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The Impact of Augmented Reality in Cosmetic Brands: The influence of Virtual Try-on tools on the decision-making process of Portuguese women

Maria Carta Gaudich

Master in Marketing

Supervisor:
PhD Ana Maria Vitorino Ferreira Comporta, Invited Associate Professor,
Department of Marketing, Operations and General Management,
ISCTE Business School

MSc. Nuno Alexandre dos Reis Teixeira, Invited Assistant Professor,
Department of Marketing, Operations and General Management,
ISCTE Business School

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Abstract

With the growing prevalence of digital technologies in marketing, understanding how Augmented Reality (AR) shapes consumer behaviour is crucial. This thesis investigates the impact of AR technologies, specifically Virtual Try-on (VTO) tools, on the online decision-making process of Portuguese women in the cosmetics industry. The research addresses a key question: how does VTO tools influence consumers' purchasing intention?

Data collection was carried out in three phases. To incorporate the participants' exposure to the stimulus (VTO system) into the research, data was collected via two structured online questionnaires (quantitative method), before and after the VTO experience (experimental data collection). Responses were analysed through descriptive and inferential statistics to explore the proposed relationships in the conceptual model presented.

The results show that Product Informativeness, System Quality, and Reality Congruence positively impacted the Perceived Usefulness of a VTO system for makeup. Surprisingly, Reality Congruence did not significantly affect the Perceived Entertainment Value of a VTO system for makeup, but the Interactivity feature did. Perceived Ease of Use of a VTO system influences both the Perceived Usefulness and the Perceived Entertainment Value of a VTO system for makeup. These last two were found to be good predictors of consumer Attitudes toward VTO adoption. On the contrary, Perceived Ease of Use of a VTO system was not. Interestingly, Privacy Concerns did not have a negative impact on consumers' Attitudes towards using a VTO system for makeup. The results therefore show that consumers' positive attitudes towards a VTO system for makeup have a positive impact on their Intention to Use this tool to make online purchases of makeup products.

Keywords: augmented reality, virtual try-on, online decision-making process, intention to use, purchase intention

JEL Classification System: M30 General (M300 Marketing and Advertising: General); M31 Marketing (M310 Marketing)

Resumo

Com a crescente prevalência das tecnologias digitais no marketing, é crucial compreender como a Realidade Aumentada (RA) molda o comportamento do consumidor. Esta tese investiga o impacto das tecnologias de RA, especificamente as ferramentas de Experimentação Virtual (VTO), no processo de tomada de decisão online das mulheres portuguesas na indústria dos cosméticos. A investigação aborda uma questão-chave: como é que as ferramentas de VTO influenciam a intenção de compra dos consumidores?

A recolha de dados foi desenvolvida em três fases. Para incorporar a exposição dos participantes ao estímulo (sistema de VTO) na investigação, os dados foram recolhidos online através de dois questionários estruturados (método quantitativo), antes e depois da experiência de VTO (recolha de dados experimental). As respostas foram analisadas através de estatística descritiva e inferencial para explorar as relações propostas no modelo concetual apresentado.

Os resultados mostram que a Informação sobre os Produtos, a Qualidade do Sistema e a Congruência com a Realidade tiveram um impacto positivo na Utilidade Percebida de um sistema VTO de maquilhagem. Surpreendentemente, a Congruência com a Realidade não afetou significativamente o Valor de Entretenimento Percebido de um sistema de VTO de maquilhagem, mas a Interatividade, sim. A Facilidade de Utilização Percebida influencia tanto a Utilidade Percebida como o Valor de Entretenimento Percebido de um sistema VTO de maquilhagem. Estes dois últimos aspetos mostraram ser bons indicadores das Atitudes dos consumidores relativamente à adoção de um sistema de VTO. Pelo contrário, a Facilidade de Utilização Percebida de um sistema de VTO não o foi. Curiosamente, as preocupações com a Privacidade não tiveram um impacto negativo nas Atitudes dos consumidores relativamente à utilização de um sistema de VTO de maquilhagem. Por conseguinte, os resultados mostram que as Atitudes positivas dos consumidores em relação a um sistema de VTO de maquilhagem têm um impacto positivo na sua Intenção de Utilizar esta ferramenta para efetuar compras online de produtos de maquilhagem.

Palavras-chave: realidade aumentada, experimentação virtual, processo de decisão online, intenção de utilização, intenção de compra

Sistema de Classificação JEL: M30 General (M300 Marketing and Advertising: General); M31 Marketing (M310 Marketing)

Index

Index of Figures

Index of Tables

Introduction

Context and Relevance

Emerging technologies are reshaping the customer experience (CX) in various industries (Hoyer *et al.*, 2020). These technologies enable companies to create new value propositions through virtual-physical touchpoints, offering customers more control over their experiences and influencing their perceptions (Flavián *et al.*, 2019). Among emerging technologies, Augmented Reality (AR) and Virtual Reality (VR) are seen as especially promising, providing customers with convenient and relevant information that enrich their omnichannel experiences throughout online and offline channels (Hoyer *et al.*, 2020; Zarantonello & Schmitt, 2023). AR, in particular, offers a vast array of new marketing opportunities, transforming how brands engage with consumers (Rauschnabel, 2021).

The cosmetic industry is a dynamic and rapidly growing sector, driven by evolving consumer preferences and the increasing prominence of online retail. Globally, the industry has witnessed substantial growth, with online sales revenues projected to rise significantly in the upcoming years (Jeong, 2023). Online platforms have become a significant part of cosmetic sales, with mobile purchases accounting for a substantial portion of 2022 revenue (Statista, 2024). In Portugal, the beauty industry reflects global trends, with a clear shift towards a holistic focus on well-being. This change aligns with broader European patterns, where many consumers consider cosmetics and personal care essential in their daily routines. For women, this emphasis is particularly strong, as these products play a significant role in their everyday lives. Among younger consumers, makeup is increasingly viewed as a way to enhance confidence (Cosmetic Europe – The Personal Care Association, 2022).

As online retail continues to gain ground, AR has emerged as a powerful instrument for cosmetic brands, especially Virtual Try-on (VTO) systems, which have emerged as one of the most promising tools within AR technology (Pantano *et al.*, 2017). The VTO technology has the potential to revolutionize the online decision-making process by reducing uncertainty, enhancing consumer confidence, and increasing satisfaction with online purchases by providing the ability to overcome the fundamental constraint of online channels – enabling customers to digitally try-on clothing and accessories in real-time before making an online purchase (Barta *et al.*, 2023). In the context of the cosmetic industry, VTO allows consumers to visualize how products will look on their skin before purchasing. Given the growing adoption of digital platforms and the importance of

cosmetics in the lives of Portuguese women, understanding the impact of a VTO tool on their purchasing behaviour is highly relevant.

Research Aim

Therefore, the present thesis aims to investigate the impact of AR on cosmetic brands, specifically the influence of VTO tools on Portuguese women's online decision-making process. In the context of this dissertation, a relevant scientific investigation was carried out to deepen knowledge about the use of AR in the field of Marketing, focusing on the specific topic of cosmetics and providing valuable information about this dynamic industry.

As someone who has grown up immersed in the digital era and is now witnessing the impact of these cutting-edge technologies, I am particularly interested in exploring how Augmented Reality is shaping the purchasing behaviour of makeup consumers in Portugal. The ability to virtually try-on products before buying offers a unique interactive experience. Understanding its influence on decision-making could reveal key insights into the evolving relationship between technology and consumer habits in the beauty industry. Thus, this dissertation aims to answer the research problem of "if and how AR technologies, such as Virtual Try-on tools influence the online decision-making process of cosmetic brand consumers in Portugal." To this end, it is aimed to answer the following research question: **RQ1 -** How does a VTO tool experience impact consumers' shopping and purchasing intention?

Dissertation Structure

The current thesis is divided into five main sections. Chapter 1 provides an overview of the cosmetic industry in Portugal and the concepts related to the new technologies impacting the customer experience, namely AR and VR technology with a special focus on Virtual Try-on tools. Furthermore, definitions of some concepts are presented, such as Online Customer Experience, and major theories such as the S-O-R Paradigm and the Technology Acceptance model. In Chapter 2 the research hypotheses are discriminated. This chapter illustrates and explains the conceptual model of this research, its variables and the reasons behind its choice. Chapter 3 addresses the research methodology, where the method used to collect and analyse the data is described. Chapter 4 presents the significant research results and discusses their meaning and implications. Finally, the conclusions and implications of this research and its contribution to academia and management are shown in the last section.

1. Literature Review

This literature review aims to contextualise the current research problem by examining the cosmetic industry in Portugal. It covers the Online Customer Experience, highlighting key technologies, particularly Augmented Reality and defines theoretical concepts related to the decision-making process to enhance understanding of how these concepts can contribute to the ongoing study.

1.1 The Cosmetic Industry in Portugal

1.1.1 Cosmetics Definition

The European Parliament and the Council of the European Union define a Cosmetic Product as *"any substance or mixture intended to be placed in contact with the external parts of the human body (…) or with the teeth and the mucous membranes of the oral cavity with a view exclusively or mainly to cleaning them, perfuming them, changing their appearance, protecting them, keeping them in good condition or correcting body odours"* (article 2, n.º 1, a) of EC Regulation on cosmetic products). Cosmetics includes a wide range of products across several categories, including personal hygiene products such as soaps, shower gels, shampoos, deodorants, toothpaste, and beauty products such as hair colours, varnishes, and makeup (Infarmed, n.d.). This last item is the focus of this research.

1.1.2 Overview of the Market

According to *Statista*, the cosmetics segment is part of the beauty and personal care market, and it includes ornamental cosmetics for the face, lips, eyes, and nails, including face and eye makeup, nail polishes, mascara, lipsticks, and natural cosmetics. Products that are meant to be applied to the skin for cleansing and care, such as skin care products, and facial cleansing products are not included in the segment of cosmetics (Statista, 2024), as well as professional products and services (Jeong, 2023). The cosmetic industry is a large and fast-growing industry: in the year 2022, despite cosmetics sales declining by 15.2% compared to the previous year, the cosmetics category accounted for 17% of overall beauty and personal care sales worldwide, reaching approximately €86.63[1] billion (Jeong, 2023). The cosmetics market, in Portugal, in the year 2024, is predicted to generate €173.90m in sales, with a 2.67% annual growth rate (CAGR 2024-2028) (Statista, 2024).

[1] Conversion value from dollars to euros on 06/11/2023

Regarding in-store and online purchase channels, in Portugal, in 2022, in-store purchases still dominate the market and comprise a substantial 84% share of total cosmetic product sales, but it is losing its importance since it is expected to decrease to 76.6% by 2027. In contrast, the online channel constituted a smaller 16% of total sales in 2022. However, due to the booming of online cosmetics retail, the online sales revenue has constantly increased and is projected to reach 23.4% by 2027. In particular, the mobile revenue constituted 41.8% of the total sales in 2022 (Statista, 2024).

1.1.3 Cosmetics Consumers

In Portugal, there is a notable shift among cosmetics consumers towards a holistic approach to well-being, in line with what has happened in Europe where 72% of Europeans, particularly those aged between 25 and 54, consider cosmetics and personal care products important in their daily lives. For female consumers, the importance is even higher, with 80% incorporating cosmetics into their daily routines. The trend towards overall well-being is reshaping the beauty industry, and 27% of consumers up to the age of 25 use makeup to boost their confidence (Cosmetic Europe - The Personal Care Association, 2022).

1.2 Online Customer Experience

1.2.1 Definition

Lemon & Verhoef (2016) define customer experience as the consumer's journey with a company throughout time, from pre-transaction (including search) to transaction to post-transaction. Based on this definition, for this research, CX is defined as the *"consumer's subjective, dynamic, multidimensional reaction, comprised of cognitive, emotional, behavioural, sensorial, and social responses, to interactions with a firm's offerings and marketing actions across the phases of the customer journey"* (Wedel *et al.*, 2020, p. 5). The personal component of the CX is well-established, but less emphasis has been dedicated to examining this idea in an online setting (Rose *et al.*, 2011).

Regarding the Online Customer Experience (OCE) numerous authors have different ways of defining it and the first authors to do so (Christodoulides *et al.*, 2006; Novak *et al.*, 1998; Nysveen & Pedersen, 2004) left out the emotional elements of the customer experience, which are important aspects to be considered when defining the OCE, focusing more on the technological skills of users' experiences when interacting with the online environment (Rose *et al.*, 2011).

Considering these aspects, Bleier *et al.* (2019) associated the subjective characteristics of the CX with the technological component and created a new concept based on four dimensions (informativeness, entertainment, social presence, and sensory appeal) to define OCE resulting in *"a customer's subjective, multidimensional psychological response to a product's presentation online"* (Bleier *et al.*, 2019, p. 1).

1.2.2 The New Technologies Impacting the OCE

Numerous emerging technologies have the potential to impact and reshape services, particularly regarding the experience that consumers will encounter when interacting with those who provide services (Hoyer *et al.*, 2020; Wedel *et al.*, 2020; Zarantonello & Schmitt, 2023).

In the marketing field, many authors have been exploring how to improve the CX and its importance for companies. There is no doubt that the CX has been significantly transformed by new and emerging technologies such as Augmented Reality, Virtual Reality, Mixed Reality, the Internet of Things and Artificial Intelligence technologies such as chatbots and virtual assistants (Hoyer *et al.*, 2020).

The incorporation of technology into the CX is of major importance for companies given that they can provide customers with new value propositions to create desirable customer experiences using virtual-physical touchpoints (Flavián *et al.*, 2019). Hoyer *et al.* (2020) argue that these technologies have the potential to launch an entirely new concept of CX since they will influence how customers view the world, engage with people, and perceive items in their surroundings. As a result, customers gain the right to have their say over their own experiences, resulting in increased value assessments. Hence, various sectors have the potential to enhance their consumers' experiences by implementing these cutting-edge technologies (Flavián *et al.*, 2019).

The sensory, emotional, behavioural, and cognitive experiences collectively shape the core shopping experience for the customer (Flavián *et al.*, 2019). Customer Journeys are described not only as a way to take the customer's perspective but also as a means of gaining insight into their experiences. Throughout the stages of the customer's decision-making process, individuals encounter various touchpoints provided by companies, that significantly influence their CX across the three stages of pre-purchase, purchase, and post-purchase (Følstad & Kvale, 2018; Romano *et al.*, 2021).

From the point of view of the consumer's experiences when interacting with a service or product, AR and VR are the most promising future technologies influencing consumer

services (Zarantonello & Schmitt, 2023). These technologies are anticipated to be able to provide customers with relevant new information easily and conveniently before, during, and after purchase. They are also expected to transform the evaluation of products, product usage ideas, and the full CX, especially in terms of providing superior omnichannel experiences for consumers across various online and offline touchpoints (Hoyer *et al.*, 2020).

1.2.2.1 Augmented Reality

To acquire a deeper understanding of the concept of AR a distinction between the different realities that are shaping a new world in which physical and virtual items are merged at various levels must be established (Flavián *et al.*, 2019).

Most of the authors draw upon the framework proposed by Milgram & Kishino (1994), the *"Reality-Virtuality Continuum"* to distinguish the different types of realities (Flavián *et al.*, 2019; Rauschnabel *et al.*, 2022; Wedel *et al.*, 2020). This taxonomy presents the realities in a spectrum that ranges from the Real environment (pure physical reality) to the Virtual environment (pure virtual reality) and identifies the realities that lie between as Mixed Reality (MR). In this view, Augmented Reality and Augmented Virtuality (AV) are described as being part of the MR environment (Flavián *et al.*, 2019). In this spectrum, AR *"refers to all cases in which the display of an otherwise real environment is augmented by means of virtual (computer graphic) objects"* (Milgram & Kishino, 1994, p. 3).

This framework is a valuable tool for understanding and categorizing different technologies and experiences, including various forms of AR, MR and VR and helps to contextualize how users engage with both the physical and virtual realms. However, some authors point out inconsistencies in the terminology used to describe the realities in this taxonomy (Flavián *et al.*, 2019; Rauschnabel *et al.*, 2022).

Flavián *et al.* (2019) point out that MR cannot be the vast section of the spectrum that includes AR and AV. It should be viewed as a distinct dimension that exists between these two realities and it is distinguished by the comprehensive integration of virtual holograms with the actual environment. Therefore, the mentioned authors propose an adjustment to the original taxonomy where they add a new reality they called *"Pure Mixed Reality"* (PMR). Hence, in this new framework, AR is referred to whenever *"virtuality overlaps reality"* (Flavián *et al.*, 2019, p. 3), PMR occurs when *"virtuality and reality are merged"* (Flavián *et al.*, 2019, p. 3) and AV occurs when "*Reality overlaps virtuality"* (Flavián *et al.*, 2019, p. 3).

A more prominent distinction between AR and VR is needed and according to Rauschnabel *et al.* (2022) that distinction is on whether, at least visually, the physical world is part of the users' experience, as it is in AR, or not, as in VR. Accordingly, VR is described as a computer-generated simulation of an environment that includes the user, who sees it through one or more of the senses (primarily vision, hearing, and touch), and where the user can navigate and interact with it in a realistic manner providing him with an immersive sensory experience (Flavián *et al.*, 2019; Wedel *et al.*, 2020). Unlike VR, AR users are not cut apart from their surroundings as they continue to view their real settings while the technology augments it through virtual information enhancing the user's experience (Plotkina & Saurel, 2019; Rauschnabel, 2021; Rauschnabel *et al.*, 2019).

In this view, for this research, Augmented Reality can be defined succinctly as *"an innovative media format that integrates virtual information into a user's perception of the real-world"* (Rauschnabel *et al.*, 2019, p. 1).

1.2.2.1.1 AR Characteristics

Various studies use different terms to refer to the same characteristics of AR. Kowalczuk *et al.* (2021) have grouped these features and classified them into five categories.

The first category, *"Interaction with virtual products"* (Kowalczuk *et al.*, 2021, p. 5), encompasses constructs related to the user's ability to engage with virtual products (control, simulated physical control, and interactivity); the second, *"Processing quality"* (Kowalczuk *et al.*, 2021, p. 5), includes constructs that evaluate the accuracy, reliability, and speed of AR in delivering requested services (responsiveness, response time, and service and system quality); the third, *"Information about virtual products"* (Kowalczuk *et al.*, 2021, p. 5), comprises constructs related to the quality and quantity of information provided by AR about virtual products (information quality, quality of information, and informativeness); the fourth, "*Quality of virtual product presentation"* (Kowalczuk *et al.*, 2021, p. 5), encompasses constructs that assess the graphical visualization quality and environmental integration of virtual products or objects (spatial presence, environmental embedding, vividness, aesthetics, aesthetics quality, augmentation quality, and augmentation); the fifth and last category, "*Handling of personal information"* (Kowalczuk *et al.*, 2021, p. 5), includes constructs addressing users' perceptions of data and security concerns when utilizing AR (information privacy control, control of access to personal information, and intrusiveness).

1.2.2.2 VTO Technology

As seen, AR is an interactive technology that has evolved as a very relevant marketing technique and delivers unique solutions that allow consumers to interact digitally with products and examine their details (Plotkina & Saurel, 2019; Romano *et al.*, 2021; van Esch *et al.*, 2019). It allows the merging of virtual elements with the real world, enabling consumers to examine product details that are seamlessly incorporated into their surroundings. This integration improves the decision-making process by giving customers a contextual sense of how things appear in their environment, which results in relevant information that increases appearance, usability, and enjoyment, as well as an enhanced interactive experience (Barta *et al.*, 2023; Romano *et al.*, 2021; van Esch *et al.*, 2019; Wedel *et al.*, 2020).

Virtual Try-on systems are one of the most promising areas of research in AR (Pantano *et al.*, 2017). The main advantages of this tool include the capacity to overcome the main limitation of online channels by allowing users to interact with the product in real-time, allowing buyers the possibility to virtually try on apparel and accessories before making an online purchase (Barta *et al.*, 2023). As a result, the information consumers must assimilate is more directly associated with the actual image of their faces and bodies and less with the image they have of themselves in their memory. Consequently, they no longer need to decide if things are appropriate based on aspects such as prior experience (Barta *et al.*, 2023; Pantano *et al.*, 2017; Plotkina & Saurel, 2019).

Older versions of VTO relied on an avatar or photo-based try-on, however, the most recent technologies function as a digital mirror which depends on AR, where it superimposes a three-dimensional (3D) virtual item over the consumer's moving reflection in real-time (Plotkina & Saurel, 2019) and rely on such devices as smartphones and tablets. Indeed, AR applications provide more dynamic 3D animation through very realistic interfaces than standard e-commerce settings (Pantano *et al.*, 2017).

Applications of VTO technology across different sectors are, for example, in the fashion industry – many brands like Asos and Nike have virtual mirrors where consumers may see themselves wearing virtual clothing and sneakers (Zarantonello & Schmitt, 2023; Willersdorf, *et al.*, 2021); in the home and goods sector – furniture planners such as the IKEA app allow consumers to scan their apartment and then see how some furniture fits in it; and in the beauty and makeup sector – virtual makeup try-ons (Rauschnabel *et al.*, 2019), the focus of this research.

1.3 Decision-Making Process

The decision-making process in consumer behaviour consists of five stages (see Figure 1.1): need recognition, information search, evaluation of alternatives, purchase decision, and post-purchase behaviour.

This model of the decision-making process implies that consumers go over all five stages during each purchase, but the speed at which consumers move through these stages can vary based on factors like the specific buying situation, the type of product and the buyer's characteristics. For routine purchases, consumers might bypass some stages (Kotler & Armstrong, 2016). Marketers are advised to focus on the entire purchasing process and not just the purchase decision so they can influence it through advertising campaigns and strategies that address consumer needs or alter perceptions (Kotler & Armstrong, 2016; Panwar *et al.*, 2019).

Need Recognition. At this initial stage of the decision-making process, customers identify a problem or a need that can be triggered by either internal stimuli like natural needs or external stimuli such as advertisements or discussions (Kotler & Armstrong, 2016).

Information Search. At this stage of the decision-making process, consumers seek additional information before making a purchase decision. The level of motivation and product availability influence whether they proceed with an immediate purchase or conduct an information search. Consumers may rely on various sources such as personal (family, friends), commercial (advertising), public (social media, online searches), and experiential to gather information (Kotler & Armstrong, 2016; Panwar *et al.*, 2019).

Evaluation of Alternatives. The phase in the consumer's decision-making process during which consumers process information to assess different brands within their options. It can varies based on the individual and the specific situation, some consumers engage in deliberate analysis and logical thinking, while others make impulsive decisions relying on intuition. Consumers may seek advice from friends, online reviews, or salespeople, or make decisions independently (Kotler & Armstrong, 2016).

Purchase Decision. In the purchase decision stage, the buyer selects a brand based on rankings and purchase intentions developed during the evaluation of alternatives. Typically, the consumer's choice aligns with the most favoured brand. However, external factors such as others' attitudes or unexpected situational changes, like an economic setback, can hinder the purchase intentions and actual decisions. Consequently, preferences and purchase intents may not always lead to a final purchase decision (Kotler & Armstrong, 2016).

Post-purchase Behaviour. In the post-purchase behaviour stage of the decision-making process, customers act based on their satisfaction or dissatisfaction with a purchase. Satisfaction or dissatisfaction hinges on the alignment between consumer expectations and a product's perceived performance. When expectations are met, it leads to satisfaction; when exceeded, it results in delight, but unmet expectations lead to disappointment. Significant purchases often induce post-purchase conflict, causing cognitive dissonance or discomfort. Setting realistic promises for product performance is crucial for brands to minimise dissatisfaction and ensure buyer satisfaction (Kotler & Armstrong, 2016).

