–71. https://doi.org/10.1016/j.sna.2011.06.005

Lee, E. J., & Park, J. (2014). Enhancing virtual presence in e-tail: Dynamics of cue multiplicity. *International Journal of Electronic Commerce*, *18*(4), 117–146. https://doi.org/10.2753/JEC1086-4415180405

Lee, S. H., Workman, J. E., & Jung, K. (2017). The influence of need for touch and gender on Internet shopping attitudes among Korean consumers. *International Journal of Fashion Design, Technology and Education*, *10*(2), 230–239. https://doi.org/10.1080/17543266.2016.1250287

Liang, T.-P., & Lai, H.-J. (2000). Electronic Store Design and Consumer Choice: An Empirical Study. In *System Sciences Proceedings of 33rd International Conference in Hawaii.*

Lindberg, O. (2020). 10 Ecommerce Trends That Will Set Your Client's Brand Apart in 2020. Retrieved May 20, 2020, from https://www.shopify.com/partners/blog/ecommerce-trends

Mallinckrodt, E., Hughes, A. L., & William Sleator, J. (1953). Perception by the Skin of Electrically Induced Vibrations. *Science*. https://doi.org/DOI:10.1126/science.118.3062.277

Mary Meeker. (2019). *Internet Trends 2019*. *BOND*. Retrieved from https://www.bondcap.com/report/itr19/#view/1

McCabe, D. B., & Nowlis, S. M. (2003). The Effect of Examining Actual Products or Product Descriptions on Consumer Preference. *Journal of Consumer Psychology*, *13*(4), 431–439. https://doi.org/10.1207/S15327663JCP1304_10

Meyer, S. (2020). Evolving Ecommercer. 14 Trends driving online retail in 2020. Retrieved May 20, 2020, from https://www.bigcommerce.com/blog/ecommerce-trends/#14-ecommerce-trends-leading-the-way

Mohsin, M. (2020). 10 Online Shopping Statistics You Need to Know in 2020. Retrieved May 20, 2020, from https://www.oberlo.com/blog/online-shopping-statistics

Moshrefjavadi, M. H., Rezaie Dolatabadi, H., Nourbakhsh, M., Poursaeedi, A., & Asadollahi, A. (2012). An Analysis of Factors Affecting on Online Shopping Behavior of Consumers. *International Journal of Marketing Studies*, *4*(5). https://doi.org/10.5539/ijms.v4n5p81

NRF. (2020). COVID-19 upends how we shop.pdf. Retrieved June 10, 2020, from https://nrf.com/blog/covid-19-upends-how-we-shop

Overmars, S., & Poels, K. (2015). Online product experiences: The effect of simulating stroking gestures on product understanding and the critical role of user control. *Computers in Human Behavior*, *51*(PA), 272–284. https://doi.org/10.1016/j.chb.2015.04.033

Ovum. (2016). The Future of E- -commerce: The Road to 2026, 22. Retrieved from http://www.criteo.com/media/4094/ovum-the-future-of-e-commerce-the-road-to-2026.pdf

Pandey, A. (2020). How Future of Ecommerce Retail is being Shaped by Millennial Shoppers. Retrieved June 10, 2020, from https://cedcommerce.com/blog/how-millennials-are-shaping-ecommerce-retail/

Park, C. H., & Kim, Y. G. (2003). Identifying key factors affecting consumer purchase behavior in an online shopping context. *International Journal of Retail & Distribution Management*, *31*(1), 16–29. https://doi.org/10.1108/09590550310457818

Park, J. K., Chung, H. E., & Yoo, W. S. (2009). Is the Internet a primary source for consumer information search?: Group comparison for channel choices. *Journal of Retailing and Consumer Services*, *16*(2), 92–99. https://doi.org/10.1016/j.jretconser.2008.11.002

Peck, J., & Childers, T. L. (2003a). Individual Differences in Haptic Information Processing: The "Need for Touch" Scale. *Journal of Consumer Research*, *30*(3), 430–442. https://doi.org/10.1086/378619

Peck, J., & Childers, T. L. (2003b). To have and to hold: The influence of haptic information on product judgments. *Journal of Marketing*, *67*(2), 35–48. https://doi.org/10.1509/jmkg.67.2.35.18612

Peck, J., & Childers, T. L. (2006). If I touch it I have to have it: Individual and environmental influences on impulse purchasing. *Journal of Business Research*, *59*(6), 765–769.

https://doi.org/10.1016/j.jbusres.2006.01.014

Peck, J., & Shu, S. B. (2009). The Effect of Mere Touch on Perceived Ownership. *Journal of Consumer Research*, *36*(3), 434–447. https://doi.org/10.1086/598614

Peck, J., & Wiggins, J. (2006). It just feels good: Customers' affective response to touch and its influence on persuasion. *Journal of Marketing*, *70*(4), 56–69. https://doi.org/10.1509/jmkg.70.4.56

