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Building Blocks for a Better Buyer Experience

Consumer Perceptions of Blockchain Authentication Methods in
Second-Hand Luxury E-Commerce

by

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Abstract

Title	Building Blocks for a Better Buyer Experience: Consumer Perceptions of Blockchain Authentication Methods in Second-Hand Luxury E-Commerce
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Authors	Lisa Alm, Amanda Gerth & Katie Fajer
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Keywords	Second-hand luxury e-commerce, Blockchain technology, Authentication, Perceived Risk, Theory of Planned Behaviour, Consumer Behaviour.
Thesis Purpose	To explore consumer perspectives towards the implementation blockchain technology as a service offered within the authentication of second-hand vintage luxury e-commerce
Methodology	This quantitative research study utilises an independent sample t-test to compare Perceived Risk, Attitudes, Perceived Behavioural Control, Subjective Norms, and Purchase Intention in regard to authentication method surveyed. Mediation analyses were performed to examine the mediating effects of each variable on the relationship between authentication method and Purchase Intention.
Theoretical Perspective	The theoretical foundation of this study is primarily grounded in “Risk theory in consumer behaviour” as proposed by Taylor, (1974) as well as Ajzen’s (1985) Theory of Planned Behaviour.
Empirical Data	A web survey was distributed through internet forums, gathering 190 respondents who were randomly assigned to answer questions regarding either Blockchain Authentication (90 respondents) or Traditional Paper Authentication (86 respondents).
Findings	The data analysis confirmed that Perceived Risk was lower among participants who received the blockchain authentication survey. Additionally, increased Perceived Behavioural Control was observed among these respondents. Mediating effects on the relationship between Authentication Method and Purchase Intention were also deemed to be present through these variables.
Implications	This thesis fills a research gap by examining consumer perceptions in relations to Blockchain Authentication within luxury resale e-commerce, creating a foundation for future consumer-based research in the field. The study confirms that by implementing Blockchain Authentication luxury resale e-platforms may lower perceived risk among consumers as well as increase perceived behavioural control, and thereby increase Purchase Intention.

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1 Introduction

The following chapter introduces the research topic by providing a background and describing related concepts with the purpose of familiarizing the reader with the subject. This is followed by defining the research aims, objectives and purpose of the study, concluding with a general outline of the thesis.

1.1 Background

The second-hand luxury fashion market has grown significantly over the past few years, driven by changing consumer behaviours and digitization, leading to a surge in second-hand luxury e-commerce platforms (Beauloye, 2023; Berg et al., 2021; Statista, 2023a). Several forces have contributed to this growth, with consumers increasingly seeking rare and unique luxury items at more affordable prices, as well as the option to purchase more sustainably (Beauloye, 2023; Berg et al., 2021). However, this growth has been followed by an upturn in counterfeit luxury items, which undermine consumer trust, tarnish brand reputation, and consequently result in lower profits (Cho, Fang & Tayur, 2015; de Boissieu et al., 2021). Traditional authentication methods alone prove too vulnerable to be able to proactively counter this challenge (Li, Fan & Wu, 2021). Therefore, there is an urgent need for the second-hand luxury market to implement a more secure, transparent, and reliable solution to authenticate luxury fashion goods. Blockchain technology has recently been introduced as one of these solutions, becoming a growing area of interest in the luxury industry, due to its inherent features of security, decentralization, and immutability (Casino, Dasaklis & Patsakis, 2019). However, although research has been approached from a luxury brand industry perspective, little is known of consumer perceptions regarding this type of authentication method compared to traditional means, and the potential impact on purchase intention within the resale market. This information may serve to inform second-hand luxury e-platforms of the best step forward in mitigating risk, building consumer trust, and potentially increase purchase intention.

1.1.1 Second-hand E-commerce Luxury Industry

As stated above, the second-hand luxury e-commerce industry has experienced significant growth in recent years, with a steady growth rate of eight percent since the year of 2017, resulting in an estimated revenue of 7.157 billion US dollars worldwide in the year 2022 (Statista, 2023a). This growth rate is forecasted to be continuous, providing insights into

consumer interest for the industry. The growth of the industry is predominantly driven by the increasing popularity of sustainable fashion and the desire for unique and rare items (Statista, 2022a). The introduction of online marketplaces for second-hand luxury goods have allowed consumers to have access to a wider range of pre-owned luxury goods than previously available (Ohta, 2022). This development has created a new avenue for retailers to sell their products and for consumers to purchase high-end luxury items at a more affordable price point (Statista, 2022a).