Figure 1.1 Steps in the Decision-Making Process
Source: Kotler & Armstrong, 2016

1.3.1 Online Decision-Making Process

During the online decision-making process, consumers go through the same five stages mentioned above such as exploring product information online, assessing various opinions, and reviewing feedback from other customers.

The accelerated availability of mobile internet is expediting the buying decision process, providing customers with additional opportunities to engage in the process at their convenience. Yet, the online decision-making process is intricate and affected by multiple factors since the online environment faces different challenges from the offline context (Mican & Sitar-Taut, 2020; Gupta *et al.*, 2023).

1.3.1.1 Online vs Offline Channel

The increasing significance of e-commerce, fuelled by technological advancements, is reshaping marketing approaches and decision-making processes (Rosário & Raimundo, 2021). E-commerce *"refers to the sale and purchase of goods and services through the internet, with the transfer of money and data to complete the transactions"* (Rosário & Raimundo, 2021, p. 1). Therefore, wholesalers and retailers must adapt to changes in consumer purchasing habits (Kammerer *et al.*, 2020).

While e-commerce offers convenience and reduced search costs (Bleier *et al.*, 2019; Y. P. Chiu *et al.*, 2019; Rosário & Raimundo, 2021), a limitation is the absence of physical interaction, impacting product evaluation and customer satisfaction (Barta *et al.*, 2023;

Pantano *et al.*, 2017). Challenges include issues with product quality assessment, returns, and refunds (Gupta *et al.*, 2023; Rosário & Raimundo, 2021). Technological innovations like AR aim to address these limitations (Barta *et al.*, 2023). Nonetheless, online shopping provides flexibility, eliminates time constraints, and reduces the inconvenience associated with physical stores (Gupta *et al.*, 2023; Rosário & Raimundo, 2021; Rose *et al.*, 2011).

However, there are various perceived risks associated with online purchasing that act as impediments to the expansion of e-commerce and might influence online purchase intent (Guru *et al.*, 2020). This concept was built on the idea that all purchasing action involves risks and is defined as "*the nature and amount of uncertainty or consequences experienced by the consumer in contemplating a particular purchase decision"* (Cox & Rich, 1964, p. 5). Studies conducted on online shopping and perceived risk over the years identified several types of perceived risks such as information risk, functional/performance risk, privacy risk, financial risk, physical risk, delivery risk, time-loss risk, psychological risk, and social risk (Alrawad *et al.*, 2023).

In this research, the risks that might influence the online purchase of cosmetics products through VTO tools are functional/performance risks (with the VTO tool itself and the product's performance) and privacy risks. Performance risk is defined as the uncertainty about whether the product's performance will meet the consumer's expectations, influenced by factors such as trust, brand, information quality, and website design (Guru *et al.*, 2020). Privacy risks, in the context of VTO tools, centre around concerns about the security of uploaded photos and the use of the camera, on top of the risk of personal information theft during transactions (Alrawad *et al.*, 2023; Plotkina & Saurel, 2019).

In summary, understanding and addressing these challenges are crucial factors for creating a seamless online customer experience.

1.3.2 Online Decision-Making Process of Cosmetic Products

As stated before, consumers in all commercial areas go through a decision-making process, just like those in the cosmetics sector.

The e-commerce cosmetics industry faces unique challenges in online product distribution, as brands must find ways to persuade customers to buy without the ability to try products firsthand (Zinklar & Photoslurp, 2019). Cosmetics consumers are increasingly interested in online shopping (BOF & McKinsey & Company, 2023; Chevalier, 2024), but the industry is facing some obstacles due to the need to consider consumer concerns other than simply personal style or individuality. They are also concerned with factors such as

skin type, sensitivity, and health. Unlike physical stores, where testers, samples, and makeovers are available, online shopping lacks these interactive elements. Therefore, there is still a significant gap in understanding which tools truly influence online cosmetics shoppers (Zinklar & Photoslurp, 2019).

Following is an overview of the online cosmetics consumers' purchasing process.

Need Recognition. The importance of choosing cosmetic products has expanded beyond mere appearance, with consumers now prioritising aesthetics as well as their well-being. Thus, the *"need recognition"* of buying cosmetic products arises from this shift toward holistic well-being that is transforming the dynamics of influence in the beauty industry (BOF & McKinsey & Company, 2023).

Information Search. Although personal connections remain essential sources of inspiration, consumers are now seeking most of the information online based on the influencers and celebrities they follow (BOF & McKinsey & Company, 2023).

Evaluation of Alternatives. Consumers prioritise quality when making purchasing decisions for cosmetics and seek both excellence and value for their money, often preferring to pay more for high-quality products over cheaper, lower-quality alternatives (BOF & McKinsey & Company, 2023). While consumers carefully evaluate various brands, a large amount of information can overwhelm them and potentially lead to decision abandonment (Kotler & Armstrong, 2016).

Purchase Decision. Based on the previous stages consumers in this stage select their most preferred brand, based on the characteristics they selected (Kotler & Armstrong, 2016). They prefer buying in a hybrid way, by both researching online and purchasing in-store (BOF & McKinsey & Company, 2023).

Post-Purchase Evaluation. Cosmetics consumers either stay loyal to trusted brands or prefer experimenting new products every six months (BOF & McKinsey & Company, 2023). Due to their regular purchasing habits, they may streamline their decision-making process, omitting steps like information search and alternative evaluation (Kotler & Armstrong, 2016).

1.3.3 The Use of VTO Technology in the Cosmetic Industry

The impact of AR is being studied in a lot of sectors and the cosmetic industry is no exception. Some well-known beauty brands are already investing in this technology using makeup try-on apps on mobile phones, websites and physical stores while making the most of it (Willersdorf *et al.*, 2021).

The ex-chief digital officer of L'Oréal Lubomira Rochet considers *"virtual make-up try-on to be the base of any experience. At the end of the day the only barrier to buying [a product] is wondering what it will look like"* (Faull, 2019).

Unlike the other VTO technologies that use the rear camera to superimpose digital information, a VTO system for makeup makes use of the front camera, which provides a unique user experience by attempting to blend the virtual seamlessly with reality, rather than overlaying it on top (Javornik *et al.*, 2016). Virtual makeup try-on allows consumers to see how different makeup products fit them through their digital devices before making a purchase (Rauschnabel *et al.*, 2019), aiming to simulate the experience of trying on makeup in real life (Javornik *et al.*, 2016). As the user moves their head, the makeup remains fixed in place on the mirrored face, creating the illusion of a seamless try-on experience (Javornik *et al.*, 2016). Ultimately, enabling clients to visualize a new style or colour on themselves is a vital component of the beauty and cosmetics online sales' process (Cook *et al.*, 2020).

Despite the technological challenges this sector is facing such as facial recognition and colour accuracy, it hasn't prevented beauty manufacturers from trying to provide meaningful experiences to their clients (Cook *et al.*, 2020). Many beauty e-commerce sites have already VTO technology that enables product testing using face filters (Barta *et al.*, 2023). Some examples are Chanel, Maybelline New York, MAC Cosmetics, and NYX Cosmetics as shown in Appendix A, page 63. More significant advancements are being made by L'Oreal who in 2018 acquired an AR platform called Modiface (Zarantonello & Schmitt, 2023; Willersdorf *et al.*, 2021) and Shiseido who also acquired, in 2017, Giaran, a data-driven firm with award-winning AI solutions for smartphones, tablets, and smart mirrors (Willersdorf *et al.*, 2021).

These types of experiences have shown results for brands, for example, the AR makeup experience of L'Oréal launched in 2019, has produced early results, more than doubling website interaction time and tripling conversion rates. Sephora Virtual Artist app has had comparable results. Their app had 200 million shades tested on more than 8.5 million visits to the AR feature between 2016 and 2018, and they continue to experience recurring consumer use (Cook *et al.*, 2020).

However, a VTO system for makeup is still unknown to many women. A survey conducted by the Boston Consulting Group with beauty trade organization Cosmetic Executive Women Inc. to US Women concluded that only 23% of consumers are aware that cosmetic brands have available makeup try-on apps outside stores. Nevertheless, once

they discover such AR-based beauty apps, more than half (52%) start using them (Willersdorf *et al.*, 2021).

1.4 Stimulus-Organism-Response Model

Several models, ranging in complexity, define the impact of decision-making on consumer behaviour, collectively declaring that different variables influence decision-making and how consumers obtain and analyse information, hence impacting behaviour.

One of these models is the Stimulus-Organism-Response (SOR) model which demonstrates how external stimuli affect the consumers' interior state by triggering a cognitive and emotional reaction influencing their decision-making (Nikhashemi *et al.*, 2021). The SOR paradigm, based on Pavlov's (2023) classic stimulus-response theory (1902), proposes that when presented with a certain stimulus, subjects produce a matched reaction. Mehrabian & Russell (1974) and Donovan & Rossiter (1982), who first used this paradigm in a retail context (Loureiro *et al.*, 2019), built on this notion to create the SOR framework (Barta *et al.*, 2023).

This framework comprises three components (Qin *et al.*, 2021):

- **Stimuli** refers to the specific elements that cause internal processes within an individual,
- which triggers an internal reaction in the **Organism** (the second component) leading to
- a behavioural **Response** (the third component) of approach or avoidance (Barta *et al.*, 2023; Loureiro *et al.*, 2019).

Hence, according to the SOR model, the organism moderates the impact of each stimulus on the response (Barta *et al.*, 2023; Qin *et al.*, 2021). This model has been recently applied in AR contexts (Barta *et al.*, 2023; McLean & Wilson, 2019; Nikhashemi *et al.*, 2021; Qin *et al.*, 2021; Wang *et al.*, 2022) and according to previous research, it's particularly useful in explaining one´s initial adoption of a specific behaviour (Nikhashemi *et al.*, 2021).

1.5 Technology Acceptance Model

Since this research is interested in the impact of a VTO technology on the consumers' decision-making it's also important to consider a model that explores the attitude of consumers towards the adoption of technology. Various theoretical models explore individual attitudes toward technological innovations, connecting them to behavioural

intentions and ultimately influencing innovation usage (Rese *et al.*, 2014). Among these models, the Technology Acceptance Model (TAM), is a widely used and accepted paradigm that investigates consumers' desire to use a certain technology (Kim & Forsythe, 2008; Lee *et al.*, 2006; Pantano *et al.*, 2017; Pillai *et al.*, 2020; Rese *et al.*, 2014, 2017).

Designed initially by Davis (1986) to describe the adoption of computer technology within an organisational environment, TAM has since been employed in various areas, extending its use to investigate the acceptance of various technologies such as online shopping and technology adoption in retail stores (Pillai *et al.*, 2020; Rese *et al.*, 2014).

The fundamental TAM model includes two concepts regarding a specific technological innovation (Kim & Forsythe, 2008; Pantano *et al.*, 2017; Rese *et al.*, 2014), perceived ease of use[2] (PEOU) and perceived usefulness[3] (PU) (Davis, 1989) and centres on how these two beliefs predict attitudes (AT), which represents the user's evaluation of the system (Pantano *et al.*, 2017) and behavioural intentions (BI) toward adopting an innovation (Kim & Forsythe, 2008; Pantano *et al.*, 2017; Rese *et al.*, 2014). An individual's subjective likelihood of engaging in a specific behaviour is referred to as intention (Pantano *et al.*, 2017; Pillai *et al.*, 2020), which has been used in previous research as an indicator of user acceptability (Rese *et al.*, 2014).

The TAM has been extended by incorporating additional constructs, resulting in a more encompassing model (Pantano *et al.*, 2017). The inclusion of the enjoyment construct (PEV) aimed to clarify how intrinsic motivation influences the adoption of new technology (Kim & Forsythe, 2008) by reflecting the extent to which utilising the system is seen as enjoyable, regardless of predicted performance, thereby potentially influencing a consumer's usage of a specific system (Pantano *et al.*, 2017).

Van der Heijden (2000) modified the original TAM to suit a web context, introducing the electronic Technology Acceptance Model (e-TAM). He identified perceived relative usefulness and perceived relative enjoyment as influential variables impacting usage. In the e-TAM framework, the perceived usefulness within the context of technology signifies its functionality, while enjoyment pertains to the hedonic aspects of online shopping. This framework aligns with earlier studies on retail shopping behaviour, confirming the

2 refers to *"the degree to which a person believes that using a particular system would be free of effort"*(Davis, 1989, p. 3).

3 is defined as *"the degree to which a person believes that using a particular system would enhance his or her job performance"* (Davis, 1989, p. 3).

simultaneous presence of utilitarian and hedonic motivations for the online shopping experience (Kim & Forsythe, 2008).

Following van der Heijden (2000), Kim & Forsythe (2008) modified the e-TAM model and proposed a new framework, the Virtual Try-on Acceptance Model (see Figure 1.2). They explored the dual roles, both functional and hedonic of a VTO and discovered that, while certain consumers may use it, primarily, for practical reasons, such as enhancing the detailed examination of a product, others may employ it for hedonic purposes. They have also found that the adoption of VTO technology by online shoppers is more probable when they perceive it as effective in minimising product risk, enhancing shopping enjoyment, or achieving both benefits (Kim & Forsythe, 2008).

Thus, this model helps examine the contributions of both utilitarian and hedonic values in forecasting attitudes towards VTOs and AR applications (Kim & Forsythe, 2008; Plotkina & Saurel, 2019; Rese *et al.*, 2017).

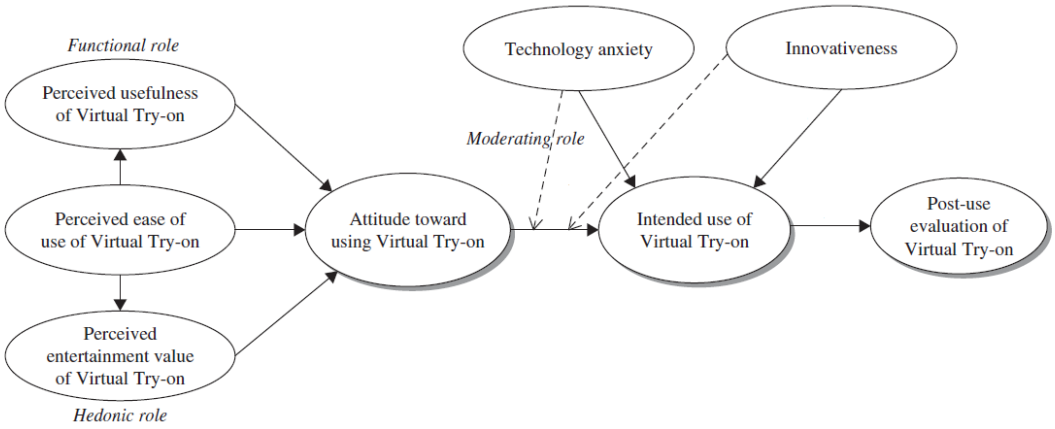

Figure 1.2 Virtual Try-on Acceptance Model
Source: Kim & Forsythe, 2008

2. Hypothesis Development and Conceptual Model

2.1 Hypothesis Development

Considering the distinctive characteristics of online retailing using AR, especially in the context of makeup VTOs, additional factors beyond those previously recognised by the TAM can exert an influence on consumers' decision-making process (Pantano *et al.*, 2017).

In comparison to in-store purchasing, where customers may directly experience the offered items through their senses, online purchases typically require consumers to base their product decisions on considerably less information (Kowalczuk *et al.*, 2021). The VTO system can aid consumers in making product decisions by providing additional information through virtual content. Offering pertinent and valuable details allows consumers to enhance their understanding of the product and assists them in making satisfactory choices which can compensate for this information shortage (Rese *et al.*, 2017). Therefore, it's critical to produce extremely informative product presentations (Kowalczuk *et al.*, 2021). Thus, Product Informativeness, in a mobile context, is defined "*as the degree to which mobile online touch points provide helpful product information for purchase decisions*" (Kowalczuk *et al.*, 2021, p. 5). Most previous research has confirmed that the effects of the constructs related to *Information about virtual products* have a positive influence on consumers' perceived usefulness of an innovation system (Kim & Hyun, 2016; Kim *et al.*, 2016; Kowalczuk *et al.*, 2021; Pantano *et al.*, 2017; Rese *et al.*, 2017).

As consumers anticipate rapid and effortless access to information, and this information should be useful in aiding their purchase decisions, the system must promptly respond to their requests, ensuring an adequate response time (Pantano *et al.*, 2017). System quality is defined as *"the degree of how well a system performs functions"* (Kowalczuk, 2018, p. 5) and encompasses the system's ability to deliver accurate and reliable performance, providing requested services at an optimal processing speed, including the pertinent quality aspects already explored in the AR literature (Kowalczuk *et al.*, 2021). The effects of the constructs related to the *Processing quality* of an AR system have been confirmed to positively influence usefulness (Kim & Hyun, 2016; Kowalczuk, 2018; Kowalczuk *et al.*, 2021; Pantano *et al.*, 2017).

In terms of the quality provided by AR technology, according to Kowalczuk *et al.* (2021), it is crucial to assess how well the consumer perceives the augmented product aligning with the actual product and not just consider factors related to the quality of the virtual product presentation that is mainly focused on the graphic quality of the exhibited

products. Hence, they introduce a new construct called Reality Congruence *"which beyond quality also comprises the fit between the virtual and real products"* (Kowalczuk *et al.*, 2021, p. 5). When product presentations lack quality, display incorrect sizes, appearing pixelated, inaccurate, or unrealistic, they fail to deliver value to the customer. Therefore, ensuring congruence with reality is crucial in eliciting positive consumer responses (Kowalczuk *et al.*, 2021). The effects of the constructs related to the *Quality of virtual product presentation* (Kowalczuk *et al.*, 2021, p. 5) have also been confirmed to have an impact on both usefulness and enjoyment (Javornik *et al.*, 2016; Kim *et al.*, 2016; McLean & Wilson, 2019; Nikhashemi *et al.*, 2021). Kowalczuk *et al.* (2021) also confirm this relationship for usefulness and Pantano *et al.* (2017) and Kang *et al.* (2020) confirmed it for enjoyment.

Regarding the AR features related to "*Interaction with virtual products"* (Kowalczuk *et al.*, 2021, p. 5), to increase the sense of realism in the overall user experience, the system's interactive tools must simulate an authentic product experience (Pantano *et al.*, 2017). Thus, Interactivity is *"the extent to which users can participate in modifying the form and content of a mediated environment in real time"* (Steuer, 1992, p. 12). The effects of this construct have been confirmed by most of the literature as having a positive influence on enjoyment (Kang *et al.*, 2020; Kim *et al.*, 2016; Kowalczuk *et al.*, 2021; McLean & Wilson, 2019; Nikhashemi *et al.*, 2021).

The model of Kim & Forsythe (2008) is lacking in the incorporation of these AR features. Therefore, it is proposed that the AR features of the VTO system used throughout the online buying process (Product Informativeness, System Quality, Reality Congruence and Interactivity) are incorporated into the VTO acceptance model as the stimulus triggering the reaction in the organism components: the TAM variables (PU and PEV) as studied by Kim & Hyun (2016); Kowalczuk *et al.* (2021); Pantano *et al.* (2017) and Rese *et al.* (2014), leading to a response (purchase intention).

Kim & Forsythe (2008) drew on the definitions of Davis (1989) and defined PU as *"the degree to which a person believes that using a (Virtual Try-on) technology would enhance his or her task-related performance"* (Kim & Forsythe, 2008, p. 5) and PEV as *"the extent to which the activity of using a (Virtual Try-on) technology is perceived to be enjoyable in its own right, apart from any performance consequences that may be anticipated"* (Kim & Forsythe, 2008, p. 5).

In line with the mentioned authors, considering that these AR features make the user experience perceived as more useful and enjoyable, it is hypothesised:

- **H1: (a)** Product Informativeness; **(b)** System Quality and **(c)** Reality Congruence positively and significantly influence the Perceived Usefulness of a Virtual Try-on system for makeup;
- **H2: (a)** Reality Congruence and **(b)** Interactivity positively and significantly influence the Perceived Entertainment Value of a Virtual Try-on system for makeup;

Online buyers perceive a VTO as a valuable tool to minimize the risk of making a poor choice and boost confidence in their decision-making since it allows them to enhance their evaluation of products before purchase (Kim & Forsythe, 2008). Therefore, the perceived usefulness of a VTO system increases as it becomes easier to use (Kim & Forsythe, 2008; van der Heijden, 2000).

Kim & Forsythe (2008) drew on the definition of Davis *et al.* (1992) and defined PEOU as *"the degree to which a person believes that using a (Virtual Try-on) technology would be free of effort"* (J. Kim & Forsythe, 2008, p. 5).

In addition to its functional value, when an innovative technology is perceived as entertaining it serves consumers' demand for escapism and diversion which, in turn, encourages increased consumer engagement. Previous research underscores that consumers perceive greater enjoyment value in virtual stores compared to physical ones, due to the interactive opportunities with the environment and products that they provide (Pantano *et al.*, 2017). Thus, the more easy to use the VTO, the more perceived entertainment value increases when shopping online (Kim & Forsythe, 2008).

Most prior research has suggested and empirically demonstrated that the perception of ease of use has a positive impact on both usefulness (Huang & Liao, 2015; Kim & Forsythe, 2008; Pillai *et al.*, 2020; Rese *et al.*, 2017; Zhang *et al.*, 2019) and enjoyment (Kim & Forsythe, 2008; Pantano *et al.*, 2017; Zhang *et al.*, 2019). Hence, it is argued that the ease of use of a makeup VTO system provides additional value to the consumer's experience both at the entertainment and functional level. Therefore, it is hypothesised:

- **H3:** Perceived Ease of Use of Virtual Try-on is positively and significantly associated with **(a)** consumers' Perceived Usefulness and **(b)** consumers' Perceived Entertainment Value of a Virtual Try-on system for makeup.

Regarding the influence of the three beliefs of the TAM model (PEOU, PU and PEV) on consumers' attitudes towards using a VTO system, apart from Kim & Forsythe's (2008) research, several other studies have corroborated the strong validation of these relationships in the context of AR systems and VTOs (Pantano *et al.*, 2017). In particular, Kim &

Forsythe (2008), Lee *et al.* (2006), Pantano *et al.* (2017), Yim *et al.* (2017) and Zhang et al (2019) established both usefulness and enjoyment as important antecedents of attitudes towards using a VTO, which in turn is consistent with research indicating the presence of functional and hedonic motives in online buying (Kim & Forsythe, 2008).

Concerning the direct impact of PEOU on attitude, prior research has shown some inconsistency (Kim & Forsythe, 2008). Some research has demonstrated that ease of use is a key element in influencing attitudes towards technology-based systems (Davis *et al.*, 1992; J. Kim & Forsythe, 2007; van der Heijden, 2000) and Lee *et al.* (2006) found that PEOU positively influence attitudes towards online retailers. However, Kim & Forsythe (2008), who first expected it to have a positive influence on attitudes toward using a VTO system, found this hypothesis to be rejected. Also, Pantano *et al.* (2017) found inconsistent results regarding this relationship[4] as well as Rese *et al.* (2017) who found the impact of PU on attitudes to be highly significant in contrast to PEOU. In addition, some authors show that PU and PEV mediate the relationship between PEOU and attitude (Davis *et al.*, 1992) which can indicate that the impact of PEOU on attitude may vary depending on the context (Kim & Forsythe, 2008).

Hence, it is argued that combining these three beliefs creates an experience value that positively impacts the attitude towards using VTO technology. Accordingly, it is hypothesised:

- **H4: (a)** Perceived Usefulness; **(b)** Perceived Ease of Use and **(c)** Perceived Entertainment Value of the Virtual Try-on will positively and significantly influence consumers' Attitudes towards using a Virtual Try-on system for makeup.