Pereira, P. (2020). O impacto Covid-19: a segunda vida do e-commerce em Portugal? *Observador*. Retrieved from https://observador.pt/opiniao/o-impacto-covid-19-a-segunda-vida-do-e-commerce-em-portugal/

Popomaronis, T. (2016). These 12 Astonishing Shopping Facts Perfectly Sum Up E-Commerce For 2016. Retrieved June 1, 2020, from https://www.forbes.com/sites/tompopomaronis/2016/12/19/these-12-astonishing-shopping-facts-perfectly-sum-up-e-commerce-for-2016/#4a0642e38bee

Rathee, R., & Rajain, P. (2019). Online shopping environments and consumer's Need for Touch. *Journal of Advances in Management Research*, *16*(5), 814–826. https://doi.org/10.1108/JAMR-12-2018-0116

Sergi, B. S., Esposito, M., & Goyal, S. (2019). Literature review of emerging trends and future directions of e-commerce in global business landscape. *World Review of Entrepreneurship, Management and Sustainable Development*, *15*(1/2), 226. https://doi.org/10.1504/wremsd.2019.10019882

Serrano, S. (2020). Complete List of Cart Abandonment Statistics : Average Cart Abandonment Rate 2020 Update. Retrieved May 18, 2020, from https://www.barilliance.com/cart-abandonment-rate-statistics/

Shobeiri, S., Mazaheri, E., & Laroche, M. (2015). Shopping online for goods vs. services: Where do experiential features help more? *International Journal of Consumer Studies*, *39*(2), 172–179. https://doi.org/10.1111/ijcs.12165

Singh, T., Malik, S., & Sarkar, D. (2016). E-commerce website quality assessment based on usability. In *Proceeding - IEEE International Conference on Computing, Communication and Automation, ICCCA 2016* (pp. 101–105). https://doi.org/10.1109/CCAA.2016.7813698

Skrovan, S. (2017). Why most shoppers still choose brick-and-mortar stores over e-commerce.

Sky Potential. (2020). Generation Y Vs Gen Z Understanding Today's e-Commerce Consumers. Retrieved from https://www.skypotential.co.uk/generation-y-vs-gen-z-understanding-todays-e-commerce-consumers/

Sohrabi, B., Mahmoudian, P., & Raeesi, I. (2012). A framework for improving e-commerce websites usability using a hybrid genetic algorithm and neural network system. *Neural Computing and Applications*, *21*(5), 1017–1029. https://doi.org/10.1007/s00521-011-0674-7

Soriano, V. (2006). Converting browsers into spenders: mall shoppers spend more time and money. *ICSC Research Review*.

Sreelakshmi, M., & Subash, T. D. (2017). Haptic Technology: A comprehensive review on its applications and future prospects. *Materials Today: Proceedings*, *4*(2), 4182–4187. https://doi.org/10.1016/j.matpr.2017.02.120

Statista. (2020a). Conversion rate of online shoppers in the United States as of 2nd quarter 2019, by device. Retrieved May 17, 2020, from https://www.statista.com/statistics/234884/us-online-shopper-conversion-rate-by-device/

Statista. (2020b). *Coronavirus impact on retail e-commerce website traffic worldwide as of March 2020*. Retrieved from https://www.statista.com/statistics/1112595/covid-19-impact-retail-e-commerce-site-traffic-global/

Stebbins, R. A. (2001). *Exploratory Research in the social sciences*. SAGE Publications.

Tarafdar, M., & Zhang, J. (2007). Determinants of reach and loyalty - A study of website performance and implications for website design. *Journal of Computer Information Systems*, *48*(2), 16–24. https://doi.org/10.1080/08874417.2008.11646005

UNCTAD. (2015). *Information Economy Report 2015 : Unlocking the Potential of E-commerce for developing Countries*.

UNCTAD. (2017). *Information Economy Report 2017 : Digitalization, Trade and Development*. *Information Economy Report 2017*. https://doi.org/10.18356/3321e706-en

UNCTAD. (2019). The UNCTAD B2C E-commerce Index 2019. Retrieved from

https://unctad.org/en/PublicationsLibrary/tn_unctad_ict4d12_en.pdf

Valentine, G. (2005). Tell me about . . . : using interviews as a research methodology. In *Methods in Human Geography* (second, pp. 110–126). Routledge. https://doi.org/10.4324/9781315837277

Verhoef, P. C., Neslin, S. A., & Vroomen, B. (2007). Multichannel customer management: Understanding the research-shopper phenomenon. *International Journal of Research in Marketing*, *24*(2), 129–148. https://doi.org/10.1016/j.ijresmar.2006.11.002

Wadhwani, P., & Saha, P. (2020). *Haptic Technology Market Size & Share | Global Report 2026 - Industry Coverage*. https://doi.org/GMI2711