One of the key advantages of the second-hand luxury e-commerce industry is its accessibility to a wider audience. In the past, luxury items were only available to a select few who could afford the high-end price point and were in close proximity to the stores that were often located in bigger metropolitan cities. However, with the growth of e-commerce, luxury items are now available to a larger audience at more affordable prices (Ohta, 2022). Consumers can browse and purchase pre-owned luxury items from the comfort of their own homes, regardless of their location.

E-commerce actors within this industry include brands such as Vestiaire collective and TheRealReal. Scandinavian e-commerce platforms include marketplaces such as A Retro Tale and Miinto. Although the industry is thriving and is expected to continue to do so, it also faces challenges. One of the main challenges for the actors within this market is the prevalence of counterfeit products. The OECD states that the counterfeit product industry accounted for 3.3% of world trade in the year 2016 and is forecasted to continue to gain market shares in the following years (OECD, 2019). The main product category affected by counterfeiting were consumer goods such as footwear, clothing, and leather goods. This phenomenon is further reflected in consumer concerns relating to the consumption of second-hand luxury goods. According to Turunen & Leipämaa-Leskinen (2015) one of the major concerns facing consumers in this industry is the risk of counterfeit products and how the consumption or investment in these may affect them, both financially as well as socially.

1.1.2 Authentication Methods for Luxury Goods

When defining luxury goods, one encounters elements such as high quality, premium pricing, authentic value, and rarity (Ko, Costello & Taylor, 2019). With the increasing sophistication and severity of counterfeit luxury items, the need for authentication has become crucial to reduce risk when trading second-hand luxury goods (Fontana, Girod & Králik, 2019; Li, Fan & Wu, 2021; Singh, Dwivedi & Srivastava, 2020; Webb, 2021). Established second-hand e-commerce platforms such as The RealReal, Vestiaire Collective, and A Retro Tale has sought to combat this issue mainly through an inhouse or third-party team of expert appraisers who manually investigate each product for authenticity, which is typically followed by a physical certificate being issued as proof if the product passes inspection (A Retro Tale, 2022; Vestiaire Collective, 2022; The RealReal, 2022a; Li, Fan & Wu, 2021; Webb, 2021). These professionals examine the products based on their knowledge and experience, scrutinizing materials, craftsmanship, stitching, hardware, logos, and other distinctive features to determine

authenticity. Traditionally, many luxury brands have implemented serial numbers and water marks during production to define a products origin (Ting & Tsang, 2013). Authenticators can then check these details and cross-reference them with brand-specific databases to verify the items legitimacy. Digital methods are, however, becoming increasingly common, where AI-driven authentication services use machine learning algorithms to analyse luxury goods (The RealReal, 2022a; Webb, 2021)

Apart from utilizing serial numbers and watermarks as authenticators, some brands have implemented digital technology such as Near Field Communication (NFC) chips, and Quick Response (QR) codes (Li, Fan & Wu, 2021; Webb, 2021). NFC chips are small, wireless devices embedded in physical items, which enable transfer of data between the chip and an NFC-enabled smartphone or reader in proximity. The chips store digital information about the item, such as its unique identifier, manufacturing details, or a digital certificate of authenticity. QR codes can be printed on labels or directly on to a physical item. When scanned with a smartphone or a QR reader they provide access to digital information related to the product such as a website, digital certificate, or product details.

Although these advancements are a step in the right direction, both the manual and digital implementations of authentication mentioned do not provide the necessary solutions alone as the information can be tampered with and potentially replicated. Thus, the application of blockchain technology as an added layer where information can be stored and tracked more securely, is becoming a growing area of interest in the fight against counterfeit luxury fashion goods.