In addition to these three variables, since when using a VTO system for makeup, consumers are required to provide some personal information as access to their live camera, many may be worried about how their personal information is used (Zhang *et al.*, 2019). Therefore, privacy concerns must be considered in the model and referred to as the user's intrinsic apprehensions concerning the possibility of losing personal information when using a specific technology (Rauschnabel *et al.*, 2018).

When consumers perceive a lack of control over the information they share, it can evoke discomfort and heighten a sense of intrusiveness which, therefore, can trigger negative emotions like irritation and annoyance, subsequently impacting consumer

[4] The relationship between ease of use and attitude was only significant for the German sample, for the Italian sample it was found to be significant in the negative direction (Pantano *et al*., 2017).

reactions adversely (Smink *et al.*, 2019). The obligation to provide excessive personal information is identified as one of the significant drawbacks associated with using AR technologies (Smink *et al.*, 2019, 2020) and not only influences how trustworthy the technology is perceived to be but establishes a psychological obstacle of risk, raising feelings of uncertainty and vulnerability. As a result, privacy concerns influence consumers' readiness to adopt new technologies (Rauschnabel *et al.*, 2018).

Previous literature on this matter is not conclusive. Most authors suggest that it negatively influences the adoption of new technology, but some end up realising that, after all, this relationship is positive (Rauschnabel *et al.*, 2018; Zhang *et al.*, 2019). Others concluded that compared to non-AR apps, AR apps are perceived as being more intrusive (Smink *et al.*, 2019, 2020). In this research, we are interested in understanding this effect on a VTO system for makeup. Hence, it is expected that perceived privacy risks will negatively influence consumers' attitudes towards using a VTO system. Accordingly, it is hypothesised:

- **H4: (d)** Perceived Privacy Risks negatively and significantly influences consumers' Attitudes towards using a Virtual Try-on system for makeup.

Numerous TAM studies on users' willingness to adopt technology have enhanced the influence of attitudes on the behavioural intention to use the system, in the context of a VTO technology (Kim & Forsythe, 2007, 2008; Pantano *et al.*, 2017; Rese *et al.*, 2017). Accordingly, an individual's attitude towards using a technology determines its adoption, implying that an individual's usage of a technology is determined by their attitude towards it (Kim & Forsythe, 2007, 2008). As a result, customers' positive attitudes regarding VTO systems are likely to have a beneficial impact on their intention to utilize them.

Online purchase intentions *"are measures of the strength of a consumer's intentions to perform a specified purchasing behaviour via the internet"* (Y. Bin Chiu *et al.*, 2005, p. 5). Since consumers with positive attitudes regarding online purchasing are much less inclined to abandon intended purchases, (Kim & Forsythe, 2008) consumers who experience favourable feelings when utilising a VTO system for makeup, while shopping online, are more inclined to actually purchase the makeup products.

Lee *et al.* (2006) found that attitudes towards online retailers positively affect the behavioural intention towards them. Previous research, in the context of using a VTO for purchasing apparel online, demonstrated that a customer's willingness to embrace VTO technology can impact their decision to make an online garment purchase (Plotkinais & Saurel, 2019; Zhang *et al.*, 2019). Yim *et al.* (2017) also found that attitudes towards AR

technology for sunglasses and watches had a significant effect on purchase intention. Hence, a favourable experience while using the VTO system for makeup positively impacts the intention to shop for these products. Accordingly, it is hypothesised:

- **H5:** Attitudes towards using a Virtual Try-on system positively and significantly influence the Intention to purchase makeup products online.

2.2 Conceptual Model

Therefore, drawing upon Kim & Forsythe's (2008) framework and SOR paradigm (Donovan & Rossiter, 1982; Mehrabian & Russell, 1974) the following conceptual model is proposed (see Figure 2.1) to investigate if online shoppers' adoption of a makeup Virtual Try-on has an impact on their shopping intentions.

The suggested conceptual model elucidates the process of adopting a VTO as a tool for supporting the online purchase intention of makeup products, thus enabling us to investigate:

1. the impact of AR features on the PU and PEV of a VTO system for makeup;
2. the relationships between PEOU with PU and PEV of a VTO system for makeup;
3. the influence of these three beliefs and privacy concerns on attitudes toward using a VTO system for makeup;
4. and the relationship between consumers' attitudes and their intention to use a VTO system for makeup for shopping for makeup products online.

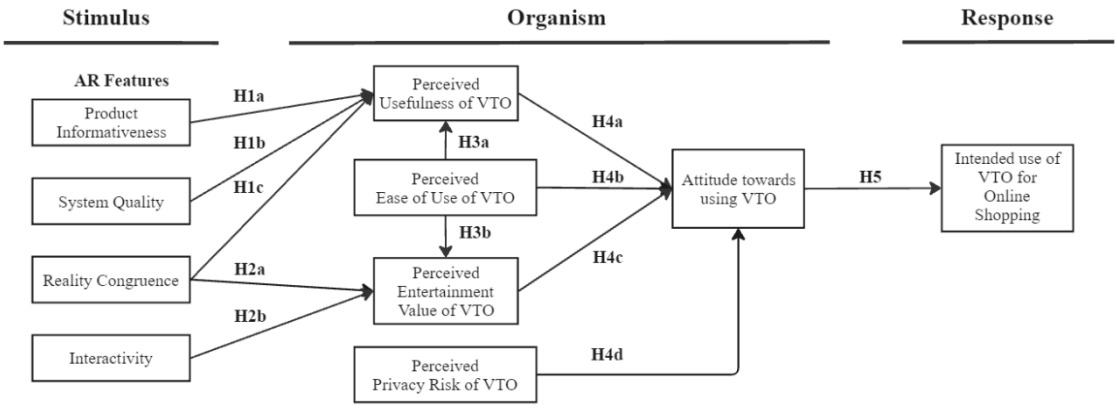

Figure 2.1 Extended VTO Acceptance Model based on the SOR paradigm
Source: Author's elaboration

3. Methodology

This chapter will present the methodological process, the research rationale, and the choice of research methods and analysis tools adopted in this dissertation, highlighting its benefits and limitations. The primary data collection method is presented in detail, along with the definition of the study population and the sample chosen. Moreover, an explanation of how the research was designed and how the data collected was processed.

3.1 Primary Data Collection

The present research employed a quantitative approach to test the research hypotheses and validate the proposed conceptual model. It involved conducting two online questionnaires and a section for collecting experimental data, explained in detail in the structure section of this chapter. Therefore, along with primary data collection, experimental data was used since participants were required to use a makeup VTO tool (MAC Cosmetics) on their mobile phones.

The survey strategy, typically linked with the deductive approach, is often used for exploratory and descriptive research. It allows for extensive data collection, provides greater control over the research process, can help identify potential reasons for relationships between variables and develops models of these relationships (Saunders *et al.*, 2007). A common and widely used primary data collection technique within the survey strategy is administering a structured questionnaire to a sample (Malhotra *et al.*, 2017; Saunders *et al.*, 2007). When sampling is employed, surveys enable cost-effective generalization of conclusions to the entire population (Saunders *et al.*, 2007).

This technique has been used in research by several authors over the years, such as one of the studies on which the proposed conceptual model was based - Kim & Forsythe (2008) - and the studies from which the variables for the model were adapted, namely Kowalczuk *et al.* (2021) and Pantano *et al.* (2017), as referenced in the literature.

The questionnaire method offers several benefits since respondents answer the same set of questions in a predetermined order, it is possible to efficiently collect responses from a large sample, standardise and analyse the data using descriptive and inferential statistics and enable easy comparison during quantitative analysis (Malhotra *et al.*, 2017; Saunders *et al.*, 2007).

3.2 Population Vs. Sampling

In most social sciences research, the goal is to develop theories and explanations that can be generalized to entire populations. In statistical terms, populations refer to all items that can be aggregated and about which conclusions are intended to be generalized. Since working with an entire population is impractical for reasons of cost, time, availability and access to the entire population, statistical research typically uses smaller, accessible groups known as a study population (Marôco, 2018).

In this research, the study population refers to Portuguese female makeup users, a key demographic in the evolving landscape of cosmetics and well-being. European women are increasingly adopting a holistic approach to self-care, with 80% regularly using cosmetics and acknowledging their importance in daily routines. This demographic also highlights how the pursuit of overall well-being is driving changes in the beauty industry, particularly among women under age 25, of which 27% use makeup to boost their confidence (Cosmetic Europe - The Personal Care Association, 2022).

Given the relevance of this population, participants were selected exclusively from Portugal for several key reasons. As the author is Portuguese, the proximity to this population was a determining factor in the decision. The convenience and ease of access to this population made data collection more practical and efficient. Focusing on Portuguese participants also ensured greater consistency and relevance when comparing results within the chosen cultural framework. Additionally, the decision to limit the study to this population was influenced by significant cultural differences between the Portuguese context and the populations studied in other research on similar topics.

From the study population, a sample is selected, and ideally, the conclusions drawn from studying this sample are extended to the larger population. This process is known as statistical inference (Marôco, 2018). In this research, a convenience sample was selected from the study population using the following sampling criteria: women who wear makeup and are familiar with technology. Therefore, as the sampling criterion is by convenience, the method is non-probabilistic, so the results cannot be generalised to the entire population. Further on, this will be noted as a limitation of this research.

3.3 Research Implementation

3.3.1 Statistical Variables and Measurement Scales

Qualitative and quantitative variables were used in these research questionnaires. Qualitative variables are *"variables whose scale of measurement only indicates their presence in exhaustive and mutually exclusive discrete classification categories"* (Marôco, 2018, p. 7). They can be measured on a nominal scale, where it is not possible to establish a relationship of order between the variables (Marôco, 2018), as is the case with gender, occupation and marital status. These variables can also be measured on an ordinal scale, in which according to a describable but not quantifiable relationship it is possible to establish an order between the variables, as is the case with the level of education and with data collected using Likert-type scales (Marôco, 2018).

Age, on the other hand, is a quantitative variable. Quantitative variables can only take on numerical values and *"are variables whose scale of measurement allows the ordering and quantification of differences between them. These variables can be measured on an interval or ratio scale"* (Marôco, 2018, p. 7).

3.3.2 Measures

The measures for the constructs of the suggested conceptual model had been previously statistically studied and validated by other authors and were slightly adapted to ensure their applicability to AR systems and smartphone-based applications (see Table 3.1). The detailed items with which the constructs were measured can be found in Appendix B, page 65.

All questions asked were based on items measured on 5-point Likert-type scales to quantify the responses and turn them into quantifiable variables. Likert-type scales are ordinal scales commonly used in social sciences research to assess peoples' attitudes, opinions, and perceptions (Marôco, 2018). Thus, making them widely used in various research as the ones previously referred to in the literature chapter (Kowalczuk *et al.*, 2021; Pantano *et al.*, 2017).

Table 3.1 Scales in the Literature for the Constructs

Construct	Source
Feelings regarding makeup	Construct developed for this study
Usage Frequency	Adapted from (Desai, 2014)
Purchase Frequency	Adapted from (Desai, 2014)
Information search	Adpated from (Peças, 2023)
Prefered place	Adapted from (Guimarães, 2016)
Average yearly spent on makeup	Adpated from (Peças, 2023)
Interactivity	Adapted from (Pantano et al., 2017)
System Quality	Adapted from (Kowalczuk et al. 2021)
Product Informativeness	Adapted from (Pantano et al., 2017)
Reality Congruence	Adapted from (Kowalczuk et al., 2021)
Perceived Privacy Risk	Adapted from (Rauschnabal, 2018)
Perceived Ease of Use	Adopted from Pantano et al., 2017
Perceived Usefulness	Adapted from (Kowalczuk et al., 2021)
Perceived Entertainment Value	Adapted from (Kowalczuk et al., 2021)
Attitude towards using a VTO	Adopted from Pantano et al., 2017
Inteded Use of VTO for Online Shopping	Adapted from (Pantano et al., 2017)

Source: Author's elaboration

3.3.3 Research Design

To incorporate the participants' exposure to the stimulus (VTO system) into the research, a three-phase dynamic was developed for data collection. The first phase consisted of administering a questionnaire to the participants to assess their relationship with the use of makeup and their degree of familiarity with a VTO system. In the second phase, the participants were exposed to a stimulus in which they used a VTO system for makeup. Finally, in the last phase of the dynamic, a final questionnaire was administered in which they evaluated the VTO experience (See Figure 3.1).

Regarding the distribution of the questionnaire, an invitation was sent out to participants followed by an explanatory session, where the first questionnaire was administered. Secondly, a link was sent so that participants could use the VTO system. Only after the experience of trying the VTO system was terminated, the second questionnaire could be finally administered.

The two online questionnaires were conducted using the Qualtrics platform (see Appendix C for the script, page 67). To protect the privacy and confidentiality of the participants, the questionnaires were completely anonymous, requiring the confirmation of the respondents' age of majority and their telephone number to ensure that they answered both questionnaires. Previously to the two questionnaires release, a pilot test was conducted with a small group of ten individuals to assess their overall sense and make any required adjustments depending on their input.

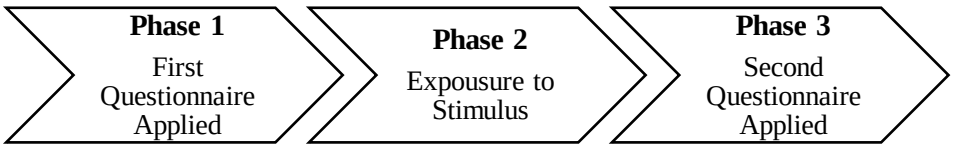

Figure 3.1 Research Phases
Source: Author's elaboration

3.3.3.1 First Questionnaire

The first questionnaire was divided into 4 sections. It consisted of 15 questions, with respondents answering 9 questions on a 5-point Likert-type scale (1 = Totally Disagree, 5 = Totally Agree), 4 multiple-choice questions and 2 demographic questions. In the first section, introduction, the objectives of the survey were presented and clarified to the respondents, namely the purpose of the survey and its applicability, thus making it a direct process (Malhotra *et al.*, 2017). Also, the security of the data collected and the guarantee that the participant would be over 18 years old were asked.

In the second section, two demographic questions were asked to filter out the age and gender of the participants. The third section titled *"Makeup consumption habits"* employed both a 5-point Likert-type scale and multiple-choice questions to collect information on participants' feelings regarding makeup usage, frequency of use, purchase frequency, the preferred place to look for information about makeup products, the preferred place to buy makeup products, and annual makeup expenditure. This section also featured a screening question that excluded non-makeup users and sent them to the end of the questionnaire.

The last section, "*Level of familiarity with a VTO system"* collected information on whether participants had ever used a makeup VTO system. If so, they were presented with a question about why they had used it and 5 Likert-type scale questions about their experience. If not, they were asked why they had never used it and whether they would be willing to try it now.

3.3.3.2 VTO Experience

After answering the first questionnaire participants were asked to access the MAC Cosmetic's VTO via the following link, https://www.maccosmetics.com/virtual-try-on, and use it for approximately five minutes, where they had time to try at least four different makeup products, such as a lipstick, eye shadow, eyelash mascara, among others. The choice of products was left up to the participants so that their use of the VTO system would not be conditioned.

Different makeup brands offer the possibility to virtually try on their products and they all fulfil the purpose of this research. However, they have distinguishing characteristics, namely the system's responsiveness, the realism of the images presented, and the variety of products available for trial through VTO. After using different VTOs from many of these brands, the choice fell on the one that delivered the sharpest results, the most accurate and high-quality images, the most realistic colours and the largest variety of products to try on the VTO. These were the primary factors influencing the decision to choose MAC Cosmetic's Virtual Try-on for this research.

3.3.3.3 Second Questionnaire

The second questionnaire is divided into two sections. The first section is divided into five parts where respondents had to answer 44 questions based on a 5-point Likert-type scale (1 = Totally Disagree, 5 = Totally Agree).

In the first part, the constructs related to the AR features were analysed, namely:

- *Interactivity* and *Product Informativeness* were evaluated with 4 and 5 items, respectively and were based on an adaptation of the scales developed and studied by Pantano *et al.* (2017);
- *System Quality* and *Reality Congruence* were assessed with 5 and 4 items, respectively and based on an adaptation of the scales developed and studied by Kowalczuk *et al.* (2021)*;*

The second part analyses the *Perceived Privacy Risks* construct, which was assessed with 4 items, based on an adaptation of the scale developed and studied by Rauschnabel *et al.* (2018). The third part introduces the constructs related to the TAM model:

- *Perceived Ease of Use* and *Attitude* were evaluated with 4 and 5 items, respectively and were based on the scales developed and studied by (Pantano *et al.*, 2017);
- *Perceived Usefulness* and *Perceived Entertainment Value* were evaluated with 5 and 3 items, respectively and were based on an adaptation of the scales developed and studied by (Kowalczuk *et al.*, 2021).
- The final construct presented is *Intended Use for Shopping Online*, which was evaluated with 5 items based on an adaptation of the scale developed and studied by (Pantano *et al.*, 2017).

The last section of this questionnaire consisted of four demographic questions regarding participants' age, level of education, occupation and marital status, intending to

analyse and compare this data to the findings from the first questionnaire and the first section of this second questionnaire.

3.4 Data Processing

Regarding data processing, the first step was to cleanse the data collected directly in the Qualtrics platform. During data cleaning, duplicate and incomplete responses from participants who did not complete both parts of the questionnaire or who filled only one part of it were excluded. Therefore, a total of 103 valid responses were obtained. After cleansing, the data was exported from the Qualtrics platform to an Excel file and then imported to the 29th version of SPSS Statistics.

The survey was conducted with data collected in Portugal, between 11th May and 17th June of 2024.

4. Results

The results of the survey were analysed using SPPS software (29th version). A characterization of the sample was carried out and, in addition to a preliminary exploratory analysis of the data, simple and multiple regression models were developed to test the hypothesis proposed between the different constructs and adequately test the proposed conceptual model.

4.1 Sample Characterization

4.1.1 Socio-Demographic Characteristics

Regarding participants' socio-demographic characteristics, gender was not necessary to analyse as only female respondents were considered eligible for participation when the data was collected. Therefore, all responses from participants of another gender or who preferred not to answer this question were removed during data cleaning.

To better understand the respondents' age range, they were divided into two groups. Group 1 consists of participants aged 35 or under (starting at 18) and Group 2 consists of participants above 35. This division was based on the characterisation of age groups used in the research *"Os jovens em Portugal, hoje"* by the Francisco Manuel dos Santos Foundation (Sagnier & Morell, 2021) that classified the Portuguese population into three age groups: from 0 to 14 years old, 15 to 34 and over 35. Therefore, this research has adopted these age groups, excluding underage participants. Moreover, this division was also due to the fact that the age of 34 is one of the thresholds with the greatest differentiating power in women's lives, according to the research *"As mulheres em Portugal, hoje"* also carried out by the *Francisco Manuel dos Santos* Foundation (Sagnier & Morell, 2019). The pie chart (Figure 4.1) shows that Group 1 is the most figurative, accounting for 77% of all participants, while Group 2 accounts for the remaining 23%.

Regarding the level of education, five different options have been created: *"High School"*, *"Bachelor's degree"*, *"Postgraduate degree"*, *"Master's degree"* and *"Doctorate"*. Concerning all higher educational studies, 93% of respondents have high education studies of which 42% have completed or are completing a master's degree, and 39% have completed or are completing a bachelor's degree. Thus, it can be inferred that the sample has a high level of education compared to the global level of education in Portugal, where in 2021 only 24% of Portuguese women had completed higher education studies at the highest level of education (Instituto Nacional de Estatística, 2021).

Concerning the respondent's occupation, 45.6% are employed, 34% are students, 14.6% are working students and the last 5.8% are self-employed. In terms of marital status, 78% are single (or have never married), 17% are married (or have a civil partnership) and 6% are divorced. Additional graphs concerning the respondents' sociodemographic profiles can be found in Appendix D, page 75.

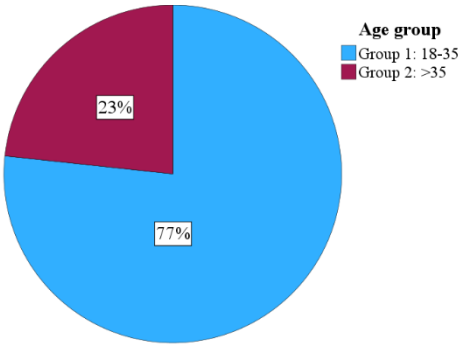

Figure 4.1 Pie Chart of Age Groups
Source: Author's elaboration using SPSS data

4.1.2 Makeup Consumption Habits

Regarding makeup use, as seen in the bar chart (Figure 4.2), half of the participants use makeup daily, 34% weekly and 10% on special occasions. The other options are not much representative in the sample. Concerning the purchase frequency, most respondents buy makeup several times a year (see Figure 4.3). When it comes to finding information about makeup products, 23% follow friends' and family's recommendations. Most of the participants (30%) prefer to buy makeup products in cosmetic stores (such as Pluricosmética, Sephora, etc.) and 13% prefer to buy them online. Finally, regarding annual expenditure on makeup, 71% of participants spend up to €80. Further details concerning participant's makeup consumption habits can be found in Appendix D, page 76.

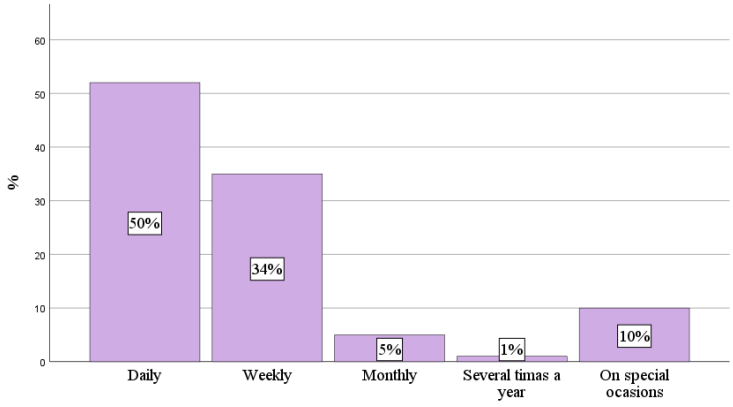

Figure 4.2 Bar Chart of Frequency of Makeup Usage
Source: Author's elaboration using SPSS data

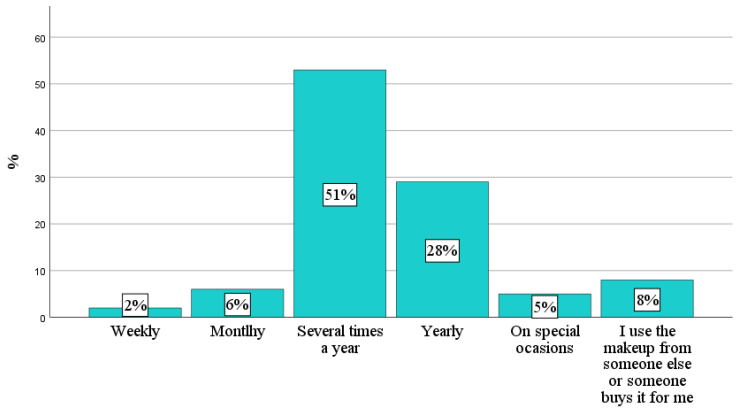

Figure 4.3 Bar Chart of Frequency of Makeup Purchase
Source: Author's elaboration using SPSS data

4.1.3 Technology Usage

Concerning previous usage of a VTO technology, as visible in the pie chart (Figure 4.4), only 17% of respondents have previously used a makeup VTO, while 83% have never used this technology before. Among those who have previously used a VTO (17%), the primary motivations include curiosity and fun (87%) but 13% have previously used a VTO with the intent to make a purchase. A significant majority of respondents, 82%, agreed that the system was easy to use, 71% enjoyed using the VTO system, 59% agreed it was a useful tool and 71% indicated they would use it again in the future. For the participants who have never used a VTO, 47% didn't know that such technology existed, 41% didn't have the opportunity to use it before and 12% didn't understand its utility or didn't know how to use it.