Yu, X., Xie, Z., Yu, Y., Lee, J., Vazquez-Guardado, A., Luan, H., … Rogers, J. A. (2019). Skin-integrated wireless haptic interfaces for virtual and augmented reality. *Nature*, *575*(7783), 473–479. https://doi.org/10.1038/s41586-019-1687-0

APPENDICES

Appendix 1: Interview Frameworks

<u>E-commerce</u>

- How is online business performing currently and what is the forecast for the next years?
- What was the impact of corona virus?
- Did you feel some changes in the consumer decision process?
- Briefly, can you guide me through a regular consumer purchasing process in an online shop? what are the different steps?
- What factors could influence the most the final decision of consumers?
- What are the steps that make most consumers decide not to buy online?
- Why you think some consumers are still not buying online?
- Why are conversion rates still so low?
- What are the biggest challenges for e-commerce platforms?
- Is the lack of touch one of them?
- How could this process (purchasing process) be improved?
- Have you heard about Haptic Technology?
- Do you think you could use this kind of technology to improve the experience of online shopping?
- What do you perceive as an opportunity for this technology?
- Why are e-commerce platforms not using this tech already?
- Which could be the biggest barriers for consumers to use this tech?
- Would your company be willing to invest in this type of technology?
- Are you preparing something around this topic?
- What is important to consider for a successful HT implementation?
- What requirements need to be fulfilled to seize the full opportunity?
- What could be the business impact after starting using this technology?
- Would a partnership between ecommerce platforms and smartphone producers be possible?

Haptic Expert

- Can you shortly describe what is haptic technology and what are the types of haptic tech currently available on the market and for what purposes?

- How widespread are haptic tech innovations in the scientific and business world so far?

- What is the cost of developing this kind tech? one device? What is the dimension of it?

- Is it possible to include inside a smartphone/personal computer/tablet?

- What have been the main obstacles you were confronted with this kind of tech so far?

- Which possibilities do you see with haptic tech at the moment (areas of action) and what excites you most In the next 5 to 10 years?

- According to you, which are the main factors that made haptic tech successful nowadays? (which areas, medicine, training etc)

- How do you see the use of this kind of technology in e-commerce?

- Do you think that haptic tech could be used in electronic devices for e-commerce purpose?

- How do you think it will be used? (inside a smartphone, tablet or one extra gadget?)

- What needs to be done in order for this happen?

- How do you feel this tech is perceived by big companies like e-commerce platforms?

- How does haptic tech could cover the lack of touch in online shopping experience? To what extend would this tech be able to diminish the lack of touch when we are buying online?

- What is important to consider for a successful HT implementation?

- What requirements need to be fulfilled to seize the full opportunity?

Appendix 2: Interview 1 – Mariana

Qual a performance atual do e-commerce?

Os números são difíceis de partilhar, mas posso partilhar contigo uma ideia que tem a generalidade tenho tido dos meus clients, que apos covid, as plataformas digitais que estavam mais bem preparadas, triplicaram as vendas. Isto aqui na Alemanha. Todos os nossos projetos mais offline oriented foram colocados em hold. Portanto há qui uma tendência para repensar o negócio e voltar para outro lado.

E o futuro?

Eu diria que os projetos online são cada vez mais, mesmo neste pai sonde a penetração de negócio online é tremendo, ainda vai crescer mais. Todos os stackeholders envolvidos no negócio online estão neste momento a funcionar muito bem. E depois tens o fator comodidade, a preguiça de comprar algo sentado. Os tempos de resposta são essenciais. Os rate e reviews assumem uma posição de relevância extraordinária. A descrição do produto, as imagens, são exemplos que dou que vão explicar o future do negócio. Ou melhor o future é hoje.

Quais são os fatores mais importantes para levar um consumidor a comprar online?

As consumer journeys em digital são super diversas de produto para produto, categoria para categoria. Já estive perante produtos com consumer journeys de dois out três passos e journeys que nem consegues contra, 6 a 8. Mas de uma forma geral tens muitos touch points até comprar. Mas para responder à tua pergunta os fatores que mais trabalhamos consideramos como importantes são: Referrals, reviews, website info, brand trust, payment system, shipment cost, tempos de entrega. Mas deixa me só dar uma nota. Nos projetos que tenho trabalho sinto que a componente offline não está ainda totalmente afastada. Nem que seja por relação O2O, ou primeiro contacto com a marca online e depois comprar online. Vamos ver vamos ver.

Conversion Rates Online vs Offline

Eu diria que no online tu consegues medir todos os touch points e estes são repetidos centenas de vezes. Portanto estatisticamente não comparava com o offline dessa forma.

É o toque um fator importante para um consumidor preferir offline ao invés de online?

Depende da indústria, depende muito do tipo de produto. Categorias de produtos funcionam supre bem com as estratégias já existentes. Outros produtos acredito que necessitem do offline, não pelo toque, mas pelo tamanho, pela dimensão. Deixo exemplo de comprar uns óculos, comprar um sofá etc.