1.1.3 Blockchain Technology as a Concept

Blockchain technology is a decentralized system that allows for secure and transparent transactions to occur without the need for a central authority (Casino, Dasaklis & Patsakis, 2019; Crosby et al., 2016; Ghosh, 2019; González et al., 2023). The technology relies on a distributed ledger, which records all transactions in a secure and immutable manner. In the resale market, the transaction would be the verification of the item by a professional or the transfer of ownership. Each transaction is validated by a network of computers, and once approved, the transaction is added to the ledger, creating a chain of blocks that is nearly impossible to tamper with (Casino, Dasaklis & Patsakis, 2019; Crosby et al., 2016; Ghosh, 2019; González et al., 2023). This means that blockchain technology can be used to create a secure and transparent record of all transactions within a retail system, including purchases, payments, and inventory tracking (Casino, Dasaklis & Patsakis, 2019; Crosby et al., 2016; Ghosh, 2019; González et al., 2023).

In luxury fashion resale, blockchain technology can provide a transparent and secure record of all transactions from production to sale to resale. This would enable retailers to track the origin of products and verify their authenticity (Crosby et al., 2016). Additionally, blockchain technology can be used to create a secure and transparent payment system, reducing the risk

of fraud, and providing consumers with greater confidence in their purchases (Casino, Dasaklis & Patsakis, 2019; Crosby et al., 2016; Ghosh, 2019). Overall, blockchain technology offers a powerful tool for retailers looking to increase transparency, improve security, and build trust with their customers.

1.1.4 Blockchain Implementation in the Luxury Fashion Industry

As stated above, a major concern for the luxury industry is the prevalence of counterfeit products due to its significant impact, not only in terms of lost revenue, but also the increased perceived risk for consumers associated with the consumption of brands where counterfeits are common. Several actors within the high-end luxury industry have attempted to find ways to counteract this. One of these efforts can be found in the Aura Blockchain consortium, a blockchain solution for luxury brands created by LVMH, Prada Group and Cartier, which is a part of Richemont (Aura Blockchain Consortium, 2022a). The Aura Blockchain Consortium is a collaboration built upon the idea of one single blockchain solution open to all luxury brands worldwide, allowing for increased transparency, traceability, and authenticity. Through blockchain technology, a link can be created between a physical product and a trusted digital identity which is recorded in the blockchain database, thus creating a digital certificate of authenticity to accompany the product throughout its lifecycle (Montecchi, Plangger & Etter, 2019). The Aura Blockchain Consortium may use a QR code and/or an NFC chip, which are in turn linked securely to a blockchain-based database (Aura Blockchain Consortium, 2022b). This in turn allows for a safe and effective transfer of ownership during resale. This indicates that luxury brands have a strong interest in further implementing blockchain as a feasible method of securing their brands in the future.

Mitzner (2022) claims that several additional luxury brands have partnered with blockchain technology to maintain a secure and reliable tracking of materials and supply chain. The author states additionally that the same technology is also able to guarantee the authenticity of the product, something that is crucial for value retention, to support a thriving second-hand market in the future and to aid with identification of counterfeit models which in turn helps fight the counterfeit market. This is further supported by Cairns (2022) who claim that the implementation of blockchain technology within the luxury industry has the potential to save these brands billions due to the diminishing impact it could have on the counterfeit market. Cairns further states that it has the potential to also greatly streamline the authentication processes for second-hand luxury retailers.

1.2 Aim and Objectives

The second-hand luxury fashion resale market continues to face several consequences of counterfeit items, most notably lost profits, a damaged brand image, and a general consumer

mistrust (Hieke, 2010). Traditional paper certificates have long served as the primary method of authenticating luxury goods, however, as technology becomes more sophisticated, traditional procedures have become increasingly easy to forge and products become easier to duplicate. With the recent boom in second hand luxury e-commerce platforms, there is little doubt a new solution is needed in this rapidly expanding industry (Ohta, 2022). As blockchain technology develops and is adopted by luxury brands for their new products, the potential for adoption in the resale market is imminent. There is substantial literature exploring the feasibility of this concept (de Boissieu et al., 2021; Pun, Swaminathan & Hou, 2021; Shen, Xu & Yuan, 2020) however, a lack of research regarding the anticipated consumer reception of this advancement. Therefore, the aim of this study is to better understand the use of blockchain as an authentication method from a consumer's point of view, compare how this measures up to the more common offering of paper authentication, and examine how this may ultimately impact purchase intention. The research presented in this paper seeks to meet the following objectives:

- Examine the influence of Blockchain Authentication on perceived risk among consumers in comparison to paper authentication.
- Investigate the impact of Blockchain Authentication on psychosocial factors that may shape behavioural intention, such as attitudes, subjective norms and perceived behavioural control, in comparison to paper authentication.
- Understand how these factors may subsequently influence purchase intention.
- Investigate whether there may be a mediating effect by these factors on the relationship between authentication methods and Purchase Intention.
- Understand whether authentication methods have a direct impact on consumer purchase intention.