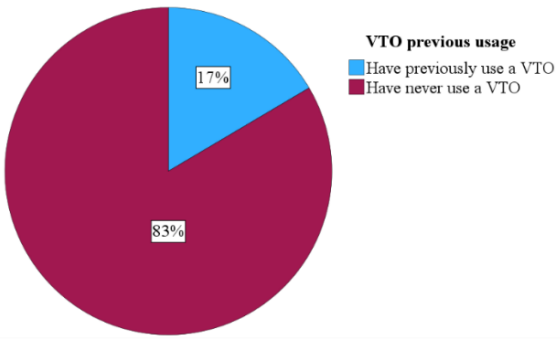

Figure 4.4 Pie Chart of VTO's Previous Usage
Source: Author's elaboration using SPSS data

Concerning the participants who have previously used a VTO system, 88% belong to Group 1 and the remaining 12% belong to Group 2. Among those who have never used a VTO, the percentage of those belonging to Group 2 rises slightly to 26% (see Figure 4.5).

Further details concerning participant's technology usage can be found in Appendix D, page 77.

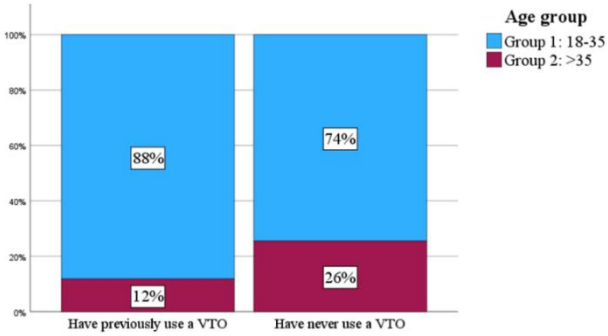

Figure 4.5 Stacked Bar Chart of VTO's Previous Usage by Age Group
Source: Author's elaboration using SPSS data

4.2 Results Presentation

Descriptive statistics, serving as the foundation for quantitative analysis are a collection of techniques used to summarise and provide insights into the distribution and characteristics of a dataset (Green *et al.*, 2023). These techniques include measures of association, dispersion, shape and location. Within the location measurements, it will be analysed the mean of the question results, calculated as the sum of the value of all observations divided by the total number of observations (Marôco, 2018).

To analyze the results, the measures of each construct were aggregated. The aggregate construct's value is calculated by averaging the individual values that constitute it, with no weighting applied. Thus, new variables were created: ScorePI, ScoreSQ, ScoreRC, ScoreI, ScorePU, ScorePEOU, ScorePEV, ScorePC, ScoreAT, and ScoreIUOS. From this point onwards, whenever the name of a construct is used, it refers to its aggregate value. Table 4.1 shows the names and acronyms of each construct under analysis.

Table 4.1 Constructs' Name and Acronym

Construct Name	Acronym
Product Informativeness	PI
System Quality	SQ
Reality Congruence	RC
Interactivity	I
Perceived Usefulness of VTO	PU
Perceived Ease of Use of VTO	PEOU
Perceived Entertainment Value of VTO	PEV
Perceived Privacy Risks of VTO	PC
Attitude towards using VTO	AT
Intended Use of VTO for Online Shopping	IUOS

Source: Author's elaboration

By observing the results obtained and displayed in Figure 4.6:

- The AR constructs (I, PI, RC) registered mean values of 3.81, 3.76 and 3.70, respectively. All values are relatively close to the second-to-last value in the Likert-type scale from 1 to 5. This indicates that participants tend to agree that they can interact with the VTO to receive information about makeup products, the VTO showed the information that they expected and that the products presented in the VTO were realistic. Regarding the AR construct System Quality, the mean value found was 3.47. This value is slightly higher than the middle value in the Likert-type scale from 1 to 5, indicating that the respondents tend to be neutral regarding the quality of the system.
- The construct Perceived Usefulness has a mean value of 3.73. This value is relatively close to the second to last value in the Likert-type scale from 1 to 5, indicating that respondents tend to agree that the VTO is a useful tool. The construct that registered the highest mean value was Perceived Ease of Use (4.34). This value is slightly higher than the second to last value in the Likert-type scale from 1 to 5, indicating that the participants tend to agree that the VTO is easy and intuitive to use. The construct Perceived Entertainment Value has a mean value of 3.88. This value is relatively close to the second to last value in the Likert-type scale from 1 to 5, which indicates that participants tend to agree that the VTO is fun to use.
- The construct Perceived Privacy Risks has registered the lowest mean value (2.97). This value is close to the middle value in the Likert-type scale from 1 to 5, which shows that participants tend to reveal neutral levels regarding privacy concerns. This indicates that participants don’t have any major issues with sharing data and understand its necessity for the system to function.
- The construct Attitudes towards using the VTO have registered a mean value of 3.81. This mean value is relatively close to the second-to-last value in the Likert-type scale from 1 to 5, which indicates that participants tend to agree that the VTO is a good tool to use and overall have a positive attitude towards it.
- The construct Intended Use of VTO for Online Shopping had a mean value only slightly above the middle value in the Likert-type scale from 1 to 5 (3.35). This neutral agreement with the items implies that users recognise the possibility of

using a VTO for shopping online in the future but may have reservations or mixed feelings about using this tool as their first choice for shopping online in the future.

The detailed individual mean values for each item within the variables are provided in Appendix E, page 79.

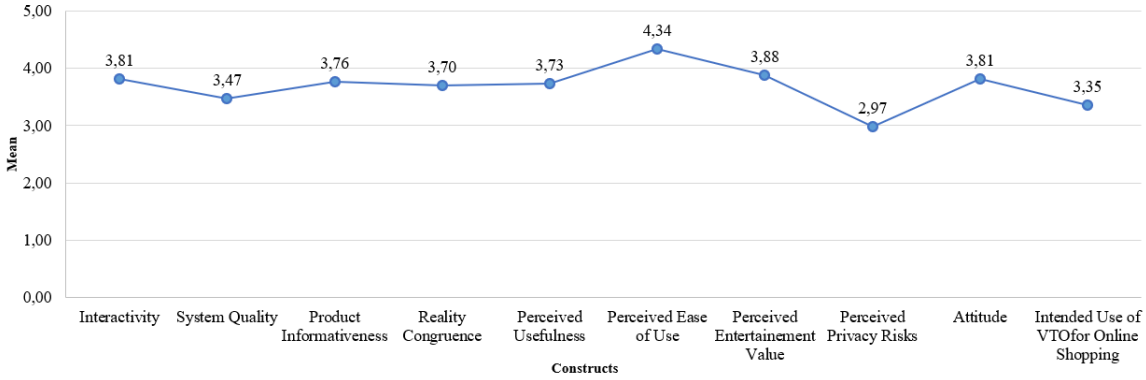

Figure 4.6 Line Chart of Mean Values
Source: Author's elaboration using SPSS data

4.3 Preliminary Exploratory Analysis

Exploratory data analysis will be carried out to identify and highlight aspects or patterns of greater interest in the data collected, in particular the reliability and validity of the proposed conceptual model and the correlations between the constructs under analysis.

4.3.1 Data Reliability

Before examining the data, it was necessary to evaluate its reliability. *Cronbach's Alpha* test was used to examine how well all the items in a variable measure the same notion or construct, assuring validity. *Cronbach's alpha* is a widely used statistic by authors to show that tests and scales designed or adapted for research purposes are suitable. It is widely used in research to assess the reliability or internal consistency of an instrument or scale concerning a specific sample or subset of a population (Taber, 2018). Reliability in a wide sense encompasses the consistency or precision of measurements (Barbera *et al.*, 2021).

The literature lacks a clear consensus on the most appropriate labels for describing the values obtained when calculating *alpha*. Despite this, it is still a common practice in science education to regard an alpha value equal to or higher than 0.70 as an adequate indicator of an instrument's reliability or internal consistency (Taber, 2018). A

Cronbach's alpha value of 0.957 was obtained (See Appendix F, page 83), which indicates a very high level of consistency between the items on the scale.

4.3.2 Correlation Analysis

In social sciences, finding and explaining causal relationships between variables is common. These relationships can be found through association measures, also called correlation coefficients, that quantify the intensity and direction of the association between two variables. It is important to note that a correlation is used to measure simply the association between variables, without providing any implication of cause and effect between the variables in case (Marôco, 2018).

Within the existing correlation coefficients, it will be analyzed, the Pearson Correlation Coefficient which measures the degree of linear association between two variables, and it ranges from -1 to 1. The sign of the correlation coefficient indicates the direction of the association. When the correlation is positive, the variables vary in the same direction (when one increases the other increases or vice versa). When it's negative, the variables vary in opposite directions (when one increases the other decreases, or vice versa). The absolute value of the correlation coefficient (|r|) indicates the intensity of the association. In general, correlations are considered to be weak if $|r| < 0.25$; moderate to $0.25 \leq |r| < 0.5$; strong for $0.5 \leq |r| < 0.75$ and are very strong $|r| \geq 0.75$ (Marôco, 2018).

By observing Table 4.2, it's possible to conclude that:

- There is a **strong positive linear association** between the variable Perceived Usefulness and each of the AR variables (System Quality, Product Informativeness, Reality Congruence). As all correlations are positive, all effects of the explanatory variables on PU will be positive. Product Informativeness is the explanatory variable most correlated with PU since it's the one with the highest value of correlation (0.719). In the regression model, it will be the most important predictor of PU.
- There is also a **strong positive linear association** between the AR variable Interactivity and PEV but between the AR construct, Reality Congruence and PEV, there is only a **moderate positive linear association**. Interactivity is the explanatory variable most correlated with PEV (0.557), meaning it will be the most important predictor in the regression model for explaining PEV.
- Regarding the TAM constructs there is a **strong positive correlation** between Perceived Ease of Use and each of the Perceived Usefulness and Perceived

Entertainment Value. As both correlations are positive the effect of PEOU on each PU and PEV variables will also be positive.

- There is also a **strong positive correlation** between Attitudes towards using a VTO and each of the PEOU, PU and PEV variables. As these correlations are positive, all effects of the explanatory variables on AT will be positive in the model. On the other hand, there is a **weak negative linear association** between AT and Perceived Privacy Risks, suggesting that PC will have a negative effect on AT and will not be a significant variable for explaining AT. Thus, PU is the explanatory variable most correlated with AT (0.721), therefore it will be the most important predictor in the regression model for explaining AT.
- Regarding AT and IUOS, there is a **strong positive correlation** between these two variables, indicating that IUOS will positively affect AT.

See Appendix G, page 85, for a detailed Correlation Matrix.

Table 4.2 Pearsons' Correlation Coefficient

Independent Variables	Dependent Variable			
	Perceveid Usefulness of VTO	Perceived Entertainment Value of VTO	Attitude towards using VTO	Intended use of VTO for Online Shopping
Product Informativeness	**0.719***	-	-	-
System Quality	**0.697***	-	-	-
Reality Congruence	**0.659***	**0.490**	-	-
Interactivity	-	**0.557***	-	-
Perceived Usefulness of VTO	-	-	**0.721***	-
Perceived Ease of Use of VTO	**0.573***	**0.508***	**0.509**	-
Perceived Entertainment Value of VTO	-	-	**0.559***	-
Perceived Privacy Risks of VTO	-	-	**-0.165**	-
Attitude towards using VTO	-	-	-	**0.760***

*Variables statistically significant for $p < 0.05$
Source: Author's elaboration using SPSS data

4.4 Simple and Multiple Linear Regression Models

Simple and Multiple Linear Regression models were used to test the hypothesis proposed between the different constructs and adequately test the conceptual model presented previously. A Simple Linear Regression model aims to analyse the relationship between an independent variable and a dependent variable, while a Multiple Linear Regression model is characterised by involving two or more independent variables (Marôco, 2018).

Within the Linear Regression Models conducted below, it was analysed:

- The **adjusted R-square** of each model which is a corrected model accuracy metric for linear models that calculates the percentage of variance of Y (dependent variable) that is explained by the explanatory variables (X) in the model. This coefficient varies between 0 and 1. When the adjusted R-square equals zero, the

model is considered not to fit the data and when it equals 1, the fit is considered to be perfect. In social sciences, the literature indicates that an adjusted R-square value above 0.5 is considered acceptable and even a good value, indicating a proper fit of the model to the data (Marôco, 2018).

- The ***ANOVA* test** was conducted to test the validity of the Linear Regression Models. At a significance level of 0.05, if *sig*<0.05, it can be concluded that, the Linear Regression under analysis is valid and that at least some of the explanatory variables used in the model are important in explaining the dependent variable.
- The **standardised beta coefficients** enable the comparison of the magnitude of the effects of each independent variable on the dependent variable. The explanatory variable with the highest standardised beta is the most important variable to explain the dependent variable.
- To test the individual contribution of each X variable of the model in explaining Y, ***t-tests*** were conducted. The *p-value* indicates whether the coefficients for each construct are statistically significant in the context. A *p-value* of 0.05 or less means that the coefficient for a given construct is statistically significant, otherwise, for a *p-value* greater than 0.05, the value of the coefficient is not statistically significant (Marôco, 2018).

4.4.1 MLRM Assumptions

For an MRLM to be used for inference, the following requirements must be met (Gauss-Markov theorem): 1) Linearity of the relationship between each X and Y; 2) The mean of the residual component of the model is zero; 3) The independent variables are not correlated with the residual terms; 4) There is no correlation among the residual terms; 5) The variance of the random term is constant; 6) Normality of the residuals and 7) There is no correlation among the explanatory variables (Marôco, 2018). Thus, if all assumptions hold it is possible to generalize conclusions for the entire population, if not, it is only possible to characterise the sample. All the assumptions are held for the three MLRMs that were conducted (see Appendix I, page 91).

4.5 Discussion of Results

The results provided largely supported the proposed hypotheses. However, hypotheses H2 and H4 are only partially supported by the results obtained. Table 4.9 summarises the hypotheses validation. The detailed SPSS outputs of the following parameters and tests

that support the validity of the Linear Regression Models conducted can be found in Appendix H, page 87.

H1 – (a) Product Informativeness; (b) System Quality and (c) Reality Congruence positively and significantly influence the Perceived Usefulness of a Virtual Try-on system for makeup:

To evaluate the influence of the AR features, System Quality, Product Informativeness and Reality Congruence on the Perceived Usefulness of a VTO, a Multiple Linear Regression was used, considering the three AR constructs as the independent variables and PU as the dependent variable. From SPSS the following values were obtained:

Table 4.3 Multiple Linear Regression, PU as the dependent variable

MODEL	Unstandardized Coefficients	Standardized Coefficients		Ajusted R	ANOVA
	β	β	Sig	Square	Sig
(constant)	-0.623		0.709		
SQ	0.34	0.294	0.004	0.593	< 0.001
PI	0.525	0.38	< 0.001		
RC	0.239	0.193	0.046		

Note: the confidence interval used is 95%
Source: Author's elaboration using SPSS data

Therefore, the equation of the fitted regression model is:

$$fittedPU = -0.623 + 0.340 * SQ + 0.525 * PI + 0.239 * RC + \varepsilon \quad (4.1)$$

- The value of the adjusted R-square of this model is 0.593. This value indicates a good fit of the model to the data, since the R-square value is greater than 0.5. Therefore, 59.3% of the variation of Perceived Usefulness of a VTO is explained by the explanatory variables in the model (System Quality, Product Informativeness, and Reality Congruence), suggesting that these variables are sufficient for the model to have a good fit to the data.
- The significance value of the ANOVA test is less than 0.001. Thus, at a significance level of 0.05, it's possible to conclude that the Multiple Linear Regression under analysis is valid, meaning that at least some of the explanatory variables used (System Quality, Product Informativeness, and Reality Congruence) in the model are important in explaining the Perceived Usefulness of a VTO.

- It can be inferred that the Perceived Usefulness of a VTO is positively influenced by all constructs as seen by the sign of the standardised coefficients β_k (all positive). In this case, Product Informativeness is the most important variable to explain the Perceived Usefulness of a VTO, as it has the largest standardised beta coefficient, in absolute value (0.380), followed by System Quality (0.294) and Reality Congruence (0.193).
- The *p-value* of the *t-tests* for Product Informativeness is less than 0.001<0.05, for System Quality is 0.004<0.05 and for Reality Congruence is 0.046<0.05. All values are less than 0.05 indicating that all constructs are significant and suitable for explaining the Perceived Usefulness of a VTO. Thus, **hypothesis H1 can be confirmed**.

The positive impact of Product Informativeness on the Perceived Usefulness of a VTO **(H1a)** is consistent with prior research done by Kim & Hyun (2016), Kim *et al.* (2016), Pantano *et al.* (2017), Rese *et al.* (2017) and Kowalczuk *et al.* (2021) that emphasises that well-designed AR features provide consumers with valuable information to improve their decision-making.

The positive influence of System Quality on the Perceived Usefulness of a VTO **(H1b)** aligns with prior research done by Kim & Hyun (2016), Pantano *et al.* (2017), Kowalczuk (2018) and Kowalczuk *et al.* (2021) which highlights that accurate and reliable system performance enhances consumer decision-making.

The positive effect of Reality Congruence on the Perceived Usefulness of a VTO **(H1c)** is consistent with earlier studies done by Javornik *et al.* (2016), Kim *et al.* (2016), McLean & Wilson (2019), Nikhashemi *et al.* (2021) and Kowalczuk *et al.* (2021), highlighting that high-quality images enhance the Perceived Usefulness of a VTO, thereby improving consumers' decision-making processes.

H2 - (a) Reality Congruence and (b) Interactivity positively and significantly influence the Perceived Entertainment Value of a Virtual Try-on system for makeup:

A Multiple Linear Regression was used to assess the impact of the AR features, Reality Congruence, and Interactivity on the Perceived Entertainment value of a VTO, with the two AR constructs serving as independent variables and PEV as the dependent variable. From SPSS the following values were obtained:

Table 4.4 Multiple Linear Regression, PEV as the dependent variable

MODEL	Unstandardized Coefficients	Standardized Coefficients		Ajusted R	ANOVA
	β	β	Sig	Square	Sig
(constant)	5.294		< 0.001		
RC	0.117	0.188	0.112	0.314	< 0.001
I	0.302	0.423	< 0.001		

Note: the confidence interval used is 95%
Source: Author's elaboration using SPSS data

Thus, the equation of the fitted regression model is:

$$fittedPEV = 5.294 + 0.117 * RC + 0.302 * Interactivity + \varepsilon \quad (4.2)$$

- The adjusted R-square value of this model is 0.314, indicating that only 31.4% of the variation in Perceived Entertainment Value of a VTO is explained by the two explanatory variables in the model, Reality Congruence and Interactivity. This value of the adjusted R-square is less than 0.5 which means that the model fits poorly to the data. The remaining 68.6% is left unexplained, suggesting the need for more explanatory variables in the model.
- The significance value of the ANOVA test is less than 0.001. Therefore, at a 0.05 significance level, it's possible to conclude that the Multiple Linear Regression model under analysis is valid, indicating that at least some of the explanatory variables in the model (Reality Congruence and Interactivity) are significant in explaining the Perceived Entertainment Value of a VTO.
- The Perceived Entertainment Value of a VTO is favourably impacted by the two constructs, as indicated by the sign of the standardised coefficients β_k (all positive). In this case, Interactivity is the most important variable for explaining the Perceived Entertainment Value of a VTO, as it has the highest standardised beta coefficient in absolute value (0.423) followed by Reality Congruence (0.188).
- The *p-value* of the *t-test* for Interactivity is less than 0.001<0.05 but for Reality Congruence is 0.112>0.05. This indicates that the construct Interactivity is significant and suitable for explaining the Perceived Entertainment Value of a VTO, but Reality Congruence is not. Thus, hypothesis **H2 is partially accepted** since H2b can be confirmed, but hypothesis H2a is rejected.

Contrary to what was expected and previously studied in the research carried out by Javornik *et al.* (2016), Kim *et al.* (2016), Pantano *et al.* (2017), McLean & Wilson (2019), Kang *et al.* (2020) and Nikhashemi *et al.* (2021), Reality Congruence did not significantly

influence the Perceived Entertainment Value of a VTO **(H2a)**. One possible explanation is that, while participants appreciate realistic product representations, the mere accuracy of these representations may not be sufficient to enhance the entertainment value of the VTO system. Users may prioritise other aspects of the experience, such as its functional value and ease of navigation or the availability of diverse product options, over the entertainment value that the realism of the Virtual Try-on provides.

The positive influence of Interactivity on the Perceived Entertainment Value of a VTO **(H2b)** strengthens the findings of Kim *et al.* (2016), Kowalczuk (2018), McLean & Wilson (2019), Kang *et al.* (2020) and Nikhashemi *et al.* (2021) that interactive virtual experiences enhance user enjoyment.

H3 - Perceived Ease of Use of Virtual Try-on is positively and significantly associated with (a) consumers' Perceived Usefulness and (b) consumers' Perceived Entertainment Value of a Virtual Try-on system for makeup:

To assess the influence of the Perceived Ease of Use of the VTO on the Perceived Usefulness of the VTO **(H3a)**, a Simple Linear Regression was used, with the PEOU construct as the independent variable and PU as the dependent variable. From SPSS the following values were obtained:

Table 4.5 Simple Linear Regression, PU as the dependent variable

MODEL	Unstandardized Coefficients	Standardized Coefficients		Ajusted R Square
	β	β	Sig	
(constant)	3.624		0.098	0.322
PEOU	0.867	0.573	< 0.001	

Note: the confidence interval used is 95%
Source: Author's elaboration using SPSS data

The equation of the fitted regression model is:

$$fittedPU = 3.624 + 0.867 * PEOU + \varepsilon \quad (4.3)$$

- The adjusted R-square value of this model is 0.322, indicating that 32.2% of the variation in Perceived Usefulness of a VTO is explained by the explanatory variable, Perceived Ease of Use. This value of the adjusted R-square is less than 0.5 which means that the model fits poorly to the data. The remaining 67.8% is left unexplained, suggesting the need for additional explanatory variables.

- Based on the sign of standardised coefficient β_k (positive), it can be inferred that the Perceived Usefulness of a VTO is positively influenced by the Perceived Ease of Use of a VTO.
- The *p-value* of the *t-test* is less than 0.05 (Sig<0.001), indicating that Perceived Ease of Use of a VTO is significant, and adequate to explain the Perceived Usefulness of a VTO. Thus, **hypothesis H3a can be confirmed**.

The positive effect of Perceived Ease of Use of a VTO on the Perceived Usefulness of a VTO is aligned with previously widely documented and confirmed literature by Kim & Forsythe (2008), Huang & Liao (2015), Rese *et al.* (2017), Zhang *et al.* (2019) and Pillai *et al.* (2020) that supports the ease of use as a crucial determinant of functional aspects of using VTO systems.