Outro exemplo: o caso de compra de sapatos. Não é o toque que influencia, mas sim o tamanho, é o facto de ser suitable, cai bem no meu pé?, calço bem?, magoa me? Não tanto a textura do tecido ou o toque da sola.

O que se pode melhorar na experiência atual de um consumidor quando compra online?

Existe ainda muitos touch points a ser melhorados, muitas ferramentas, muitas estratégias a serem melhoradas. Nós agora estamos a desenvolver novas estratégias que acho que vem ao encontro daquilo que falamos. Try free, o que isto te permite é o seguinte: podes pedir vários modelos, tamanhos, tipos de tecido, etc., podes pedir tudo para a tua casa. Experimentas em casa e no caso de nao quereres alguma coisa devolves. Esta estratégia está a começar a ser muito usada na Alemanha e tem resultado super bem. Esta estratégia permite eliminar o gap de falta de toque. Outra estratégia usada é Augmented reality. Honestamente acho que o caminho vai ser este. Visualizas o que queres em ti, na tua casa, etc.

Por fim acho que a melhoria da informação disponibilizada será também ainda muito trabalhada pelas plataformas online.

Já ouviu falar em tecnologia sensorial, Haptic tech?

Não tenho muito conhecimento sobre essa tecnologia. Penso ter ouvido falar, penso que foi a indústria dos objetos sexuais de forma a proporcionar prazer à distância.

Acha que o uso desta tecnologia poderia melhorar a experiência online?

Penso não ser prioridade. Penso não ser essencial no decision process. Acho a inteligência artificial mais hot topic, mais explorável, mais sexy. Virtual try on também penso ter potencial. O toque por si só parece me pouco sexy para uma empresa investir.

É importante salientar que a minha resposta é devido ao meu muito pouco conhecimento sobre a tecnologia em si. Penso que existe muito pouca informação ainda.

Mas ao dizeres que a tecnologia ira resolver a questão da falta de toque, penso que o problema de uma compra online não é o toque, mas sim o resultado final.

Appendix 3: Interview 2 – Vanessa

Qual o status do e-commerce? Quais as previsões?

Pré-covid, a situação continuava a ser de uma penetração muito baixa em Portugal, na ordem dos 5%. Com covid, as lojas físicas fecharam, apenas as lojas de bens essências permaneceram aberta. Isto levou a que os Portugueses que ja compravam online, começaram a comprar mais, e tivemos uma realidade muito interessante, tivemos pessoas a experimentar e comprar pela primeira vez. Portanto do ponto de vista do mercado, quase que podemos dizer que avançámos 2 anos em relação as projeções que existiam sobre o e-commerce para o future, ao fim do primeiro semestre de 2020, estamos numa realidade que acreditávamos estar em 2022/23. Muitos diziam que seria o fim da loja física, mas o que se tem verificado, é o contrário. Não se verifica a totalidade, mas de facto houve um recomeço. Nós acreditamos e prevemos que o hábito de comprar online se vá manter nos portugueses. Nós acreditamos ainda assim, mesmo com o salto de 2/3 anos, que a procura pela compra online vá continuar a crescer. Prevemos que ao fecho de 20/21 estaremos numa ordem de realidade que inicialmente prevíamos ter em 2025/2026.

Mesmo após este boom o crescimento vai permanecer, para muito consumidores foi quebrada a barreira da primeira compra online. Estes consumes vão permanecer para a eternidade. O comodismo experimentado deste tipo de compra vai ajudar muito a que os consumidores voltem a repetir. O facilitismo de obter os bens e a forma comoda é algo que vai moldar os hábitos do future. Muitos vezes comparamos Portugal a Alemanha, Inglaterra, mas é importante ter em atenção que temos landscapes de retalho bastante distintos, em Portugal as vendas dependem muito dos centros comerciais, o nosso comercio é um bocado em torno disto, e isso não e uma realidade que se verifiquei nestes países europeus. A nossa população também é mais envelhecida que a restante media europeia, muito mais difícil de fazer a penetração online e muitas vezes nos como players locais identificamos ate que existem bastantes portugueses, acima do percentual que mencionei à pouco, que não compram no mercado local , casos de ali-express, ebay, de uma forma mais lata, mas verificamos o efeito conhecido como cross-border, que são sites europeus, de varias categorias de produto que também transacionam para Portugal e que acabam por não contabilizar nesta penetração local.

Decision process, como descrevia os principais fatores que influenciam a compra online?