1.3 Research Purpose

The purpose of this research is to provide important insights to second hand luxury e-commerce companies who may benefit from implementing blockchain technology as an authentication method, potentially creating a first mover advantage. Blockchain authentication is currently being introduced as a robust defence against the persistent issue of luxury counterfeits by offering more secure solutions to register and track products, and potentially reduce perceived risk of purchasing luxury products, especially online, where a product can't be physically examined prior to purchase by the consumer. This is therefore an important opportunity to explore for resale luxury e-commerce platforms, where determining and effectively communicating the origin, authenticity, and condition of products can be challenging. If blockchain authentication can contribute to a more secure and genuine marketplace in the eyes of the consumers, this may have the potential to positively impact purchase intention and thereby the bottom line.

This study additionally intends to expand literature on the use of blockchain technology in the luxury resale market, a highly underexplored but important research area considering the growing application of this technology, the boom in luxury resale commerce, and the growing sophistication of counterfeit products (Cho, Fang & Tayur, 2015; Gentry, Putrevu & Shultz, 2006). The research of this study intends to fill a gap in the current literature addressing the potential implementation of blockchain technology by considering the consumer perception towards this advancement as well as create a foundation for further consumer-based research within the field.

1.4 Research Questions

Based on the previously stated information, the thesis at hand seeks to answer the following research questions:

What are consumer perceptions regarding blockchain technology as an authentication method, and how does it compare to the more traditional use of paper authentication?

How does a platform's choice of authentication method potentially effect consumers' purchase intention when shopping on a resale luxury e-platform?

1.5 Outline of the Thesis

The research presented below is divided into seven sections. This first chapter serves as an introduction to the topic, providing relevant background, defining concepts, and providing the purpose of the study. The second chapter provides a comprehensive review of existing literature within second hand luxury consumption and blockchain technology, summarizing current knowledge pertinent to the research. The following chapter presents the theoretical framework, where the research model and hypotheses are outlined and the theories upon which they are drawn are introduced. The fourth chapter outlines methodology, describing how the research was conducted. This includes the approach and design of the research, how data was collected, validity and reliability, and any limitations tied to the research method. Chapter five provides a detailed analysis of the collected data, and the results relating to the previously established hypotheses. In the subsequent chapter the findings are discussed and evaluated, connecting and comparing them to existing literature and applied theory to gain further insights. The final chapter concludes the thesis summarizing key findings, theoretical and managerial implications, any limitations to the study as well as recommendations for future research.

2 Literature Review

The following chapter provides a review of existing literature within second hand luxury consumption and blockchain technology, outlining current research findings relevant to the study at hand. The review begins by exploring what motivates consumers to purchase second hand luxury goods and the perception of risk to better understand consumer behaviour in relation to second hand luxury consumption. This is followed by current insights within blockchain technology, how it's being implemented, and how this pertains to the luxury market. The purpose is to better understand how these two concepts may intersect.