To determine the effect of the construct's Perceived Ease of Use of the VTO on the Perceived Entertainment value of the VTO **(H3b)**, a Simple Linear Regression was used, with the PEOU construct as the independent variable and PEV as the dependent variable. From SPSS the following values were obtained:

Table 4.6 Simple Linear Regression, PEV as the dependent variable

MODEL	Unstandardized Coefficients	Standardized Coefficients		Ajusted R Square
	β	β	Sig	
(constant)	4.902		< 0.001	0.251
PEOU	0.388	0.508	< 0.001	

Note: the confidence interval used is 95%
Source: Author's elaboration using SPSS data

The equation of the fitted regression model is:

$$fittedPEV = 4.902 + 0.388 * PEOU + \varepsilon \quad (4.4)$$

- The value of the adjusted R-square of this model is 0.251, meaning that only 25.1% of the variation of Perceived Entertainment Value is explained by the explanatory variable in the model (Perceived Ease of Use of a VTO). This adjusted R-square value is much lower than 0.5, which means that the model fits the data poorly. The remaining 74.9% is left unexplained, which means that more explanatory variables are needed for the model to have a good fit to the data.
- The sign of the standardised coefficient β_k (positive) shows that Perceived Ease of Use of a VTO has a positive impact on the Perceived Entertainment Value of a VTO.

- The *p-value* of the *t-test* is less than 0.05 (*Sig*<0.001), indicating that the Perceived Ease of Use of a VTO is significant and adequate to explain the Perceived Entertainment Value of a VTO. Thus, **hypothesis H3b can be confirmed**.

The positive effect of Perceived Ease of Use of a VTO on the Perceived Entertainment Value of a VTO is consistent with the findings of well-established literature by Kim & Forsythe (2008), Pantano *et al.* (2017) and Zhang *et al.* (2019), which emphasises that ease of use is a key factor in determining the hedonic aspects of using VTO systems.

H4 - (a) Perceived Usefulness; (b) Perceived Ease of Use and (c) Perceived Entertainment Value of the Virtual Try-on will positively and significantly influence consumers' Attitudes towards using a Virtual Try-on system for makeup and (d) Perceived Privacy Risk negatively and significantly influences consumers' Attitudes towards using a Virtual Try-on system for makeup:

A Multiple Linear Regression was used to assess the effect of the three TAM constructs (Perceived Usefulness of a VTO, Perceived Ease of Use of a VTO and Perceived Entertainment Value of a VTO) and Perceived Privacy Risks of a VTO on Attitude towards using VTO, with AT as the dependent variables and the other four variables the independent ones. From SPSS the following values were obtained:

Table 4.7 Multiple Linear Regression, AT as the dependent variable

MODEL	Unstandardized Coefficients	Standardized Coefficients		Ajusted R	ANOVA
	β	β	Sig	Square	Sig
(constant)	6.35		< 0.001		
PU	0.48	0.566	< 0.001		
PEOU	0.105	0.082	0.332	0.551	< 0.001
PEV	0.293	0.174	0.044		
PC	-0.127	-0.132	0.051		

Note: the confidence interval used is 95%
Source: Author's elaboration using SPSS data

Therefore, the equation of the fitted regression model is:

$$fittedAT = 6.350 + 0.480 * PU + 0.105 * PEOU + 0.293 * PEV - 0.127 * PC + \varepsilon \quad (4.5)$$

- The value of the adjusted R-square in this model is 0.551. This value is greater than 0.5 which indicates a good fit of the model to the data. Therefore, it's possible to conclude that 55.1% of the variation of Attitude towards using a VTO is explained by

the explanatory variables in the model, namely, Perceived Usefulness of a VTO, Perceived Ease of Use of a VTO, Perceived Entertainment Value of a VTO and Perceived Privacy Risks of a VTO. This suggests that these variables are sufficient for the model to have a good fit.

- The significance value of the ANOVA test is less than 0.001, thus at a significance level of 0.05, it's possible to conclude that the Multiple Linear Regression under analysis is valid, meaning that at least some of the explanatory variables used in the model are important in explaining Attitudes towards using a VTO.
- The sign of the standardised coefficient β_k shows that Perceived Usefulness of a VTO, Perceived ease of Use of a VTO and Perceived Entertainment Value of a VTO favourably impact the Attitude towards using a VTO (all signs are positive), but Perceived Privacy Risks negatively impacts the Attitude towards using a VTO (the sign is negative). In this case, the Perceived Usefulness of a VTO is the most important variable for explaining the Attitude towards using a VTO since it has the highest standardised beta coefficient in absolute value (0.566), followed by Perceived Entertainment Value (0.174), Perceived Privacy Risks (0.132) and Perceived Ease of Use (0.082).
- The *p-values* of the *t-tests* for Perceived Usefulness of a VTO and Perceived Entertainment Value of a VTO are respectively, less than 0.001 and 0.044, both less than 0.05. The *p-values* of Perceived Ease of Use and Perceived Privacy Concerns are respectively, 0.332 and 0.051, both higher than 0.05 which indicates that only the constructs Perceived Usefulness of a VTO and Perceived Entertainment Value of a VTO are significant and suitable for explaining the Attitude towards using a VTO. Thus, **hypothesis H4 is partially accepted** since H4b and H4d are rejected and only H4a and H4c can be confirmed.

The positive influence of the Perceived Usefulness of a VTO on Attitudes towards using VTO systems **(H4a)** is in line with prior research by Lee *et al.* (2006), Kim & Forsythe (2008), Pantano *et al.* (2017), Yim *et al.* (2017) and Zhang *et al.* (2019), which identifies usefulness as a key factor influencing attitudes toward VTO adoption.

The non-significant relationship between Perceived Ease of Use of a VTO and Attitude towards using the VTO system **(H4b)** contrasts with previous literature on the TAM framework, where ease of use is generally a strong predictor of positive attitudes (Davis *et al.*, 1992; Kim & Forsythe, 2007; Lee *et al.*, 2006; van der Heijden, 2000). However, these results are in line with the, also inconsistent, findings of both authors Kim

& Forsythe (2008) and Pantano *et al.* (2017). A possible reason for this could be that, in the context of VTO systems, the entertainment and novelty aspects overshadow the simplicity of use. Consumers might value the immersive and interactive experience more than the ease with which the system can be operated. These results may also confirm that the impact of perceived ease of use on attitude may vary depending on the context (Kim & Forsythe, 2008).

The consistent positive impact of the Perceived Entertainment Value of a VTO on Attitudes toward using VTO systems **(H4c)** aligns with findings from previous research by Lee *et al.* (2006), Kim & Forsythe (2008), Pantano *et al.* (2017), Yim *et al.* (2017) and Zhang *et al.* (2019) that identified entertainment value as a key antecedent influencing attitude towards using a VTO.

Surprisingly, Perceived Privacy Risks did not have a significant negative impact on consumers' attitudes towards using VTO systems **(H4d)**. This finding is somewhat unexpected given that privacy concerns are often associated with AR technologies (Smink *et al.*, 2019, 2020; Zhang *et al.*, 2019). However, this result is in line with the findings of Rauschnabel *et al.* (2018) and Zhang *et al.* (2019) who also believed privacy concerns to have a negative impact but rather found it not to be the case. These results may indicate a shift in consumer attitudes where the convenience and enjoyment provided by AR experiences mitigate privacy concerns and that consumers are becoming more accustomed to sharing personal information online, particularly when the perceived benefits of the technology (such as trying on makeup virtually with a buying perspective) outweigh the privacy concerns.

H5 – Attitudes towards using a Virtual Try-on system positively and significantly influence the Intention to Purchase makeup products Online:

A Simple Linear Regression was used to examine the influence of the construct's Attitude towards using a VTO on the Intention to Use a VTO for Online Shopping, with the AT construct as the independent variable and IUOS as the dependent. From SPSS the following values were obtained:

Table 4.8 Simple Regression, IUOS as the dependent variable

MODEL	Unstandardized Coefficients	Standardized Coefficients		Ajusted R Square
	β	β	Sig	
(constant)	-0.841		0.581	0.574
AT	0.923	0.76	< 0.001	

Note: the confidence interval used is 95%
Source: Author's elaboration using SPSS data

The equation of the fitted regression model is:

$$fittedIUOS = -0.841 + 0.923 * AT + \varepsilon \quad (4.6)$$

- The value of the adjusted R-square of this model is 0.574. This value is greater than 0.5 which indicates a good fit of the model to the data. Therefore, it's possible to conclude that 57.4% of the variation of the Intention to use a VTO for Online Shopping is explained by the explanatory variable in the model, Attitude towards using a VTO, suggesting that this variable is sufficient for the model to have a good fit.
- Based on the sign of the standardised coefficient β_k, it can be inferred that the Intention to Use a VTO for Online Shopping is positively influenced by the Attitude towards using a VTO system.
- The *p-value* of the *t-test* is less than 0.05 (*Sig*=0.001), indicating that Attitude towards using a VTO is significant and adequate to explain the Intention to use a VTO for Online Shopping. Thus, **hypothesis H5 can be confirmed**.

The positive influence of Attitudes towards using VTO systems on the Intention to Use a VTO to purchase makeup products online further supports the notion that TAM beliefs are key drivers of technology adoption as studied by Kim & Forsythe (2007, 2008), Pantano *et al.* (2017) and Rese *et al.* (2017). Therefore, this result aligns with previous research done by Lee *et al.* (2006), Yim *et al.* (2017), Plotkina & Saurel (2019) and Zhang *et al.* (2019), who found that a positive attitude towards the VTO can influence consumers' intention to purchase.

Table 4.9 Hypothesis Validation

Hypotheses	Validation
H1 - (a) Product informativeness; (b) System quality and (c) Reality congruence positively and significantly influence the Perceived Usefulness of a Virtual try-on system for makeup.	Accpected
H2 - (a) Reality congruence and (b) Interactivity positively and significantly influence the Perceived Entertainment Value of a Virtual try-on system for makeup.	Partially Accepted
H3 - Perceived ease of use of Virtual try-on is positively and significantly associated with (a) consumers' Perceived Usefulness and (b) consumers' Perceived Entertainment of a Virtual try-on system for makeup	Accpected
H4 - (a) Perceived usefulness; (b) Perceived ease of use and (c) Perceived entertainment value of the Virtual Try-on will positively and significantly influence consumers' attitudes towards using a Virtual Try-on system for makeup and (d) Perceived privacy risk negatively and significantly influences consumers' attitudes towards using a Virtual Try-on system for makeup.	Partially Accpected
H5 - Attitudes towards using a Virtual Try-on system positively and significantly influence the intention to purchase makeup products online.	Accpected

Source: Author's elaboration

Therefore, the proposed conceptual model with the hypothesis's validation is represented is Figure 4.7.

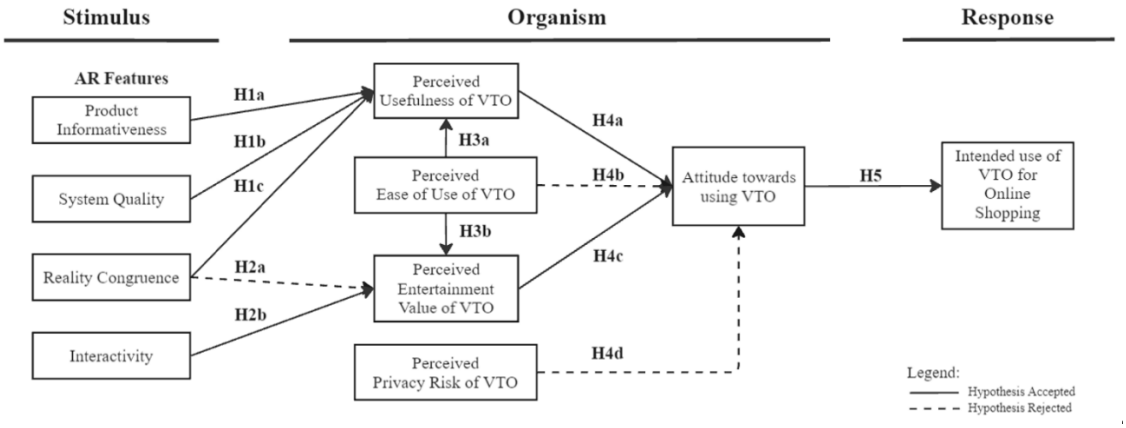

Figure 4.7 Conceptual Model with Hypothesis Validation
Source: Author's elaboration

Conclusions and Limitations

This chapter will review the research objectives by discussing their theoretical and managerial implications. To achieve this, a summary of the findings from the literature review and empirical research will be provided, leading to conclusions regarding the research's hypotheses and research questions. Additionally, the research's limitations will be addressed, and recommendations for future research will be offered.

In the dynamic cosmetics industry, the integration of AR technology through Virtual Try-on tools has the potential to revolutionize product evaluation and consumer engagement, leading to more informed decision-making and superior omnichannel experiences (Hoyer *et al.*, 2020; Zarantonello & Schmitt, 2023). This research aimed to measure the impact of AR on cosmetic brands, particularly focusing on the influence of a VTO system on Portuguese women's online decision-making process.

To accomplish this a conceptual model was developed, incorporating relevant constructs determined by a thorough literature review. The model was then evaluated through two online surveys, targeting female Portuguese respondents. The sample comprised mainly individuals aged 18 to 35. The survey results revealed that the various metrics for measuring validity and reliability support the model and corroborate most of the research hypotheses proposed.

This research investigated how different AR features, namely, Product Informativeness, System Quality, Reality Congruence, and Interactivity influence the Perceived Usefulness and Perceived Entertainment Value of a VTO system for makeup. Additionally, it examined how the Perceived Ease of Use of a VTO system for makeup affects both its Usefulness and Entertainment Value. Ultimately, the research measured how these TAM variables along with privacy considerations influenced consumers' Attitudes towards using the VTO system for makeup and consequently their intention to use the system to purchase for makeup products online.

Although some studies have investigated the impact of a VTO system on the intention to use it and purchase with it, very few have focused on the cosmetic industry, and none have specifically investigated these constructs in the context of using a VTO system to buy makeup products online, in the Portuguese market. Therefore, the present research contributes to the literature by providing new insights into the relationship between these constructs in the context of the cosmetic industry in Portugal.

Theoretical Contribution

This research explores how immersive AR technology such as Virtual Try-on systems can impact the online decision-making process and its influence on consumer behaviour, contributing to the existing academic literature on the subject.

In the domain of Online Customer Experience, this research emphasizes the role of interactive technologies like AR and VTO technology in creating more engaging and personalized online environments, adding to the understanding of OCE in the cosmetics industry.

It also underscores the importance of understanding how AR influences the different stages of the online decision-making process, from problem recognition to post-purchase evaluation. A VTO facilitates this process by offering a risk-free way for consumers to assess products, reducing hesitation, and enhancing confidence in their choices (Barta *et al.*, 2023). This adds to the understanding of how AR technology can accelerate decision-making by decreasing cognitive dissonance and increasing product satisfaction, especially in industries like cosmetics where visual and experiential evaluation is critical.

Additionally, this research examines the different AR characteristics that serve as a stimulus to the adoption of a VTO. The findings highlight the importance of Product Informativeness, System Quality and Reality Congruence as determinant factors that impact the Perceived Usefulness of a VTO system for makeup and Interactivity as a key factor impacting user Entertainment while using a VTO system for makeup. This adds to the understanding of the role that different AR characteristics play in shaping consumers' AR adoption.

Finally, the research also adds to the theoretical understanding of technology adoption within the cosmetic industry. By examining how Portuguese women interact with a VTO in the context of cosmetics, this research provides insights into the factors that drive technology adoption specifically within this industry. The findings support the relationships of the TAM by highlighting the importance of Perceived Usefulness and Perceived Enjoyment as critical drivers of VTO adoption in the cosmetic industry and, consequently, in the intention to use a VTO to purchase cosmetic products online.

Managerial Implications

These research findings provide marketers and managers with an understanding of the potential real-world impacts of VTO systems in online shopping scenarios. Its findings offer

valuable insights for cosmetic brands looking to integrate AR and Virtual Try-on tools into their customer engagement and marketing strategies.

In marketing, AR stands out as an emerging technology that improves customer journeys throughout the pre-purchase, purchase, and post-purchase phases by delivering accessible and relevant information, consequently affecting how customers perceive and engage with products and services (Følstad & Kvale, 2018; Romano *et al.*, 2021).

Understanding the factors that determine consumer acceptability of VTO systems can help practitioners build and execute these technologies in the cosmetics business. First, since Product Informativeness, System Quality and Reality Congruence play pivotal roles in shaping the Perceived Usefulness of a VTO system for makeup, cosmetic brands should ensure that their AR platforms include complete and accurate product information, such as realistic colour rendering, ingredient specifications, and compatibility with various skin types. At the same time, these tools' technical performance must be seamless, with minimal glitches or slow load times, to provide a high-quality user experience.

Although Reality Congruence was not significantly linked to the Perceived Entertainment value of a VTO system for makeup, interaction with the tool has shown to be important regarding user enjoyment. Therefore, it remains important for brands to create engaging and fun experiences with interactive features to increase user enjoyment and engagement with the tool.

The findings highlight that Perceived Ease of Use was crucial in shaping both the functional and entertainment aspects of a VTO system for makeup. This suggests that cosmetic brands should prioritise creating a streamlined and intuitive user experience for their VTO tools, reducing friction points that could hinder usability. By doing so, they can enhance the tool's perceived utility in helping consumers make purchase decisions. Conversely, when users perceive the VTO as easy to use, they are more likely to enjoy the process, leading to a higher entertainment value. This finding encourages brands to focus not only on the technical aspects of usability but also on enhancing the overall enjoyment factor of their VTO tools by integrating playful, user-friendly features that elevate the shopping experience.

The results also suggest that Perceived Ease of Use did not significantly affect consumers' Attitudes towards using a VTO system for makeup, suggesting that users may be familiar with such technologies or willing to overlook minor complexities if the tool offers substantial utility or entertainment. While simplicity in design is important, brands

should prioritise enhancing the functionality and interactivity of VTO tools over making them overly simplified.

Privacy concerns, while not found to have a significant impact on users' Attitudes towards using a VTO system for makeup in this research, remain important in a business context. Cosmetic brands should still prioritise user privacy by clearly communicating data usage policies and implementing visible data protection measures. This transparency will help reduce potential concerns and build trust among users.

A key takeaway from this research is that positive Attitudes towards VTO systems significantly influence users' intention to adopt them for online shopping. The more a consumer perceives a VTO as a positive tool, the more likely he or she is, to purchase from it. This research shows that cosmetic brands would benefit by creating high-quality, engaging VTO experiences that foster positive perceptions. For managers, VTO tools should be seen as more than just a novelty, they are a strategic asset that can drive online sales, improve customer loyalty, and enhance brand perception.

In this regard, any brands planning to launch a VTO must make the required efforts to ensure that their managers understand what consumers consider relevant when using a VTO to make a purchase. Managers should also keep in mind that since AR technology is constantly changing and expanding, brands should continue to invest in breakthroughs. Staying ahead of technical changes will enable cosmetic brands to meet consumers' expanding demands while maintaining a competitive advantage in the digital era.

Research Limitations

It is important to acknowledge that this research has certain inherent limitations that should be considered when interpreting the results and that it may affect the findings' generalisation and real-world applicability. Factors such as the study design, time constraints, budget, sample size, and questionnaire structure could influence the results obtained.

A key limitation of this research relates to the sampling method used. Although the size of the sample and its quality were sufficient for this research, since the sampling method used was by convenience, it is impossible to project to the universe. Therefore, the findings cannot be generalized to wider populations. Since the sample is not representative of the entire population, calculating the margin of error – an indicator typically used to refine sample size – was not applicable.

Another limitation of this research is the reliance on a declarative data collection format. This format may encourage participants to answer what they think they should say rather than what they truly believe or how they would act in real-world situations. As a result, the data collected might compromise the accuracy and authenticity of the findings.

It is critical to note that the research was conducted within a certain period and context. Consequently, changes in the topic's conditions or dynamics may have happened, such as the appearance of new research that offers different results or impacts the significance of the conclusions reached. Another factor that may affect the validity and relevance of the conclusions obtained is the inability to compare the research findings with real-world examples. Since the experience made with respondents didn't obligate them to actually make a purchase, it rather focused on the conceptual idea of using a VTO system for purchasing. This lack of comparable data injuries this research's ability to fully confirm its findings.

Lastly, it is important to acknowledge that this research was conducted under certain assumptions. As with any research based on assumptions, inherent limitations may have influenced the accuracy and validity of the findings. To confirm and expand on the findings of this research, future research with wider and more representative populations is necessary.

Therefore, addressing these limitations could be a key focus for future research to enhance the methodology and produce more reliable results.

Future Research

The findings of this research open promising avenues for further investigation.

First, studying the long-term impact of AR-based VTO tools on consumer behaviour would be beneficial to determine how this tool affects long-term outcomes since certain aspects do not remain constant over time and can be affected by experience. A cross-cultural investigation could extend the findings from the Portuguese market to determine whether the acceptance and effectiveness of VTO systems vary across different cultural contexts, countries and industries.

To overcome the limitation of declarative data collection, future research could incorporate more robust methodologies that better capture participants' behaviour. A suggestion might be to employ experimental designs or observational studies to directly assess participants' actions in real-world or controlled settings, reducing the bias of socially desirable responses. Additionally, the use of advanced statistical techniques such as

structural equation modelling (SEM) can help uncover latent variables that influence behaviour but are not explicitly reported by respondents.

Future investigations could also expand the demographic scope of the research, exploring how other groups, including men, engage with VTO tools, whether for cosmetics or other product categories. This broader perspective could offer valuable insights into diverse consumer behaviours and preferences.

Furthermore, despite privacy concerns were not significant in this research, evolving regulations and growing consumer awareness could change that, making it important for future research to explore how data protection policies impact consumer trust and willingness to use VTO technologies.

Another aspect that could be explored in the future would be finding out if there are differences in the results if the sample was separated into two groups: those who had already tried a VTO before and those who had never tried it in the past.

At last, these recommendations indicate numerous pathways for furthering our understanding of VTO tools in the cosmetic business and beyond. By filling these gaps, future research might give even more relevant insights for both academics and practitioners in AR and e-commerce.