Não é uma linha linear, em primeiro lugar, um dos grandes desafios do digital são as consumer journey são completamente estapafúrdios e dão muitas voltas, tem muitos processos, muitos pontos de entrada e muitos pontos de saída. Tipicamente temos vários fatores que podem levar ao consumidor a entrar em contacto com determinado website, quer seja a nível de advertising que seja a nível orgânico, que possa ver em determinado influencer e que me faça ir ao website. E depois quando entram no website, o consumidor pode assumir dois tipos de missão. A sua consumer journey já dentro do site pode variar consoante isso. Em primeiro lugar posso ter a necessidade direta de comprar um produto que acabou o stock em casa, a ferramenta utilizada neste caso é pesquisa, search torna se relevante para dar os resultados que o consumidor procura, e este aqui tem a necessidade por comparação de preços, portanto o preço torna se relevante, pois no fundo já conhece o produto, compra repetida. Aqui nesta etapa será importante o tempo de entrega, e a rapidez de envio. Em Segundo lugar temos outro tipo de compra, que até pode ser o mesmo consumidor, mas em momentos diferentes. Este agora procura roupa nova para ir a uma festa, ou quer ver as novidades de maquilhagem, procura um creme para usar dia a dia. Em todas estes cenários existem várias possibilidades de escolha. Neste momento o consumidor assume uma posição de pesquisa diferente. Utiliza menos navegação no site, procura mais sites e compara todos os produtos visto. Nesta fase e muito importante a descrição dos produtos, o tipo de conteúdo (vídeo, foto), preço, velocidade de entrega. O consumidor reúne muita informação nesta fase. Importante notar novamente que estas etapas dependem muito do tipo de produto. A determinada altura ele compra, ocorre a conversão, e chegamos ao fim do funil de conversão.

Quais são os fatores que mais influencia a conversão?

Depende muito da categoria de produto, do tipo de produto. Vai depender se é um produto conhecido para o consumidor ou não, vai depender da frequência com que compra online, da confiança que tem com o site. Mas diria de uma forma tens: preço, confiança no retailer, métodos de pagamento, taxa de entrega, e também o nível de detalhe que consegues obter sobre o produto que pretende adquirir.

Loja física Vs Loja online?

Depende mais uma vez do tipo de produto. Por exemplo no caso da empresa onde trabalho atualmente, cosmética. Na loja física eu tenho aconselhamento, caso contrário na internet a informação tem de ser obtida através de muito pesquisa.

Quando falamos de produtos perecíveis, tem a questão do gosto individual, exemplo banana madura ou verde. Portanto gostas de tocar e ver o produto real para respeitar a tua preferência.

Do ponto de vista geral, transversal a todas as categorias, que é a questão que colocas, o português ainda considera o toque algo essencial, é um fator determinante o contacto com o produto. Mas não sei se por muito tempo.

Quando procuras uma peça de roupa, quero perceber como é realmente o produto, é algo que ainda se valoriza muito.

Preferência por loja física/online. será o toque um fator essencial?

Sem dúvida. Diria que neste momento para alem da experiência que a loja física pode proporcionar, o toque é algo que distingue estes dois canais. Mas mais uma vez depende do tipo de produto.

Porque as conversion rates das lojas online são tao baixos quando o comparado com uma loja física?

Em primeiro lugar, o que temos de ter em conta para estes %, é que nos hoje em dia estamos em contacto com os nossos touch points digitais a toda a hora, e eu estou aqui a responder as tuas questão, e se for preciso estou a entrar num site, estou a ver algo, algo ate que me podem ter sugerido por WhatsApp. Entretanto estamos a falar de determinado produto eu vou ao site, ou seja, eu consigo a qualquer hora a qualquer momento, estar em contacto com as plataformas digitais /e-commerce o que não acontece num centro comercial. Porta tanto a % na plataforma esta sempre c contra as entradas. A predisposição à compra num Centro comercial é também muito maior. Tu descolaste por algum motive a um espaço desses. Também não nos devemos esquecer, que os websites, plataformas digitais não devem ser somente consideradas plataformas de conversão. São ferramentas de awareness, são montras digitais. Por exemplo, podes ir a um centro comercial comprar um ténis. No caminho vais fazendo pesquisa para filtrar os produtos que vais experimentar. Importante falar também do fenómeno O2O. Pesquisar online, comprar offline. A omnicanalidade é uma trend neste momento.

Falamos muito de toque, mas seria esta tecnologia a resolução de todos os problemas? Será essa uma prioridade para o consumidor?

Difícil de responder, volto ao exemplo dos perecíveis, os e-retailers cada vez mais adaptam as suas plataformas de forma que o consumidor não sinta a necessidade de toque. A nível de maquilhagem já existem os virtual try-on. Portanto os consumidores têm a oportunidade de experimentar o produto sem tocar. São enumeras as estratégias que os e-retailers estão a desenvolver de forma a eliminar este gap da falta de toque.