2.1 Second-Hand Luxury Consumption

2.1.1 Second-hand luxury consumption and the motivation to purchase

Previous research within second-hand luxury consumption mainly focuses on antecedents of purchase. According to Turunen & Leipämaa-Leskinen (2015), possessing second-hand luxury goods is characterized by five themes: sustainable choice, real deal, pre-loved treasure, risk investment, and unique find. These themes reflect the environmental responsibility, perceived value, emotional attachment, authenticity concerns embodying both financial and reputational risks, and self-representation through uniqueness associated with buying second-hand luxury items. The study confirms the importance for retailers in the luxury fashion resale market to take into account the perceptions related to authenticity by the consumer, and the underlying structuring of uniqueness on what it means to trade second-hand goods as it is demonstrated to overlap with all other themes. Amatulli et. al. (2018) views determinants to purchasing vintage luxury products as functional, psychological, but also of instrumental and terminal value. Functionality refers to timelessness in the form of durability and superior quality, affordable luxury, and avoidance of waste. Psychological relates to factors such as distinction deriving from the sense of uniqueness and exclusivity of luxury products, status, nostalgia and historical value, emotional bond, and treasure hunt. Instrumental value indicates social acceptance, and finally, terminal value refers to factors such as self-identification and self-fulfillment. Cervellon & Carey, (2012) on the other hand views the principal driver of vintage luxury fashion consumption as nostalgia, which points to the importance of authentic and unique heritage. Sihvonen & Turunen, (2016) examine consumption behaviour at online flea markets, evaluating perceived value. They consequently highlight perceived quality, price, and design as it pertains to age of product, brand availability in terms of scarcity, origin, and authenticity. Additionally, a study by Slaton & Pookulangara (2022) investigates the online consumption of a secondary luxury consumer and find that consumer beliefs including

environmental, frugality, online retailing, and fashion consciousness, positively influence consumer attitudes, which in turn is proved to positively impact purchase intent.

In conclusion motivations of second-hand luxury consumption may vary, but most research commonly find perceptions of authenticity and uniqueness as strong drivers indicating the importance of positive consumer attitudes in regard to these drivers. Understanding the best way to ensure and communicate authenticity is therefore very important when selling second hand luxury goods.

2.1.2 Second-hand luxury consumption and risk perception

Previous research has identified several findings associated with the consumption of second-hand luxury goods. These findings relate to both external and internal aspects of the individual's reasoning throughout the process of making a purchase, and the meanings associated with said purchase. In relation to the risk investment meaning, of the Turunen & Leipämaa-Leskinen (2015) work described in the previous section, the authors found that the authenticity parameter was especially interesting and was described as that of a double-edged sword. The authors explained that authenticity was desired and viewed as something positive, but could also be associated with that of taking a financial or reputational risk. The financial risk was associated with the potential losses that can be experienced through the acquirement of an inauthentic luxury item, and the reputational risk was perceived to be in relation to what others in one's environment might think of the individual in question given that the luxury item would turn out to be inauthentic. The risk investment theme is highly relevant to the research question of this paper, as Turunen & Leipämaa-Leskinen's (2015) research found that the fear of inauthenticity is one of the major factors affecting the consumer in their purchase decision. The authors also highlight that the meanings attached to authenticity appear to be particularly significant, claiming that this is a highly relevant observation for retailers that offer authenticity services.

The importance of the social repercussions in relation to consumption of second-hand luxury goods are also identified by Amatulli, et al. (2018) who claim that second-hand or vintage consumption is closely tied to an individual's desire for social acceptance. This type of consumption might be a way of acquiring acceptance by a specific social group and utilized to create a sense of belonging. This aligns with the findings presented by Turunen & Leipämaa-Leskinen (2015) regarding the consumers perceived social risk, within the Risk Investment meaning, in relation to accidentally purchasing inauthentic goods. It is sensible that an individual perceives the risk of not belonging due to an inauthentic product as highly relevant given their desire to be accepted and to belong.

Furthermore, Pueschel, Chamaret & Parguel, (2017) research introduces the topic of cognitive dissonance in relation to purchase of counterfeit products. The authors introduce a scenario, when the consumer might suspect or might not know if the product is in fact authentic or not but decides to purchase it regardless, and how this will generate cognitive dissonance within

the consumer. Cognitive dissonance is defined by Festinger, (1957) by the drive or need experienced by an individual and the conflict that occurs within when this is not aligned with the individual's self-concept, but instead threatens it. Festinger, (1957) further explains that due to inconsistency between what an individual believes and how they act, they can experience a psychological discomfort that places pressure upon the individual to reduce the dissonance and in turn also the discomfort. In relation to counterfeiting, giving up the purchase of an inauthentic item can act in a dissonance-reducing manner (Pueschel, Chamaret & Parguel, 2017). Pueschel, Chamaret & Parguel's (2017) research further states, in relation to risk perceptions, that consumption of counterfeit luxury consumption mainly had an association with the potential for its impact on psychosocial risks. The psychosocial risk was associated with the potential for being perceived as someone who consumes counterfeit products if caught by others, and in turn its reflection upon the individual by the group and that others might think less of you after the reveal. This can be further described as the psychosocial and social cost that counterfeit consumption might render for an individual (Gistri et al., 2009).