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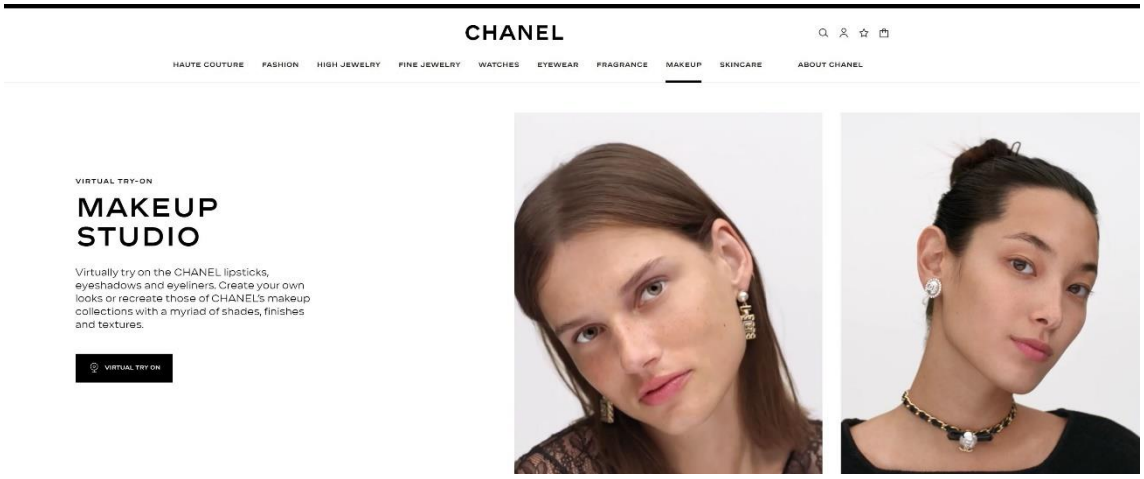
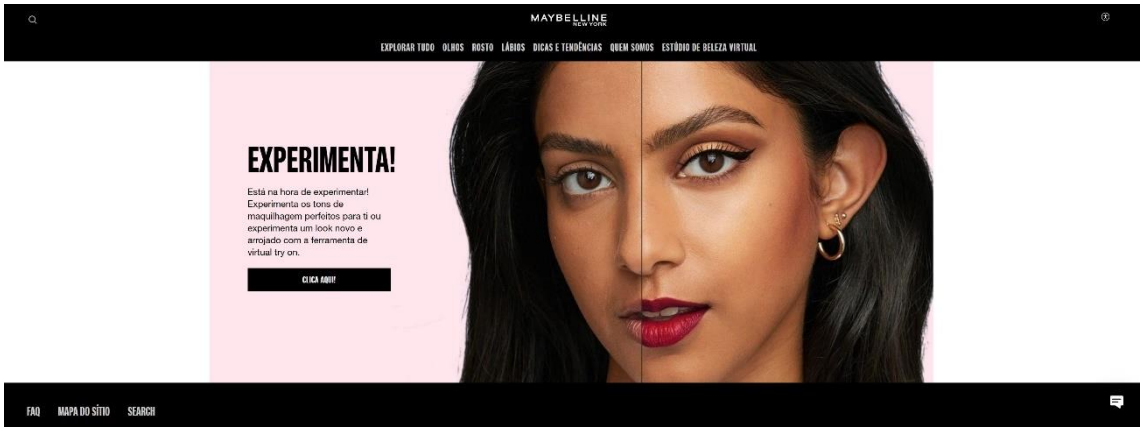
Appendices

Appendix A – VTO Examples

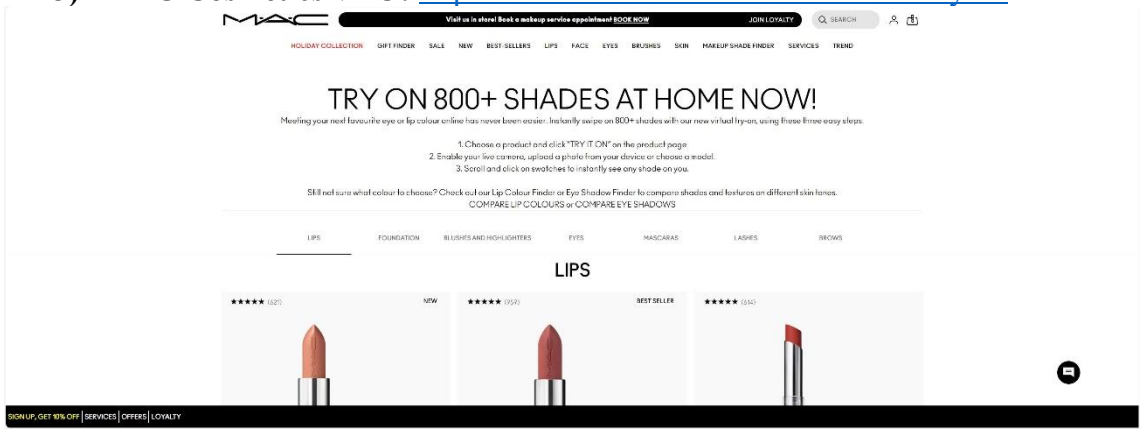
1) **Channel VTO:** https://www.chanel.com/us/makeup/virtual-makeup-try-on/



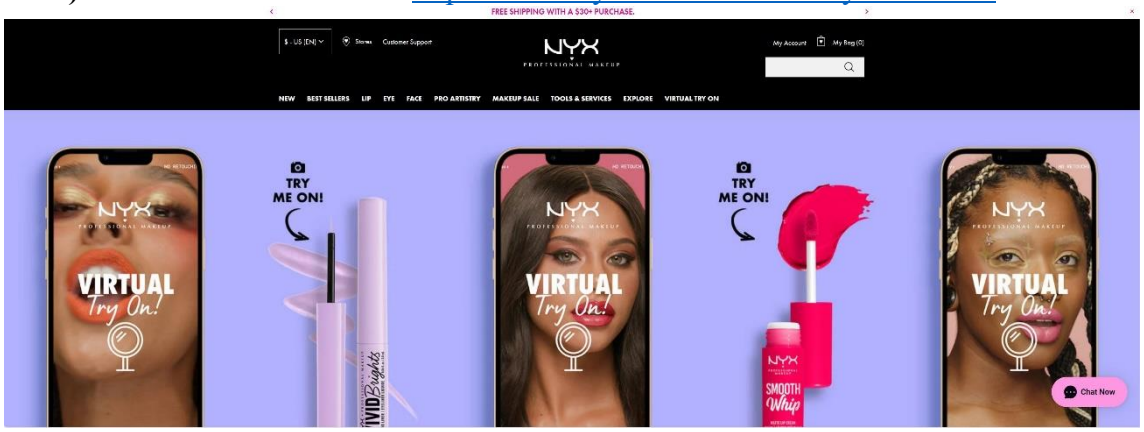
2) **Maybelline New York VTO:** https://www.maybelline.pt/estudio-de-beleza-virtual/virtual-try-on



3) **MAC Cosmetics VTO:** https://www.maccosmetics.com/virtual-try-on



4) **NYX Cosmetics VTO:** https://www.nyxcosmetics.com/try-it-on.html



Appendix B – Constructs, Scales and Authors

Variable	Acronym	# Items	Source	Items	Translated Items
Feelings regarding makeup	-	5	Construct developed for this study	-	Usar maquilhagem aumenta a minha confiança/autoestima. Vejo a maquilhagem como uma forma de esconder falhas imperfeições. A maquilhagem é essencial para a aparência profissional. Sinto-me pressionada a usar maquilhagem para me adequar aos padrões de beleza da sociedade. A maquilhagem é uma despesa desnecessária.
Usage Frequency	-	7	Adapted from (Desai, 2014)	Daily Weekly Monthly Several times a year Yearly Special Occasions I do not use any makeup products	Diariamente Semanalmente Mensalmente Várias vezes por ano Anualmente Em ocasiões especiais Não uso quaisquer produtos de maquilhagem (Saltar para os dados demográficos)
Purchase Frequency	-	7	Adapted from (Desai, 2014)	Daily Weekly Monthly Several times a year Yearly Special Occasions I use the makeup from someone else or someone buys it for me	Diariamente Semanalmente Mensalmente Várias vezes por ano Anualmente Em ocasiões especiais Uso a maquilhagem de outra pessoa ou alguém a compra para mim
Information search	-	6	Adpated from (Peças, 2023)	By experience it (sample use) On newspaper and/or magazines On social media On television and/or radio On the internet Through a doctor Through friends and family recommendation Other. Please specify.	Experimentando (uso de amostra) Seguindo as recomendações de Influencers Procurando recomendações e comentários online Através de um médico Através da recomendação de amigos e familiares Através de aconselhamento em loja Outro. Por favor, especifique.
Prefered place to buy	-	9	Adpated from (Peças, 2023)	Cosmetic stores (Pluricosmética, Sephora,…) Catalogue (Avon, Oriflame,…) Department Store (El Corte Ingles) Online Own brand store (Kiko, Inglot,…) Perfumery Pharmacies Supermarkets Other. Please specify.	Lojas de cosmética (Pluricosmética, Sephora, etc.) Catálogos (Avon, Oriflame, etc.) Grandes armazéns (El Corte Ingles) Online Loja de marca própria (Kiko, Inglot, etc.) Perfumaria Farmácias Supermercados Outros. Por favor, especifique.
Average yearly spent on makeup	-	6	Adpated from (Peças, 2023)	0€ - 40€ 41€ - 80€ 81€ - 120€ 121€ - 160€ 161€ - 200€ More than 200€	Menos de 40€ 41€ - 80€ 81€ - 120€ 121€ - 160€ 161€ - 200€ Mais de 200€
Product Informativeness	PI	5	Adapted from (Pantano et al., 2017)	The virtual try-on shows the information I expected. The virtual try-on provides detailed information about the products. The virtual try-on provides complete information about the products. The virtual try-on provides information that helps me in my decision. The virtual try-on provides information to compare products.	O sistema de VTO apresenta as informações que eu esperava. O sistema de VTO fornece informações pormenorizadas sobre os produtos. O sistema de VTO fornece informações completas sobre os produtos. O sistema de VTO fornece informações que me ajudam na minha decisão. O sistema de VTO fornece informações para comparar produtos.
System Quality	SQ	5	Adapted from (Kowalczuk et al. 2021)	The virtual try-on is promptly responsive to my requests and provides good results. The virtual try-on performs its functions quickly and efficiently. The virtual try-on is reliable (it is always up and running, runs without errors, and does what it is supposed to do). The virtual try-on provides perfect and precise services in line with the purpose of the system. The virtual try-on fully meets my needs.	O sistema de VTO responde prontamente aos meus pedidos e fornece bons resultados. O sistema de VTO desempenha as suas funções de forma rápida e eficiente. O sistema de VTO é fiável (está sempre a funcionar, funciona sem sem erros e faz o que é suposto fazer). O sistema de VTO fornece serviços perfeitos e precisos, de acordo com o objetivo do sistema. A experiência virtual satisfaz plenamente as minhas necessidades.
Reality Congruence	RC	3	Adapted from (Kowalczuk et al., 2021)	The virtual try-on presents virtual products impressively. The virtual try-on presents virtual products visually appealingly. The virtual try-on presents the virtual products (e.g., colors, shapes) realistically. The virtual try-on presents virtual products as if they were real.+	O sistema de VTO apresenta os produtos virtuais de forma impressionante (como se estivessem efetivamente no meu rosto). O sistema de VTO apresenta os produtos virtuais de forma visualmente apelativa. O sistema de VTO apresenta os produtos virtuais (por exemplo, cores, formas) de forma realista. No geral, considero que o sistema de VTO apresenta os produtos virtuais de forma atrativa.
Interactivity	I	4	Adapted from (Pantano et al., 2017)	The virtual try-on allows me to interact with it to receive tailored information about the makeup products. The virtual try-on has interaction features, which help me to come to a decision in the selection of makeup products. I am able to interact with the virtual try-on in order to get information tailored to my specifie needs. The degree of interaction with the virtual try-on is sufficient.	Sou capaz de interagir com o sistema de VTO para obter informações adaptadas às minhas necessidades específicas. O grau de interação com o sistema de VTO é suficiente. O sistema de VTO tem características de interação que me permitem receber informações personalizadas sobre os produtos de maquilhagem. O sistema de VTO tem características de interação que me ajudam a tomar uma decisão na seleção de produtos de maquilhagem.
Perceived Usefulness	PU	5	Adapted from (Kowalczuk et al., 2021)	The virtual try-on enhances my ability to make product choices more effectively. Using the virtual try-on saves me time. Using the virtual try-on improves the quality of my search for products. The virtual try-on enables me to acquire information more quickly. Overall, I find the virtual try-on useful in my shopping experience.	O sistema de VTO aumenta a minha capacidade de fazer escolhas de produtos de forma mais eficaz. A utilização do sistema de VTO poupa-me tempo. A utilização do sistema de VTO melhora a qualidade da minha pesquisa de produtos. O sistema de VTO permite-me obter informações mais rapidamente. No geral, considero a sistema de VTO útil na minha experiência de compra.
Perceived Ease of Use	PEOU	4	Pantano et al., 2017	I found the virtual try-on to be very easy to use. The virtual try-on was intuitive to use. It was easy to learn how to use the virtual try-on. Handling the virtual try-on was easy.	Achei o sistema de VTO muito fácil de utilizar. A utilização do sistema de VTO foi intuitiva. Foi fácil aprender a utilizar o sistema de VTO. O manuseamento do sistema de VTO foi fácil.
Perceived Entertainment Value	PEV	3	Adapted from (Kowalczuk et al., 2021)	I find using the virtual try-on to be enjoyable. The actual process of using the virtual try-on is pleasant. I have fun using the virtual try-on.	Considero a utilização do sistema de VTO prazerosa. O processo de utilização do sistema de VTO é agradável. Divirto-me a utilizar o sistema de VTO.

Variable	Acronym	# Items	Source	Items	Translated Items
Perceived Privacy Risk	PC	4	Adapted from (Rauschnabal, 2018)	The virtual try-on would collect too much information about a user. I would be concerned about my privacy when using the virtual try-on. I have doubts as to how well my privacy is protected while using the virtual try-on. My personal information would be misused when the camera is running.	O sistema de VTO recolhe demasiada informação sobre o utilizador. Preocupa-me com a minha privacidade quando utilizo o sistema de VTO. Tenho dúvidas quanto ao grau de proteção da minha privacidade durante a utilização do sistema de VTO. As minhas informações pessoais podem ser utilizadas indevidamente quando a câmara está a funcionar.
Attitude towards Using a VTO	AT	5	Pantano et al., 2017	I am positive about the virtual try-on The virtual try-on is so interesting that you just want to learn more about it. It just makes sense to use the virtual try-on. The virtual try-on is a good idea Other people should also use the virtual try-on.	A minha opinião sobre o sistema de VTO é positiva. O sistema de VTO é tão interessante que só apetece saber mais sobre ele. Faz sentido usar o sistema de VTO. O sistema de VTO é uma boa ideia. As outras pessoas também deviam usar o sistema de VTO.
Intended Use of VTO for Online Shopping	IUOS	5	Adapted from (Pantano et al., 2017)	If I were to buy make-up products in the future, I would… …use the virtual try-on immediately. …give the virtual try-on priority over a physical shop. …give the virtual try-on priority over other online shops. ... I will recommend using the virtual try-on to my friends. ... I will use the virtual try-on regularly in the future.	Se eu fosse comprar produtos de maquilhagem no futuro, eu... ...utilizaria imediatamente a experimentação virtual. ...daria prioridade à experimentação virtual em relação a uma loja física. ...daria prioridade à experimentação virtual em relação a outras lojas online. ...recomendaria a utilização da prova virtual aos meus amigos. ...utilizarei regularmente a prova virtual no futuro.

Appendix C – Survey Script

1) Questionário Pré utilização VTO

Introdução

Caro participante,

Gostaria de agradecer o seu tempo e disponibilidade para responder a este questionário. Este questionário faz parte do desenvolvimento da minha dissertação de mestrado no ISCTE Business School.

Esta pesquisa tem como objetivo investigar o impacto da utilização de uma ferramenta de Virtual Try-on (VTO) no processo de decisão de compra de maquilhagem online.

Uma ferramenta de VTO é um processo tecnológico que permite aos utilizadores visualizarem digitalmente e experimentarem virtualmente os produtos antes de efetuarem uma compra. Envolve a utilização de técnicas de realidade aumentada para sobrepor representações virtuais de produtos, como vestuário, acessórios ou cosméticos, a imagens ou vídeos do utilizador, permitindo que os utilizadores vejam como os produtos lhes ficam em tempo real sem os experimentarem fisicamente.

A sua participação neste estudo consistirá em três fases, um breve questionário inicial sobre a sua relação com a maquilhagem e para compreender o quão familiarizado está com o conceito de VTO, segue-se a experimentação de um VTO e por último um questionário para avaliar a experiência. Não se pretende que avalie a marca de maquilhagem deste VTO em específico, nem o preço dos produtos, apenas que avalie a experiência.

O tempo médio total será de 15 minutos e a sua participação é totalmente voluntária. O questionário é anónimo e os dados recolhidos serão mantidos estritamente confidenciais e utilizados exclusivamente para fins académicos e apenas serão utilizados os resultados agregados.

Não há respostas certas ou erradas.

Por favor, tenha em consideração que a ferramenta de VTO deve ser experimentada através do seu telemóvel.

Obrigada pela sua atenção e cooperação,

Maria Gaudich

Ao clicar em “Eu concordo”, declaro que sou maior de idade (18 anos ou mais) e que concordo em participar nesta pesquisa. Declaro que fui informado que a minha participação neste estudo é voluntária e que a informação recolhida é completamente confidencial e que será utilizada apenas para fins académicos.

a. Eu concordo
b. Eu não concordo (saltar para o fim)

Por favor, indique o seu nº de telemóvel.
(Serve apenas para conseguir identificar que a mesma pessoa respondeu ao primeiro e ao segundo questionário)
a. Resposta aberta

<u>Dados Demográfico - Filtrar</u>

1. Por favor, indique a sua idade.
a. resposta aberta

2. Por favor, indique o seu género.
a. Feminino
b. Masculino
c. Outro/ Prefiro não responder

<u>Hábitos de utilização de maquilhagem</u>

1. Tendo em conta a sua **relação com a maquilhagem**, indique, numa escala de 1 a 5 (1 - Discordo totalmente; 5 - Concordo totalmente), em que medida concorda com as seguintes afirmações:
a. Usar maquilhagem aumenta a minha confiança/autoestima.
b. Vejo a maquilhagem como uma forma de esconder falhas e imperfeições.
c. A maquilhagem é essencial para a aparência profissional.
d. Sinto-me pressionada a usar maquilhagem para me adequar aos padrões de beleza da sociedade.
e. A maquilhagem é uma despesa desnecessária.

2. Com que frequência **usa** maquilhagem?
a. Diariamente
b. Semanalmente
c. Mensalmente
d. Várias vezes por ano
e. Anualmente
f. Em ocasiões especiais
g. Não uso quaisquer produtos de maquilhagem (Saltar para os dados demográficos)

3. Com que frequência **compra** maquilhagem?
a. Diariamente
b. Semanalmente
c. Mensalmente
d. Várias vezes por ano
e. Anualmente
f. Em ocasiões especiais
g. Uso a maquilhagem de outra pessoa ou alguém a compra para mim

4. Quando deseja comprar um produto de maquilhagem **onde procura informação** sobre os produtos? (Note que pode escolher mais do que uma opção):
a. Experimentando (uso de amostra)

b. Seguindo as recomendações de *Influencers*
c. Procurando recomendações e comentários online
d. Através de um médico
e. Através da recomendação de amigos e familiares
f. Através de aconselhamento em loja
g. Outro. Por favor, especifique.

5. Qual é o seu **local preferido para comprar** produtos de maquilhagem? (Note que pode escolher mais do que uma opção):
a. Lojas de cosmética (Pluricosmética, Sephora, etc.)
b. Catálogos (Avon, Oriflame, etc.)
c. Grandes armazéns (El Corte Ingles)
d. Online
e. Loja de marca própria (Kiko, Inglot, etc.)
f. Perfumaria
g. Farmácias
h. Supermercados
i. Outro. Por favor, especifique.

6. Quanto é que **gasta em média** em produtos de maquilhagem **por ano**?
a. Menos de 40€
b. 41€ - 80€
c. 81€ - 120€
d. 121€ - 160€
e. 161€ - 200€
f. Mais de 200€

<u>Grau de familiaridade com um sistema de VTO</u>

Relembrando o que é um VTO:

É um processo tecnológico que permite aos utilizadores visualizarem digitalmente e experimentarem virtualmente os produtos antes de efetuarem uma compra. Envolve a utilização de técnicas de realidade aumentada para sobrepor representações virtuais de produtos, como vestuário, acessórios ou cosméticos, a imagens ou vídeos do utilizador, permitindo que os utilizadores vejam como os produtos lhes ficam em tempo real sem os

experimentarem fisicamente.Veja os seguintes exemplos de um VTO de maquilhagem de batom e sombra de olhos, respetivamente:

3. Já utilizou um VTO?
   a. Sim
   b. Não

4. **Se sim,**
   a. Porquê?
      i. Por diversão
      ii. Por curiosidade
      iii. Para efetuar uma compra
      iv. Outro. Por favor, especifique.
   b. Indique, numa escala de 1 a 5 (1 - Discordo totalmente; 5 - Concordo totalmente), em que medida concorda com as seguintes afirmações:
      i. Foi fácil utilizar o sistema de Virtual Try-on.
      ii. Gostei de utilizar o sistema de Virtual Try-on.
      iii. Achei o sistema de Virtual Try-on uma ferramenta útil.
      iv. Eu voltaria a utilizar este sistema no futuro.

5. **Se não,**
   a. Porquê?
      i. Não sabia que existia
      ii. Não percebo a utilidade
      iii. Não sei como utilizar
      iv. Nunca surgiu a oportunidade
      v. Outro. Por favor, especifique.
   b. Gostaria de experimentar?
      i. Sim
      ii. Não

2) Experimentar o VTO da MAC:
https://www.maccosmetics.com/virtual-try-on

3) Questionário Pós utilização VTO

Agora que utilizou este sistema de Virtual Try-on de maquilhagem, por favor responda às seguintes questões.

Obrigada.

Maria Gaudich

Por favor, indique o seu nº de telemóvel.
   a. Resposta aberta

Avaliar o VTO

1. Tendo em conta **o grau de interatividade com o sistema de VTO** indique, numa escala de 1 a 5 (1 - Discordo totalmente; 5 - Concordo totalmente), em que medida concorda com as seguintes afirmações:

    a. Sou capaz de interagir com o sistema de VTO para obter informações adaptadas às minhas necessidades específicas.
    b. O grau de interação com o sistema de VTO é suficiente.
    c. O sistema de VTO tem características de interação que me permitem receber informações personalizadas sobre os produtos de maquilhagem.
    d. O sistema de VTO tem características de interação que me ajudam a tomar uma decisão na seleção de produtos de maquilhagem.

2. Tendo em conta **a qualidade do sistema de VTO** indique, numa escala de 1 a 5 (1 - Discordo totalmente; 5 - Concordo totalmente), em que medida concorda com as seguintes afirmações:

    a. O sistema de VTO responde prontamente aos meus pedidos e fornece bons resultados.
    b. O sistema de VTO desempenha as suas funções de forma rápida e eficiente.
    c. O sistema de VTO é fiável (está sempre a funcionar, funciona sem erros e faz o que é suposto fazer).
    d. O sistema de VTO fornece serviços perfeitos e precisos, de acordo com o objetivo do sistema.
    e. A experiência virtual satisfaz plenamente as minhas necessidades.

3. Tendo em conta **a informação apresentada pelo sistema de VTO** indique, numa escala de 1 a 5 (1 - Discordo totalmente; 5 - Concordo totalmente), em que medida concorda com as seguintes afirmações:

    a. O sistema de VTO apresenta as informações que eu esperava.
    b. O sistema de VTO fornece informações pormenorizadas sobre os produtos.
    c. O sistema de VTO fornece informações completas sobre os produtos.
    d. O sistema de VTO fornece informações que me ajudam na minha decisão.
    e. O sistema de VTO fornece informações para comparar produtos.

4. Tendo em conta **a congruência com a realidade apresentada pelo sistema de VTO** indique, numa escala de 1 a 5 (1 - Discordo totalmente; 5 - Concordo totalmente), em que medida concorda com as seguintes afirmações:

    a. O sistema de VTO apresenta os produtos virtuais de forma impressionante (como se estivessem efetivamente no meu rosto).
    b. O sistema de VTO apresenta os produtos virtuais de forma visualmente apelativa.
    c. O sistema de VTO apresenta os produtos virtuais (por exemplo, cores, formas) de forma realista.
    d. No geral, considero que o sistema de VTO apresenta os produtos virtuais de forma atrativa.

5. Relativamente à **sua privacidade durante a utilização do VTO** indique, numa escala de 1 a 5 (1 - Discordo totalmente; 5 - Concordo totalmente), em que medida concorda com as seguintes afirmações:

- **c.** O sistema de VTO recolhe demasiada informação sobre o utilizador.
- **d.** Preocupo-me com a minha privacidade quando utilizo o sistema de VTO.
- **e.** Tenho dúvidas quanto ao grau de proteção da minha privacidade durante a utilização do sistema de VTO.
- **f.** As minhas informações pessoais podem ser utilizadas indevidamente quando a câmara está a funcionar.