Quais são os grandes desafios que as plataformas online enfrentam para os próximos anos. É o toque um deles? Ou a falta dele

Em primeiro lugar toda esta transformação que existiu no negócio online nos últimos meses, deixa muitas dúvidas do que será o e-commerce daqui a 2 anos, 1 ano até. Nós acreditamos que seja um hábito que venha para ficar. Para mim o maior challenge é o desafio da omnicanalidade. Como melhora a relação entre a loja física e online, como poderemos fazer com que o consumidor considere este canal um só. Se eu acho que a falta de toque vai ser um fator? Sim e não. Na verdade, esse desafio faz com que os winners do e-commerce do future tenham ferramentas que eliminassem esse gap. Obvio que nunca vai ser a mesma coisa, mas as alternativas já começaram a surgir, e acredito que nos próximos anos ainda se desenvolvam mais ferramentas. Nunca vai ser transversal a todos os produtos e todos os clientes. Será muito importante as empresas continuarem a investir em novas ferramentas para melhorar a experiência e para eliminar a distância que existe ao produto.

Qual o caminho mais próximo neste momento, HT ou AR?

Pelo que sei, e o que já começou a ser implementado será AR. Maquilhagem, skincare, decoração já usam estas ferramentas que ajudar o processo de conversão. Em relação ao toque não te consigo responder pois nunca ouvi falar em tecnologias sensoriais.

Algumas vez ouviu falar de tecnologia Háptica?

Não, nunca ouvi falar nesse tipo de tecnologia.

Via uma oportunidade na utilização desta tecnologia nas plataformas online?

Difícil de responder, não sei do que é capaz a tecnologia. Mas sim, mas não será ainda muito distante? Imagino como complementaridade. Pois só o toque não me parece suficiente.

Porque será que os grandes players do retail online ainda não pensaram nesta tecnologia?

Primeiro, principalmente em Portugal, existem ainda muitos outros desafios e mais básicos que ainda não foram respondidos.

Acredito que os grandes player possam vir a introduzir techs como esta, mas para diferenciação, mas a verdade é que ainda me parece muito distante, ainda é muito prematuro.

Acha que esta ferramenta podia ter impacto no negócio?

Difícil de responder. As ferramentas atuais têm taxas de aceitação baixíssimas, taxas de conversão baixíssimas. Ainda estamos a aprender a usar estas ferramentas para benefício da conversão. As próprias empresas não estão mega focadas nestes gadgets e os consumidores estão muito pouco informados.

Appendix 4: Interview 3 – Oliver Shneider

At this moment, the technology is being used in surgery, rehab projects, and vibration elements in mobile phones. But we are in a very interesting phase, because in the last 30 years of haptic tech research has reached the point we are now and we have very interesting technologies that can be reproduced in mass-market (?) and we are starting to see this tech showing in different fields. Since 5 to 10 years ago the technology started being applied in the automotive industry, o BMW idrive has rotation buttons that have reverse feedback and recently luxury cars have many tactile features in their touch screens to simulate real buttons. These are buttons that recreate touch, combining the touch sensation and sound, making the feeling even more convincing. The more senses you add, the more convincing is the experience.

At this moment, diverse startups are exploring different technologies. One of them in Chicago, they are developing a technology called "surface haptic". Their idea is to have a touch screen that also emits sensations. So, when you move your finger in the surface, you feel different textures and resistance. This is a very relevant step because for the first time we have "touch

feedback" something that was missing in screens. What can be very interesting from an e-commerce point of view, because you can, for example, feel the texture of a fabric.

Can you describe briefly what is the haptic tech and what kind of tech is available today?

I describe haptic tech as anything that engages the sense of touch, so this could be force feedback, a joystick that pushes back at you, or vibrotactile, libre vibrations that you have in your phone or wearables (i.e. bracelets, vest where you can fill sensations across your body) it could be surface haptic, where a touch screen provides texture feedback. There's also mid-air haptic, where you can use ultrasonic arrays to produce sensations on your hand.

To sum up, haptic tech is anything that has to be with the sense of touch, could even be suitable haptics where if you have VR set and you are moving an object, it will seem heavier because it moved slowly. You can do this kind of illusion to create sensations of touch without actually stimulating the skin.

There are a lot of things that qualify as haptic tech, the uniting factor is that all feel like something in the sense of touch but they manifest in different ways, they could be wearables, mobile devices, in VR, they can be purely visual but come together in haptic tech. Which is a very difficult field because you might focus in one type of haptic sensation or try to combine them or focus on the psychology so as you can see it is a really challenging field to work because of all of these variety and not only this but of each different field, you have to work with the hardware, the software, the psychology, the design of it, in a broader context and all of these influence each other.

What are the open problems of HT?