This leads into the relevance of this study, namely, how assured authenticity, through different means such as authenticators or blockchain implementation, can act as a reassurance in relation to the psychosocial and social risks associated with the purchase of second-hand luxury items. What impact do these different authenticity methods render for consumers through the limiting of risk of the product being inauthentic, thereby reducing the risk for the consumer and making their decision process easier.

2.2 Blockchain Technology in Luxury Fashion

2.2.1 Introduction to Blockchain technology

Building on the introduction to blockchain provided in the previous chapter, this technology was introduced by Satoshi Nakamoto in 2008, and is described as a distributed peer-to-peer linked structure that can solve the problem of maintaining the order of transactions and avoiding double-spending issues (Casino, Dasaklis & Patsakis, 2019). Blockchain creates an auditable registry of all transactions by ordering and grouping them in constrained-size structures known as blocks, which share the same timestamp (Casino, Dasaklis & Patsakis, 2019; Crosby et al., 2016). The nodes of the network (miners) link the blocks to each other in chronological order, and each block contains the hash of the previous block to create a blockchain. The system can record and secure transactions involving data, goods, and financial services, where each peer has access to the entire database and its history (Chen, 2018). Transactions are validated and recorded by distributed consensus, removing the need for a trusted central entity (Chen, 2018). Once validated, the transactions become irreversible, verifiable, and permanent on the blockchain. Blockchain technology thus offers a transparent,

secure, and decentralized way of operating with the same level of certainty and at a generally lower cost than centralized systems or trusted third parties; the two primary systems used in retail prior to the introduction of this technology (Casino, Dasaklis & Patsakis, 2019). The most common use of blockchain technology following its introduction has been for cryptocurrencies, with the number of distinct cryptocurrencies growing exponentially in recent years, and blockchain's relevance growing alongside it. Three generations of blockchains can be distinguished. Blockchain 1.0 includes applications enabling digital cryptocurrency transactions, Blockchain 2.0 includes smart contracts and a set of applications extending beyond cryptocurrency transactions, and Blockchain 3.0 includes applications in areas beyond the previous two versions, such as government, health, science, and IoT (Casino, Dasaklis & Patsakis, 2019). According to Montecchi, Plangger & Etter, (2019) blockchain technology can offer powerful solutions to increase consumers' provenance knowledge by enabling tracing of origin, certifying authenticity, tracking custody, and verifying integrity of products. This can in turn reduce perceived risks that may affect purchasing decisions as consumers have limited knowledge of the products they buy in terms of lifecycle (Montecchi, Plangger & Etter, 2019).

2.2.2 Implementations of Blockchain Technology

Although blockchain is not yet used in the authentication of second-hand luxury goods, it has been implemented in other similar uses, which can attest to the feasibility of adapting such technology for this purpose. Mani, Prakash & Lai, (2022) described the use of blockchain in the medical supply chain to increase security and traceability of certain drugs and reduce counterfeits. The article describes traditional supply chains as insecure, manual, anonymous, ineffective, opaque, centralized, and inaccessible. The proposed solution, blockchain technology, is said to have the potential to transform the industry by providing security and transparency (Mani, Prakash & Lai, 2022). The authors focus on the implementation of a proposed system for the drug supply chain using Hyperledger Fabric, a permissioned blockchain network suitable for stakeholders with unique identifiers (Mani, Prakash & Lai, 2022). The proposed system is described as reliable, always available, transparent, secure, and private, which solves many of the issues that exist within the current system. The article concludes with a discussion regarding the use of blockchain technology in COVID-19 vaccine anti-counterfeiting frameworks (Mani, Prakash & Lai, 2022).