6. Tendo em conta **a facilidade de utilização do sistema de VTO** indique, numa escala de 1 a 5 (1 - Discordo totalmente; 5 - Concordo totalmente), em que medida concorda com as seguintes afirmações:

- **a.** Achei o sistema de VTO muito fácil de utilizar.
- **b.** A utilização do sistema de VTO foi intuitiva.
- **c.** Foi fácil aprender a utilizar o sistema de VTO.
- **d.** O manuseamento do sistema de VTO foi fácil.

7. Tendo em conta **a utilidade do sistema de VTO** indique, numa escala de 1 a 5 (1 - Discordo totalmente; 5 - Concordo totalmente), em que medida concorda com as seguintes afirmações:

- **a.** O sistema de VTO aumenta a minha capacidade de fazer escolhas de produtos de forma mais eficaz.
- **b.** A utilização do sistema de VTO poupa-me tempo.
- **c.** A utilização do sistema de VTO melhora a qualidade da minha pesquisa de produtos.
- **d.** O sistema de VTO permite-me obter informações mais rapidamente.
- **e.** No geral, considero o sistema de VTO útil na minha experiência de compra.

8. Tendo em conta **o grau de entretenimento do sistema de VTO** indique, numa escala de 1 a 5 (1 - Discordo totalmente; 5 - Concordo totalmente), em que medida concorda com as seguintes afirmações:

- **a.** Considero a utilização do sistema de VTO prazerosa.
- **b.** O processo de utilização do sistema de VTO é agradável.
- **c.** Divirto-me a utilizar o sistema de VTO.

9. Tendo em conta **a experiência global** indique, numa escala de 1 a 5 (1 - Discordo totalmente; 5 - Concordo totalmente), em que medida concorda com as seguintes afirmações:

- **a.** A minha opinião sobre o sistema de VTO é positiva.
- **b.** O sistema de VTO é tão interessante que só apetece saber mais sobre ele.
- **c.** Faz sentido usar o sistema de VTO.
- **d.** O sistema de VTO é uma boa ideia.
- **e.** As outras pessoas também deviam usar o sistema de VTO.

10. Indique, numa escala de 1 a 5 (1 - Discordo totalmente; 5 - Concordo totalmente), em que medida concorda com as seguintes afirmações:

"Se eu fosse comprar produtos de maquilhagem no futuro, eu..."

- **a.** ...utilizaria imediatamente o sistema de VTO.
- **b.** ...daria prioridade ao sistema de VTO em relação a uma loja física.
- **c.** ...daria prioridade ao sistema de VTO em relação a outras lojas online.
- **d.** ...recomendaria a utilização do sistema de VTO aos meus amigos.
- **e.** ...utilizarei regularmente o sistema de VTO no futuro.

Dados Demográficos

11. Por favor indique o grau ou nível de ensino mais elevado que concluiu ou está a concluir.

- **a.** Ensino secundário
- **b.** Licenciatura
- **c.** Pós-Graduação
- **d.** Mestrado
- **e.** Doutoramento

12. Por favor indique a sua ocupação.

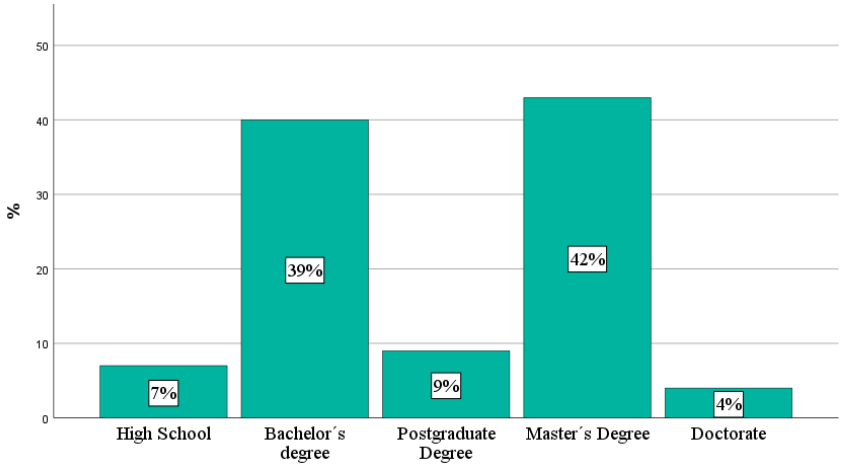
- **a.** Estudante
- **b.** Empregado por conta de outrem
- **c.** Empregado por conta própria
- **d.** Desempregado

13. Por favor indique o seu estado civil.

- **a.** Solteiro (nunca casou)
- **b.** Casado(a) ou em União de facto
- **c.** Viúvo(a)
- **d.** Divorciado

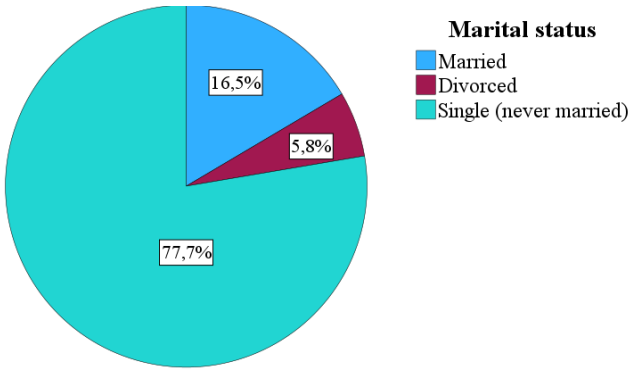
Appendix D – Sample Characterization Additional Graphs

Participants' Level of education (Author's elaboration using SPSS data):

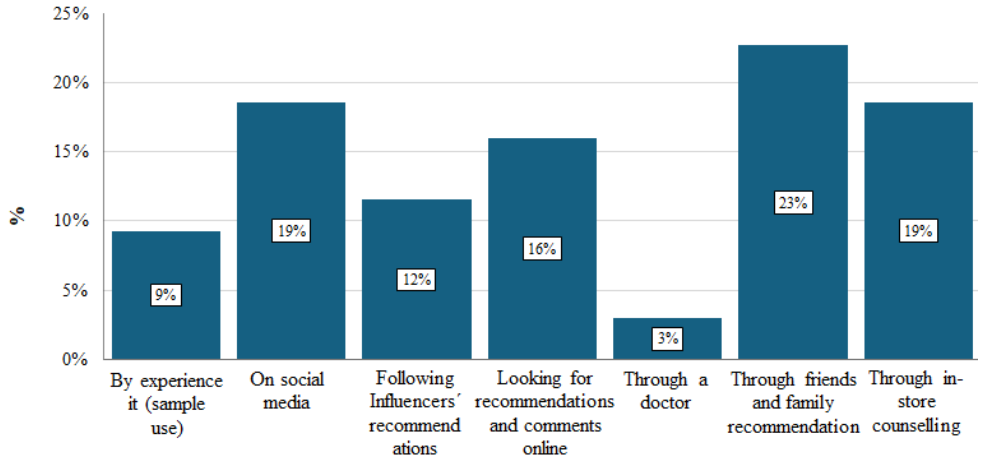


Participants' Occupation (Author's elaboration using SPSS data):

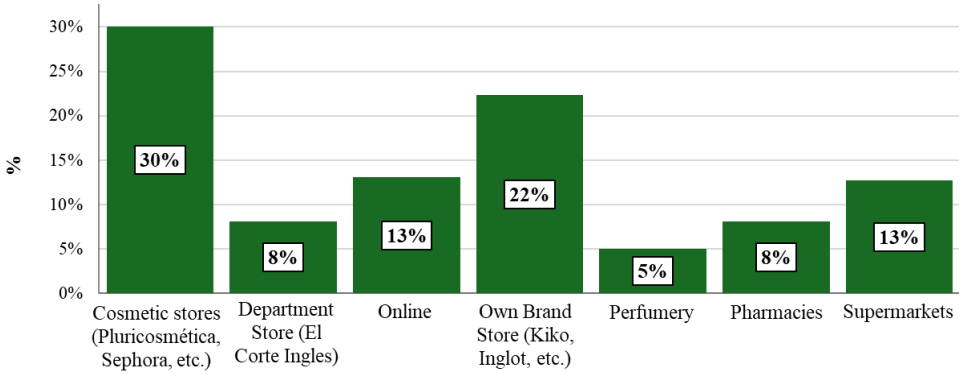
Participants' Marital Status (Author's elaboration using SPSS data):



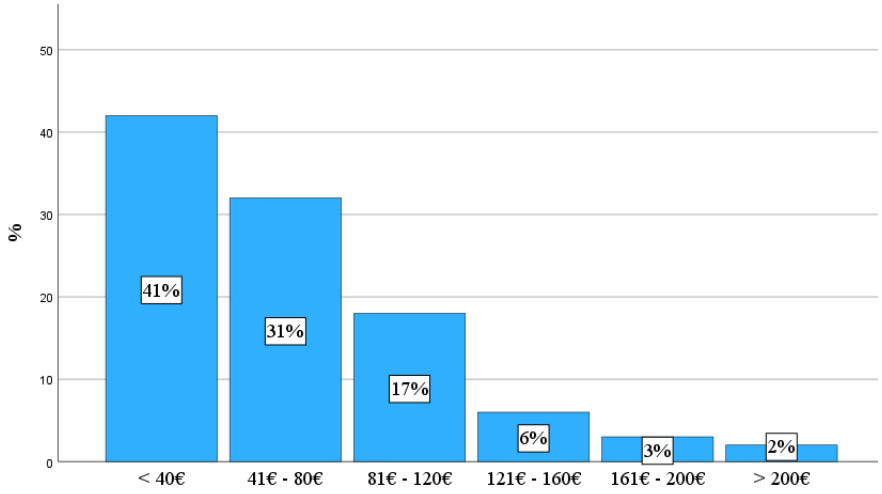
Where participants look for information about makeup products (Author's elaboration using SPSS data):



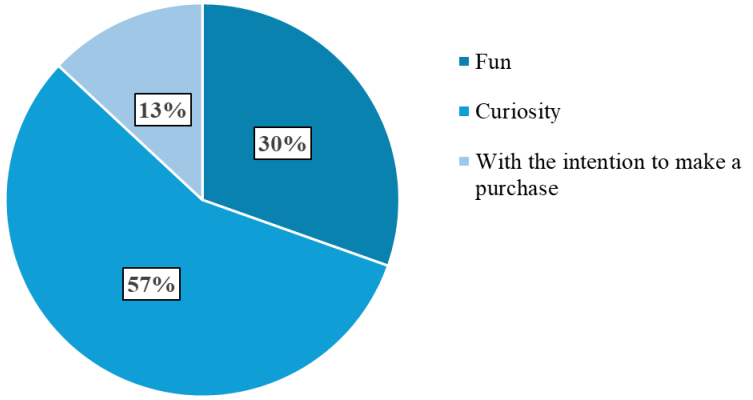
Participants' Preferred place to buy makeup products (Author's elaboration using SPSS data):



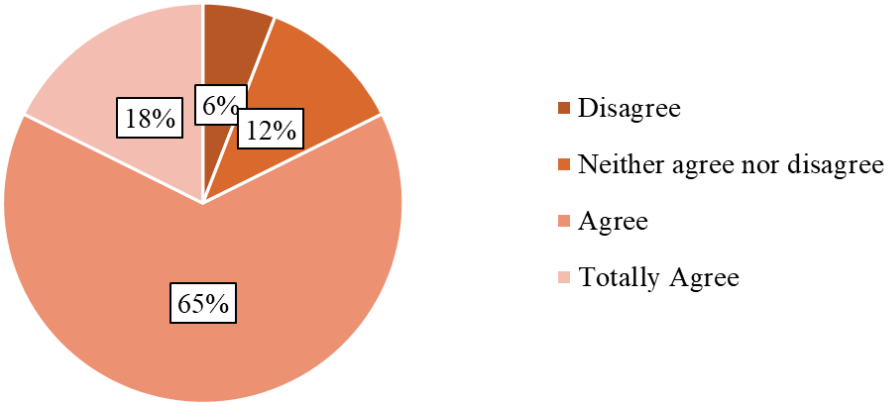
Participants' Annual expenditure on makeup products (Author's elaboration using SPSS data):



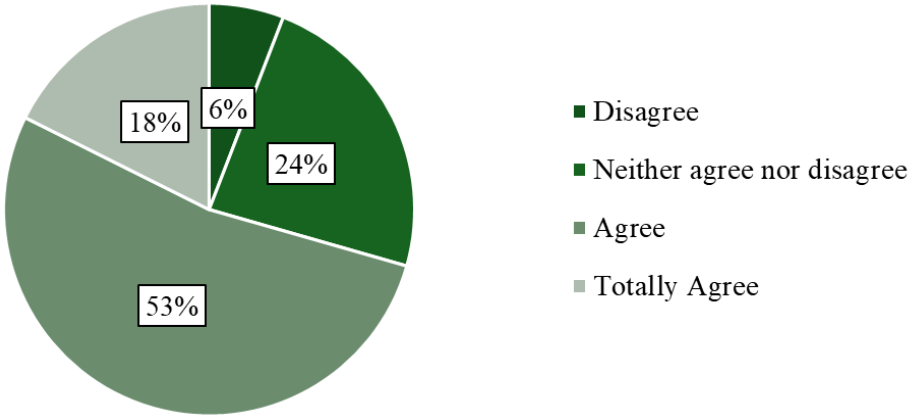
Participants' Reasons for previous VTO's usage (Author's elaboration using Excel data):



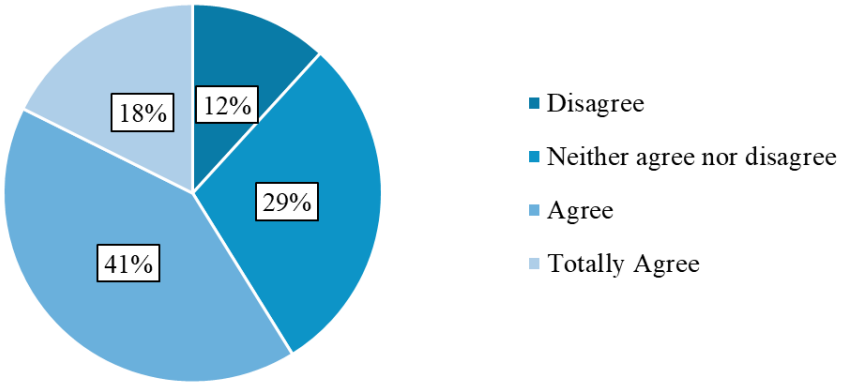
Participants' Answers to the question: "It was easy to use the Virtual Try-on system." (Author's elaboration using Excel data):



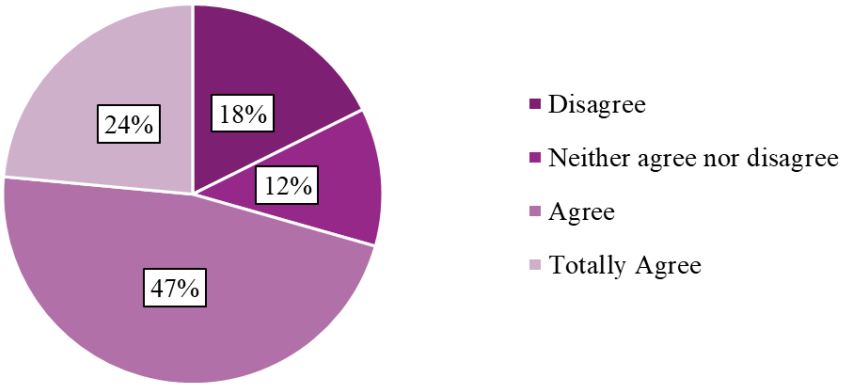
Participants' Answers to the question: "I enjoyed using the Virtual Try-on system". (Author's elaboration using Excel data):



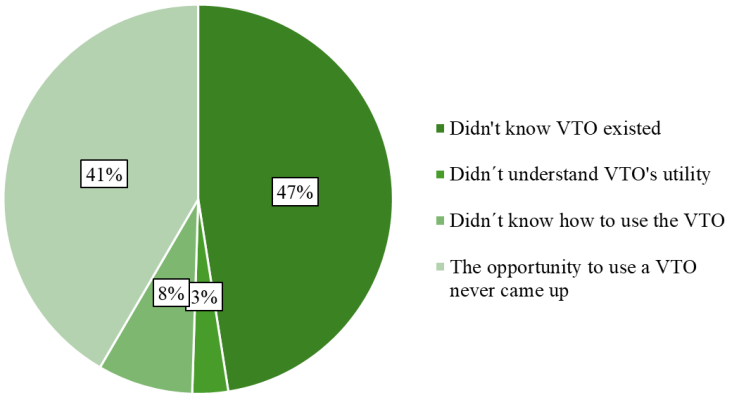
Participants' Answers to the question: "I found the Virtual Try-on system a useful tool". (Author's elaboration using Excel data):



Participants' Answers to the question: "I would use this system again in the future". (Author's elaboration using Excel data):



Participants' Reasons for never having used a VTO before (Author's elaboration using Excel data):



Appendix E – Detailed Mean Values (SPSS Outputs)

Interactivity

Descriptive Statistics

	N	Minimum	Maximum	Mean
AR_I1. Sou capaz de interagir com o sistema de VTO para obter informações adaptadas às minhas necessidades específicas.	103	1	5	4,02
AR_I2. O grau de interação com o sistema de VTO é suficiente.	103	1	5	3,60
AR_I3. O sistema de VTO tem características de interação que me permitem receber informações personalizadas sobre os produtos de maquilhagem.	103	2	5	3,75
AR_I4. O sistema de VTO tem características de interação que me ajudam a tomar uma decisão na seleção de produtos de maquilhagem.	103	1	5	3,88
Interactivity_Score	103	2,00	5,00	3,8131
Valid N (listwise)	103			

System Quality

Descriptive Statistics

	N	Minimum	Maximum	Mean
AR_SQ1. O sistema de VTO responde prontamente aos meus pedidos e fornece bons resultados.	103	2	5	3,68
AR_SQ2. O sistema de VTO desempenha as suas funções de forma rápida e eficiente.	103	1	5	3,83
AR_SQ3. O sistema de VTO é fiável (está sempre a funcionar, funciona sem sem erros e faz o que é suposto fazer).	103	1	5	3,42
AR_SQ4. O sistema de VTO fornece serviços perfeitos e precisos, de acordo com o objetivo do sistema	103	1	5	3,26
AR_SQ5. A experiência virtual satisfaz plenamente as minhas necessidades.	103	1	5	3,15
SistemQuality_Score	103	1,80	5,00	3,4660
Valid N (listwise)	103			

Product Informativeness

Descriptive Statistics

	N	Minimum	Maximum	Mean
AR_PI1. O sistema de VTO apresenta as informações que eu esperava.	103	2	5	3,90
AR_PI2. O sistema de VTO fornece informações pormenorizadas sobre os produtos.	103	1	5	3,54
AR_PI3. O sistema de VTO fornece informações completas sobre os produtos.	103	1	5	3,54
AR_PI4. O sistema de VTO fornece informações que me ajudam na minha decisão.	103	2	5	3,89
AR_PI5. O sistema de VTO fornece informações para comparar produtos	103	2	5	3,89
ProductInformativeness_Score	103	2,00	5,00	3,7553
Valid N (listwise)	103			

Reality Congruence

Descriptive Statistics

	N	Minimum	Maximum	Mean
AR_RC1. O sistema de VTO apresenta os produtos virtuais de forma impressionante (como se estivessem efetivamente no meu rosto).	103	1	5	3,52
AR_RC2. O sistema de VTO apresenta os produtos virtuais de forma visualmente apelativa.	103	1	5	3,83
AR_RC3. O sistema de VTO apresenta os produtos virtuais (por exemplo, cores, formas) de forma realista.	103	1	5	3,57
AR_RC4. No geral, considero que o sistema de VTO apresenta os produtos virtuais de forma atrativa.	103	1	5	3,87
RealityCongruence_Score	103	1,00	5,00	3,7015
Valid N (listwise)	103			

Perceived Usefulness

Descriptive Statistics

	N	Minimum	Maximum	Mean
TAM_PU1. O sistema de VTO aumenta a minha capacidade de fazer escolhas de produtos de forma mais eficaz.	103	1	5	3,79
TAM_PU2. A utilização do sistema de VTO poupa-me tempo.	103	1	5	3,59
TAM_PU3. A utilização do sistema de VTO melhora a qualidade da minha pesquisa de produtos.	103	1	5	3,72
TAM_PU4. O sistema de VTO permite-me obter informações mais rapidamente.	103	1	5	3,72
TAM_PU5. No geral, considero o sistema de VTO útil na minha experiência de compra.	103	1	5	3,85
PU_Score	103	1,00	5,00	3,7340
Valid N (listwise)	103			

Perceived Ease of Use

Descriptive Statistics

	N	Minimum	Maximum	Mean
TAM_PEOU1. Achei o sistema de VTO muito fácil de utilizar.	103	2	5	4,30
TAM_PEOU2. A utilização do sistema de VTO foi intuitiva	103	2	5	4,32
TAM_PEOU3. Foi fácil aprender a utilizar o sistema de VTO.	103	2	5	4,42
TAM_PEOU4. O manuseamento do sistema de VTO foi fácil.	103	2	5	4,32
PEOU_Score	103	2,00	5,00	4,3398
Valid N (listwise)	103			

Perceived Entertainment Value

Descriptive Statistics

	N	Minimum	Maximum	Mean
TAM_PEV1. Considero a utilização do sistema de VTO prazerosa.	103	1	5	3,74
TAM_PEV2. O processo de utilização do sistema de VTO é agradável.	103	2	5	3,87
TAM_PEV3. Divirto-me a utilizar o sistema de VTO.	103	1	5	4,02
PEV_Score	103	1,67	5,00	3,8770
Valid N (listwise)	103			

Perceived Privacy Risks (or Privacy Concerns)

Descriptive Statistics

	N	Minimum	Maximum	Mean
PC1. O sistema de VTO recolhe demasiada informação sobre o utilizador.	103	1	5	2,63
PC2. Preocupo-me com a minha privacidade quando utilizo o sistema de VTO.	103	1	5	3,20
PC3. Tenho dúvidas quanto ao grau de proteção da minha privacidade durante a utilização do sistema de VTO.	103	1	5	3,02
PC4. As minhas informações pessoais podem ser utilizadas indevidamente quando a câmara está a funcionar.	103	1	5	3,04
PrivacyConcerns_Score	103	1,00	4,75	2,9733
Valid N (listwise)	103			

Attitudes towards using

Descriptive Statistics

	N	Minimum	Maximum	Mean
TAM_AT1. A minha opinião sobre o sistema de VTO é positiva.	103	1	5	3,94
TAM_AT2. O sistema de VTO é tão interessante que só apetece saber mais sobre ele.	103	1	5	3,25
TAM_AT3. Faz sentido usar o sistema de VTO.	103	1	5	3,83
TAM_AT4. O sistema de VTO é uma boa ideia.	103	1	5	4,18
TAM_AT5. As outras pessoas também deviam usar o sistema de VTO.	103	2	5	3,83
Attitudes_Score	103	1,40	5,00	3,8097
Valid N (listwise)	103			

Intended Use

Descriptive Statistics

	N	Minimum	Maximum	Mean
IUOS1. ...utilizaria imediatamente o sistema de VTO.	103	1	5	3,31
IUOS2. ...daria prioridade ao sistema de VTO em relação a uma loja física.	103	1	5	2,56
IUOS3. ...daria prioridade ao sistema de VTO em relação a outras lojas online.	103	1	5	3,71
IUOS4. ...recomendaria a utilização do sistema de VTO aos meus amigos.	103	1	5	3,85
IUOS5. ...utilizarei regularmente o sistema de VTO no futuro.	103	1	5	3,31
IUOS_Score	103	1,00	5,00	3,3495
Valid N (listwise)	103			