I can give three big ones. The first one is that full-stack… so you have the hardware, software, design, psychology, the individual… all of that collides to make a certain sense of touch. If you change one part of that stack it influences the other stacks, so you must have a team with engineers, psychologists, software engineers, designers and they all must be familiar with all fields and the field of sense of touch because it requires that in the end everyone understands all of that. This is costly and slow. Another big challenge is that, there is such a variety in all of the different devices, so if I know how to design for surface haptics, for the touch screen, I may not know how to design the mid-air sensation or force-feedback. It isn't easy to find for

different people to share things back and forth because they all have different complements. Finally, there is a challenge that people don't know what haptics are. That barrier is because it is difficult to find. It is challenging to design something with this whole team and at the same time look for engineers perspective. But we are at the point where this is starting to make some progress. There is a group called haptic industry forum which is developing standards for haptics so it will make it easier to share software around particular devices. This will create protocols to deliver different sensations in different devices. I think it will take a while until we have it in a smartphone but I'm positive industries are starting.

Why do you feel it will take so much time?

This tech just passed embryonic. We are at the point where there is hardware that is reliable for you to put in a device, but it is still isolated from specific senses, you only get one or two types of stimulation, which is very good, but to polish, it takes a lot of effort. The cost-benefit is very hard to explain. There is evidence that proofs user experience, but that evidence is recent and it's still hard to rely and understand what the ROI is.

Do you think that this technology could be used to improve the user experience?

Absolutely! It is going to be very valuable. There are certain utility aspects with a sense of touch like you can do surgery without the sense of touch, and you can think of things like accessibility concerns. You may not have access to other senses, or you want to augment an extra sense. There are a lot of opportunities for you to get the additional utility. That is very clear for me, very useful. So, I think those areas are valuable and important but even everyday applications, like movies with haptic feedback, are good examples. There are already a few technologies in the market like touch screens in smartphones, wearables, like watches, and most of them are super pleasant and that will be important for people to know and start missing it.

What kind of tech will be used for e-commerce purpose?

It depends on the stage of e-commerce. It will be very hard in a short period of time—surface haptic, which is focusing on texture; wearables for feedback touch.

In which kind of fields do you feel this tech will be used?

I would say in wearables in personal electronics, and medical training. So, if you have a particular task that has a very high value, like in medicine, companies could invest in a good device. And then you can have these general devices that can gives you that extra experience, general sense of touch, but in between , is where is hard, where you want some generality but you still want have a very real experience.

The automotive industry will be the other big one.

The research of this tech is extremely costly

Just for curiosity, what is the cost of a current gadget like the one you are showing?

This mid-air device, around 1000-5000 US Dollars.

What you think is important to consider for the implementation of this tech in the future?

The thing that is really missing is that a lot of haptic researchers are very sill out, partially because some people focus on the device, some on the software, some in the interaction and some in the psychology. The hard part is put this all together.

The standards gone be critical, and that is happening and that is a great indicator.

Very important will be also the study of the cost-benefit. There is almost nothing available. Im preparing a team to starting doing this, start ij the end of this year. We expect to have this prepared to present in two years. This project may persuade people to invest

Appendix 5: Interview 4 – Hugo Fernandes

Muitas das tecnologias hápticas nasceram do gaming, hoje a investigação esta na área do marketing medico, operações à distância com force-feedback. A resistência é partilhada para ambos os lados, feedback loop.

No início da história não havia sensores, este era o problema, não havia feedback loop. Todo o feedback é criado peço homem sobre a forma de fórmulas matemáticas complexas.

Este tipo de tecnologia não ajuda muito para o tema da tua pesquisa, embora os princípios sejam transacionados. Imagina um ecrã com um determinado e este ecrã responder com a textura do tecido.

Como define Haptic Tech?
Tecnologia háptica diz respeito a uma modelação/interação com o órgão do tato. Conjunto de tecnologias que de alguma forma interagem, traduzem o tato numa ação ou podem modular a sensação do tato.

Human- computer interaction?
É uma interceção pessoa-máquina sim- Também se chama human machine interface.
O core é o órgão do tato. É uma interação in two ways. Utilizas o tato como um meio para fazer qualquer coisa a acontecer ou modulas a tua perceção de tato. Exemplo: o que é mais usado nos dias de hoje: display do telemóvel.

Existem diversas formas de responder a esta interação: (1) Óticas - utilizava se no passado, através do uso de emissores e recetores de luz. Portanto interrompias os feixos de luz. (2) Resistivas, através da alteração da resistência de corrente (3) Capacitivas (mais comum), na prática é semelhante à resistiva, mas em vez de ter algo que altera a resistência ao longo do tempo, tens uma superfície condutora, depois ao tocar com o dedo, alteras as propriedades elétricas desta interação.

No futuro existe a possibilidade de a máquina enviar info sobre a forma de toque?
Sim, sem dúvida, já o fazemos.

Ultra sound, Mid-air Haptic techs. Acha ser esta a tecnologia mais próxima para fins de comercio online?
Não. É outro caminho.
São tecnologias diferentes. Ainda esta num estado muito embriónico, muito inicial, precisa de economia de escala para diminuir a dimensão destes gadgets por exemplos, são ainda muito grandes.