Appendix F – Cronbach's Alpha (SPSS Output)

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,957	,959	44

Appendix G – Correlation Matrix (SPSS Output)

Correlations

		ScoreInteractivity	ScoreSQ	ScorePI	ScoreRC	ScorePC	ScorePEOU	ScorePU	ScorePEV	ScoreAT	ScoreIUSO
ScoreInteractivity	Pearson Correlation	--									
	N	103									
ScoreSQ	Pearson Correlation	,772**	--								
	Sig. (2-tailed)	<,001									
	N	103	103								
ScorePI	Pearson Correlation	,712**	,706**	--							
	Sig. (2-tailed)	<,001	<,001								
	N	103	103	103							
ScoreRC	Pearson Correlation	,714**	,700**	,685**	--						
	Sig. (2-tailed)	<,001	<,001	<,001							
	N	103	103	103	103						
ScorePC	Pearson Correlation	-,047	-,063	-,120	,029	--					
	Sig. (2-tailed)	,638	,528	,228	,770						
	N	103	103	103	103	103					
ScorePEOU	Pearson Correlation	,476**	,486**	,459**	,366**	-,108	--				
	Sig. (2-tailed)	<,001	<,001	<,001	<,001	,276					
	N	103	103	103	103	103	103				
ScorePU	Pearson Correlation	,744**	,697**	,719**	,659**	-,030	,573**	--			
	Sig. (2-tailed)	<,001	<,001	<,001	<,001	,763	<,001				
	N	103	103	103	103	103	103	103			
ScorePEV	Pearson Correlation	,557**	,456**	,565**	,490**	-,040	,508**	,597**	--		
	Sig. (2-tailed)	<,001	<,001	<,001	<,001	,687	<,001	<,001			
	N	103	103	103	103	103	103	103	103		
ScoreAT	Pearson Correlation	,715**	,635**	,690**	,662**	-,165	,509**	,721**	,559**	--	
	Sig. (2-tailed)	<,001	<,001	<,001	<,001	,096	<,001	<,001	<,001		
	N	103	103	103	103	103	103	103	103	103	
ScoreIUSO	Pearson Correlation	,686**	,683**	,645**	,684**	-,055	,451**	,754**	,509**	,760**	--
	Sig. (2-tailed)	<,001	<,001	<,001	<,001	,578	<,001	<,001	<,001	<,001	
	N	103	103	103	103	103	103	103	103	103	103

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

Appendix H – Linear Regression Models (SPSS Outputs)

Perceived Usefulness as the dependent variable and SQ, PI and RC as the independent variables:

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,778[a]	,605	,593	2,58442	2,008

a. Predictors: (Constant), ScoreRC, ScorePI, ScoreSQ

b. Dependent Variable: ScorePU

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1013,531	3	337,844	50,581	<,001[b]
	Residual	661,246	99	6,679		
	Total	1674,777	102			

a. Dependent Variable: ScorePU

b. Predictors: (Constant), ScoreRC, ScorePI, ScoreSQ

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-,623	1,665		-,374	,709		
	ScoreSQ	,340	,114	,294	2,990	,004	,413	2,420
	ScorePI	,525	,133	,380	3,946	<,001	,430	2,326
	ScoreRC	,239	,118	,193	2,017	,046	,437	2,290

a. Dependent Variable: ScorePU

Perceived Entertainment Value as the dependent variable and Interactivity and RC as the independent variables:

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,572[a]	,327	,314	1,69271	1,814

a. Predictors: (Constant), ScoreRC, ScoreInteractivity

b. Dependent Variable: ScorePEV

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	139,454	2	69,727	24,335	<,001[b]
	Residual	286,527	100	2,865		
	Total	425,981	102			

a. Dependent Variable: ScorePEV

b. Predictors: (Constant), ScoreRC, ScoreInteractivity

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	5,294	,924		5,728	<,001		
	ScoreInteractivity	,302	,084	,423	3,611	<,001	,490	2,039
	ScoreRC	,117	,073	,188	1,603	,112	,490	2,039

a. Dependent Variable: ScorePEV

Perceived Usefulness as the Dependent Variable and PEOU as the independent variable:

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,573[a]	,328	,322	3,33756

a. Predictors: (Constant), ScorePEOU

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	3,624	2,167		1,672	,098
	ScorePEOU	,867	,123	,573	7,025	<,001

a. Dependent Variable: ScorePU

Perceived Entertainment Value as the dependent variable and PEOU as the independent Variable:

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,508[a]	,258	,251	1,76888

a. Predictors: (Constant), ScorePEOU

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	4,902	1,148		4,268	<,001
	ScorePEOU	,388	,065	,508	5,928	<,001

a. Dependent Variable: ScorePEV

Attitudes towards using as the dependent variable and PU, PEOU, PEV and PC as the independent variables:

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,754[a]	,569	,551	2,30466	1,758

a. Predictors: (Constant), ScorePC, ScorePU, ScorePEOU, ScorePEV

b. Dependent Variable: ScoreAT

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	686,233	4	171,558	32,300	<,001[b]
	Residual	520,524	98	5,311		
	Total	1206,757	102			

a. Dependent Variable: ScoreAT

b. Predictors: (Constant), ScorePC, ScorePU, ScorePEOU, ScorePEV

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	6,350	1,865		3,405	<,001		
	ScorePU	,480	,076	,566	6,294	<,001	,545	1,836
	ScorePEOU	,105	,108	,082	,974	,332	,622	1,608
	ScorePEV	,293	,144	,174	2,038	,044	,602	1,660
	ScorePC	-,127	,064	-,132	-1,976	,051	,987	1,013

a. Dependent Variable: ScoreAT

Intended Use of VTO for Shopping Online and AT as the independent variable:

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,760[a]	,578	,574	2,72608

a. Predictors: (Constant), ScoreAT

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-,841	1,519		-,554	,581
	ScoreAT	,923	,078	,760	11,766	<,001

a. Dependent Variable: ScoreIUOS

Appendix I – Multiple Linear Regression Assumptions (SPSS Outputs)

<u>Perceived Usefulness as the dependent variable and SQ, PI and RC as the independent variables:</u>

1) Linearity of the relationship between each X and Y

By construction, the theoretical model assumes linearity:

Perceived Usefulness = $\beta 0 + \beta 1$ * Product Informativeness + $\beta 2$ * System Quality + $\beta 3$ * Reality Congruence + ε

2) The mean of the residual component of the model is zero: $E(\varepsilon_i) = 0$

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	9,9060	25,7884	18,6699	3,15223	103
Residual	-6,90551	5,45956	,00000	2,54613	103
Std. Predicted Value	-2,780	2,258	,000	1,000	103
Std. Residual	-2,672	2,112	,000	,985	103

a. Dependent Variable: ScorePU

3) The independent variables are not correlated with the residual terms: $Cov(\varepsilon_i, X_k) = 0$

Correlations

		Unstandardized Residual	ScoreSQ	ScorePI	ScoreRC
Unstandardized Residual	Pearson Correlation	1	,000	,000	,000
	Sig. (2-tailed)		1,000	1,000	1,000
	N	103	103	103	103
ScoreSQ	Pearson Correlation	,000	1	,706**	,700**
	Sig. (2-tailed)	1,000		<,001	<,001
	N	103	103	103	103
ScorePI	Pearson Correlation	,000	,706**	1	,685**
	Sig. (2-tailed)	1,000	<,001		<,001
	N	103	103	103	103
ScoreRC	Pearson Correlation	,000	,700**	,685**	1
	Sig. (2-tailed)	1,000	<,001	<,001	
	N	103	103	103	103

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

4) There is no correlation among the residual terms: $Cov(\varepsilon_i, \varepsilon_j) = 0, \quad i \neq j$

Model Summary[b]

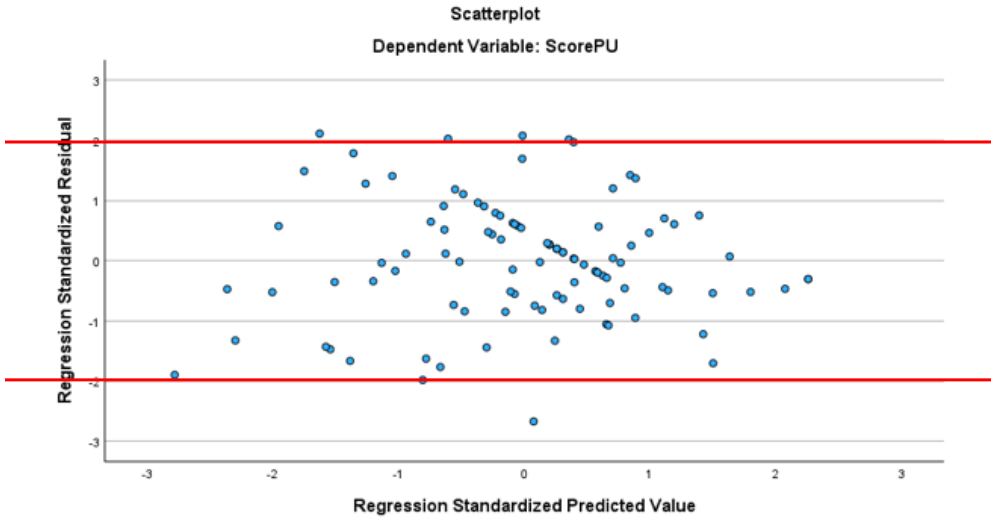
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,778[a]	,605	,593	2,58442	2,008

a. Predictors: (Constant), ScoreRC, ScorePI, ScoreSQ

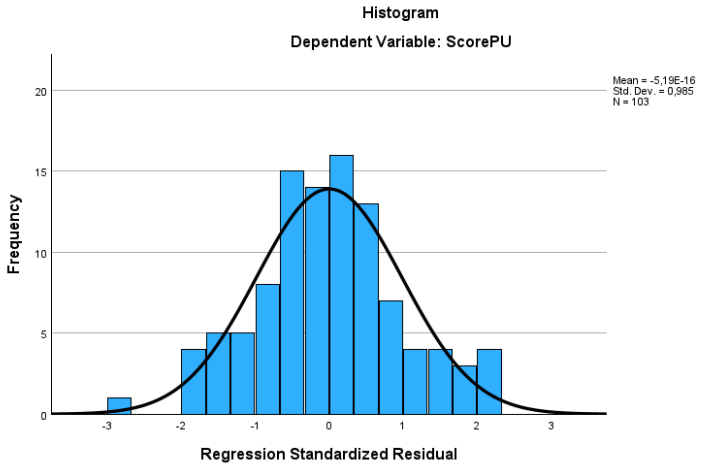
b. Dependent Variable: ScorePU

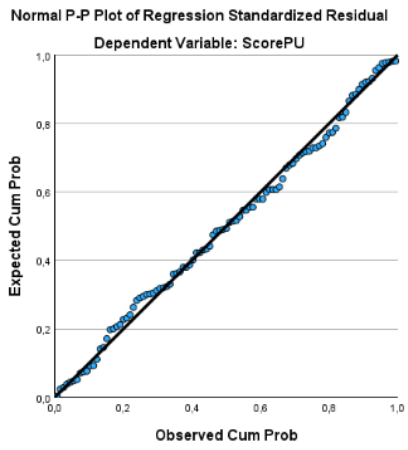
Since the value of the Durbin-Watson is close to 2, residuals are assumed to be independent.

5) The variance of the random term is constant: $Var(\varepsilon_i) = \sigma^2$



6) Normality of the residuals: $\varepsilon_i \cap N(0, \sigma^2)$





7) There is no correlation among the explanatory variables:

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	-,623	1,665		-,374	,709		
	ScoreSQ	,340	,114	,294	2,990	,004	,413	2,420
	ScorePI	,525	,133	,380	3,946	<,001	,430	2,326
	ScoreRC	,239	,118	,193	2,017	,046	,437	2,290

a. Dependent Variable: ScorePU

Conclusion:

- since TOL > 0.1 for all independent variables, the conclusion is that they are not correlated among themselves, and the assumption holds.
- since VIF < 10 for all explanatory variables, conclude that there is no serious correlation among themselves and therefore the assumption holds.

Perceived Entertainment Value as the dependent variable and Interactivity and RC as the independent variables:

1) Linearity of the relationship between each X and Y

By construction, the theoretical model assumes linearity:

Perceived Entertainment Value = $\beta 0 + \beta 1$ * Interactivity + $\beta 2$ * Reality Congruence + ε

2) The mean of the residual component of the model is zero: $E(\varepsilon_i) = 0$

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	8,2931	13,6724	11,6311	1,16927	103
Residual	-4,20358	4,37749	,00000	1,67603	103
Std. Predicted Value	-2,855	1,746	,000	1,000	103
Std. Residual	-2,483	2,586	,000	,990	103

a. Dependent Variable: ScorePEV

3) The independent variables are not correlated with the residual terms: $Cov(\varepsilon_i, X_k) = 0$

Correlations

		Unstandardized Residual	ScoreInteractivity	ScoreRC
Unstandardized Residual	Pearson Correlation	1	,000	,000
	Sig. (2-tailed)		1,000	1,000
	N	103	103	103
ScoreInteractivity	Pearson Correlation	,000	1	,714**
	Sig. (2-tailed)	1,000		<,001
	N	103	103	103
ScoreRC	Pearson Correlation	,000	,714**	1
	Sig. (2-tailed)	1,000	<,001	
	N	103	103	103

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

4) There is no correlation among the residual terms: $Cov(\varepsilon_i, \varepsilon_j) = 0, \quad i \neq j$

Model Summary[b]

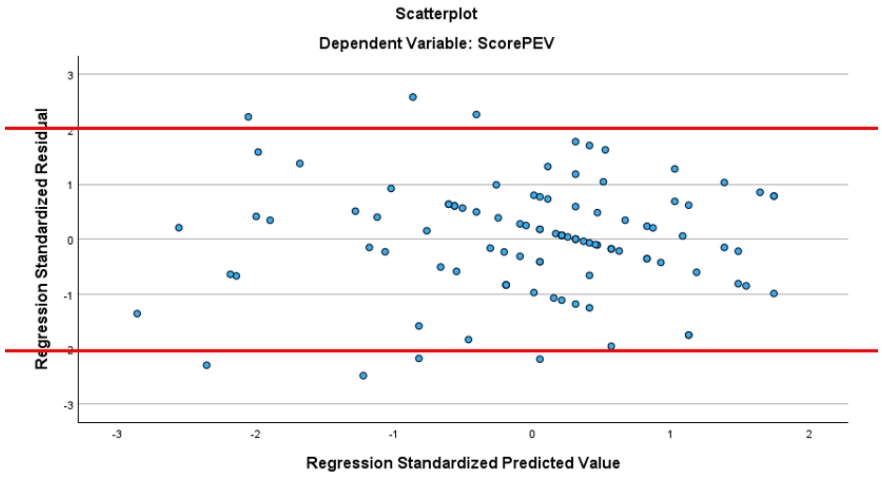
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,572[a]	,327	,314	1,69271	1,814

a. Predictors: (Constant), ScoreRC, ScoreInteractivity

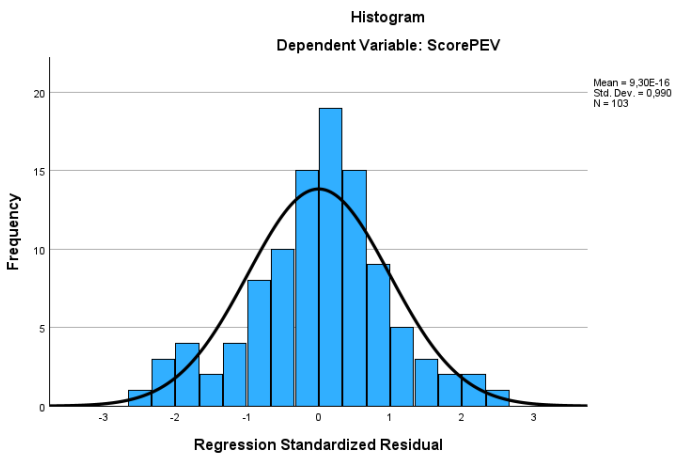
b. Dependent Variable: ScorePEV

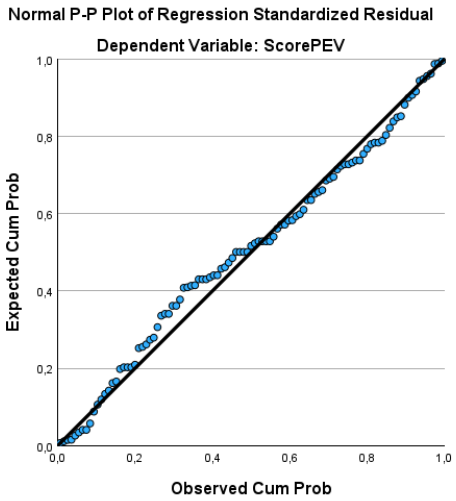
Since the value of the Durbin-Watson is close to 2, residuals are assumed to be independent.

5) The variance of the random term is constant: $Var(\varepsilon_i) = \sigma^2$



6) Normality of the residuals: $\varepsilon_i \cap N(0, \sigma^2)$





7) There is no correlation among the explanatory variables

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	5,294	,924		5,728	<,001		
	ScoreInteractivity	,302	,084	,423	3,611	<,001	,490	2,039
	ScoreRC	,117	,073	,188	1,603	,112	,490	2,039

a. Dependent Variable: ScorePEV

Conclusion:

- Since TOL > 0.1 for all independent variables, the conclusion is that they are not correlated among themselves, and the assumption holds.
- Since VIF < 10 for all explanatory variables, conclude that there is no serious correlation among themselves and therefore the assumption holds.

Attitudes towards using as the dependent variable and PU, PEOU, PEV and PC as the independent variables:

1) Linearity of the relationship between each X and Y

By construction, the theoretical model assumes linearity:

Attitude towards Using VTO = $\beta 0 + \beta 1$ * PU + $\beta 2$ * PEOU + $\beta 3$ * PEV + $\beta 4$ * PC + ε

2) The mean of the residual component of the model is zero: $E(\varepsilon_i) = 0$

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	10,0015	23,6202	19,0485	2,59380	103
Residual	-5,96121	5,80400	,00000	2,25902	103
Std. Predicted Value	-3,488	1,763	,000	1,000	103
Std. Residual	-2,587	2,518	,000	,980	103

a. Dependent Variable: ScoreAT

3) The independent variables are not correlated with the residual terms: $Cov(\varepsilon_i, X_k) = 0$

Correlations

		Unstandardized Residual	ScorePU	ScorePEOU	ScorePEV	ScorePC
Unstandardized Residual	Pearson Correlation	1	,000	,000	,000	,000
	Sig. (2-tailed)		1,000	1,000	1,000	1,000
	N	103	103	103	103	103
ScorePU	Pearson Correlation	,000	1	,573**	,597**	-,030
	Sig. (2-tailed)	1,000		<,001	<,001	,763
	N	103	103	103	103	103
ScorePEOU	Pearson Correlation	,000	,573**	1	,508**	-,108
	Sig. (2-tailed)	1,000	<,001		<,001	,276
	N	103	103	103	103	103
ScorePEV	Pearson Correlation	,000	,597**	,508**	1	-,040
	Sig. (2-tailed)	1,000	<,001	<,001		,687
	N	103	103	103	103	103
ScorePC	Pearson Correlation	,000	-,030	-,108	-,040	1
	Sig. (2-tailed)	1,000	,763	,276	,687	
	N	103	103	103	103	103

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

4) There is no correlation among the residual terms: $Cov(\varepsilon_i, \varepsilon_j) = 0, \quad i \neq j$

Model Summary[b]

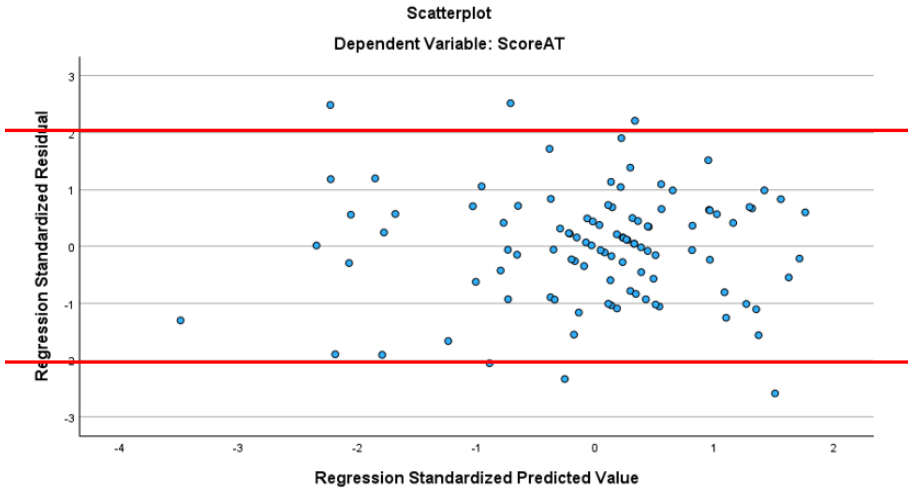
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,754[a]	,569	,551	2,30466	1,758

a. Predictors: (Constant), ScorePC, ScorePU, ScorePEOU, ScorePEV

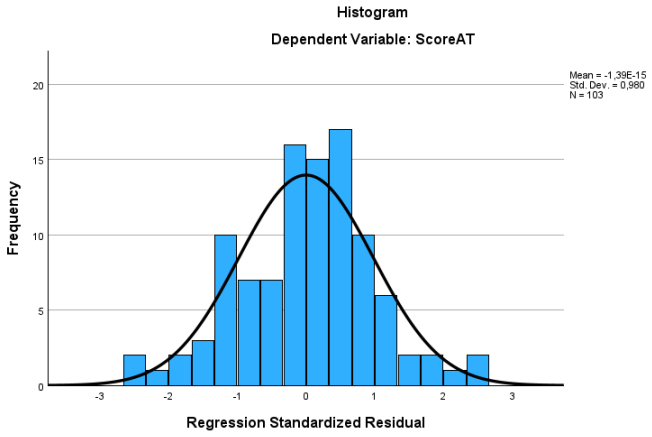
b. Dependent Variable: ScoreAT

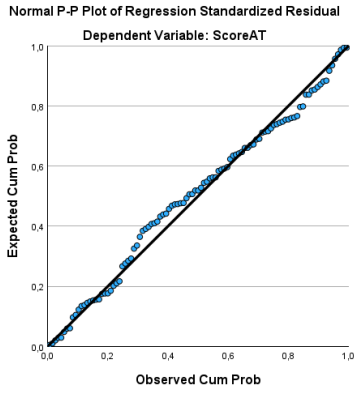
Since the value of the Durbin-Watson is close to 2, residuals are assumed to be independent.

5) The variance of the random term is constant: $Var(\varepsilon_i) = \sigma^2$



6) Normality of the residuals: $\varepsilon_i \cap N(0, \sigma^2)$





7) There is no correlation among the explanatory variables

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	6,350	1,865		3,405	<,001		
	ScorePU	,480	,076	,566	6,294	<,001	,545	1,836
	ScorePEOU	,105	,108	,082	,974	,332	,622	1,608
	ScorePEV	,293	,144	,174	2,038	,044	,602	1,660
	ScorePC	-,127	,064	-,132	-1,976	,051	,987	1,013

a. Dependent Variable: ScoreAT

Conclusion:

- Since TOL > 0.1 for all independent variables, the conclusion is that they are not correlated among themselves, and the assumption holds.
- Since VIF < 10 for all explanatory variables, conclude that there is no serious correlation among themselves and therefore the assumption holds.