Os emissores emitem ondas na onda dos megahertz, tu não consegues ouvir nada. So é possível a distâncias curtas. Só consegues impressionar a curtas distâncias. As ondas são acima dos 20 quilo hertz. Acima é ultra sound. Abaixo são infra sounds. Por exemplo os elefantes comunicam nas savanas a longas distâncias através dos infra sounds. Os golfinhos utilizam os ultra sounds no mar.

Esta tecnologia tem uns emissores, e utiliza um fenómeno, interferência, que na prática é chamado batimento. Crias no ar pontos de pressão maior e menor. É muito semelhante a tocar guitarra. Quando vibras as cordas. Esta tecnologia delimita a onda. Eles conseguem pegar em dois sons e interferi-los de modo a criar uma delimitação, criando a sensação de toque.

Estas tecnologias são muito caras para o consumidor final?

Sim, não é ainda muito main stream. Para chegar a um produto final, o R&D esta na ordem dos milhões. Dou te um exemplo, para desenvolver uma tecnologia custam cerca de 85Milhoes para desenvolver. O preço é proporcional à capacidade de absorção do mercado.

Faz sentido no futuro as empresas de smartphones (por exemplo), se juntarem a empresas ou grupos de research para aprofundar/melhoras estas tecnologia?

Sim, claro. Nas empresas tem duas formas de obter inovação. Ou tem departamentos (interno) ou via aquisição de conhecimento, via parcerias.

Que mais tecnologias trabalha?

Wearables, muito barata, e que pode entrar no mercado mais B2C, mais escalável. Uma luva em que incluis motores de vibração, hoje existentes nos telemóveis. Pode juntar a uns óculos de visão virtual e juntar toque. Com a luva tens a noção de espaço, podendo sentir objetos. Estas luvas mimetizam a sensação de toque. Agora esta tecnologia depende muito do grau de resolução. Precisa de ser mais fidedigno.

Imagina esta tecnologia em coletes para gaminig. Já existe.

Das tecnologias faladas, qual tem mais potencial para lojas online?

Chamado a esta tecnologia, sexto sentido. Utilizamos estimulação elétrica, neuro modelação. Ativar os circuitos que estão relacionados com o processamento dos órgãos dos sentidos. Hoje

em dia já conseguimos criar não só perceber que imaginas que a pessoa está a ver, como poderes estimular visualmente ou auditivamente do cérebro de alguém, e dito isto, também se sabe onde estão as áreas de tato. Se eu estimular os campos magnéticos, os campos elétricos, ou hoje também, com esta tecnologia, com ultrasound, eu consigo fazer com que estres neurónios disparem e me deem a perceção de toque. Hoje fazemos já de uma forma não invasiva. Imagina o córtex cerebral com elétrodos minúsculos que vão estimular determinados pontos e recriar o toque. O cérebro já cria a realidade. Agora das uma ajudinha.

Eu diria que esta é a perspetiva mais interessante, mais próxima de chegar ao consumidor, porque faz recurso de eletrónica, não precisa de fazer nada. Do ponto de vista técnico, já temos ao dispor toda a tecnologia para avançar.

No fundo com esta tecnologia nos enganamos os órgãos dos sentidos.

Quais são as limitações que levam a que esta tecnologia não ser ainda usada?

As limitações atuais são o consumo de energia. Todas estas tecnologias precisam de muita energia. Outra limitação é a falta de appeal do lado do mercado. Coloco o gaming, o entretenimento são categorias de produto que pedem esta tecnologia atualmente.

Acha possível estas tecnologias nos próximos 5-10 anos diminuírem a falta de toque numa compra online?

Acho! Eletro-vibração reversa será a tecnologia mais interessante. Surface accoustic também é superinteressante. Agora as tecnologias com maior possibilidade de ser usadas tem de ser passivas de serem micro fabricadas, integradas diretamente nos smartphones, ou extra gadget.

Quais são os requisitos para esta tecnologia avançar?

Reprodução para o consumidor final. Pensar como será feita a interação, se de forma mecânica se de forma elétrica. A solução tem de ter a capacidade de criar ambos os tipos de estímulo, se não será realística o suficiente. Por fim capacidade de integração.

Penso que o início do uso desta tecnologia será sobre a forma B2B. Desta forma consegues começar a testar o consumidor, verificar a sua disposição a pagar pelo produto. Depois sim avançar para B2C.

Acha que os grandes player do e-commerce vão pensar nestas tecnologias no futuro?

Sem dúvida. Fator de inovação, fator de diferenciação. Se perceberem que lhes aumenta a faturação então aí, penso que iram colocar facilmente no mercado.

Como fazia a bridge para o consumidor? Quem pagaria pelo extra gadget?

Imagino isto a introduzido num perfil premium de um grande player. Portanto este player oferece ao consumidor a oportunidade de ter este extra gadget que lhe da sensação de toque, que melhora a sua experiência de compra online, isto tudo incluído numa subscrição mensal. Desta forma o custo do device esta sobre o lado do player.