Previous research additionally explores the value of blockchain technology for diamond authentication and certification through analytical models. A study by Choi, (2019) compares traditional jewellery retail (TJR) operations with blockchain technology supported (BTS) selling platforms and explores a new model, Model BCR, which combines both. The results show that the BTS platform generates more benefits if the unit net benefit of blockchain technology for authentication and certification is higher than the shopping convenience utility of retailers, however, high certification costs harm all parties in the supply chain (Choi, 2019). Holm & Chester Goduscheit (2020) on the other hand examine the Technology Readiness Level (TRL) of blockchain technology for use in provenance, tracking, and traceability-

related use cases among other non-cryptocurrency scenarios. By implementing the Technology Readiness Level (TRL) framework, a 1-9 scale originally developed by NASA, the study assesses the maturity level of the cases. For example, the case of blockchain-technology-supported platforms for diamond authentication and certification in luxury supply chains (Choi, 2019) is evaluated and assigned a score of 9 on the TRL scale, indicating the legitimacy of this system for current use (Holm & Chester Goduscheit, 2020).

Studies have also examined the use of blockchain technology for anti-counterfeiting measures as well as quality control in retail. Pun, Swaminathan & Hou (2021) examine blockchain anti-counterfeiting measures. The study finds that blockchain adoption may not be beneficial to the manufacturer without government subsidy but can be more effective than differential pricing strategy with government subsidy (Pun, Swaminathan & Hou, 2021). The article advocates for government intervention in the manufacturer's blockchain decision as it benefits the manufacturer, customers, and society (Pun, Swaminathan & Hou, 2021). The study suggests further research on exploring the traceability feature of blockchain in a multi-tier supply chain, motivating online sellers to deploy blockchain, and minimizing customers' privacy concerns (Pun, Swaminathan & Hou, 2021). Quality control, an issue heavily related to counterfeit products, has also been studied in the realm of problems that could potentially be solved with the implementation of blockchain technology. Shen, Xu & Yuan (2020) discuss the value of blockchain technology in disclosing second-hand product quality in a supply chain where contributors consign second-hand products to an online platform that resells them and competes with suppliers of new products (Shen, Xu & Yuan, 2020). The article highlights the increasing popularity of blockchain technology in various industries and its potential in preventing moral hazard problems in resales such as counterfeit or misvalued goods by allowing consumers access to verified information regarding the quality and authenticity of a good rather than leaving purchase decision up to perceived quality by a potentially uninformed consumer (Shen, Xu & Yuan, 2020).

2.2.3 Blockchain Technology Application in New Luxury Production

Blockchain technology, despite being in its infancy, is already on the radar of luxury fashion brands for implementation within their future production and supply chain as a solution to the severe problem of counterfeiting (de Boissieu et al., 2021). Furthermore, the COVID-19 pandemic has accelerated the digitalization of luxury brands' processes, leading to a boom in demand for optimizing their supply chain management. With the potential to revolutionize the luxury goods industry, blockchain technology provides a tamper-proof, traceable, and transparent platform for tracking the origin of luxury products, ensuring authenticity, and verifying the integrity of products (de Boissieu et al., 2021; Noonan & Doran, 2021; Thanasi-Boçe et al., 2022). According to Noonan & Doran, (2021) blockchain technology can therefore additionally offer a solution towards a more ethical supply chain network, offering stakeholders an insight into production and journey of product. De Boissieu et al. (2021) examines several anti-counterfeiting blockchain platforms, such as Everledger, BlockVerify, VeChain, and Luxochain, concluding blockchain-based traceability as safer, more transparent,

and efficient than traditional traceability methods. According to Shih, Bick & Murawski, (2022) blockchain application is recognized by luxury industry experts as highlighting the most essential core values of luxury brands such as protecting heritage and craftsmanship, providing exclusivity, and innovating. Decision-makers in luxury companies may, however, be reluctant to implement blockchain solutions due to their unfamiliarity with the technology, consumer privacy issue when registering ownership, and return on investment (ROI) (de Boissieu et al., 2021; Pun, Swaminathan & Hou, 2021; Shih, Bick & Murawski, 2022). Furthermore, there may be friction between transparency and brand control as it pertains to sensitive company information being publicly available on a blockchain. Luxury brands may also be affected by their size and structure, with family firms being slow to make decisions (de Boissieu et al., 2021). Demonstrating the “plug and play” capability of blockchain applications, which may reduce the concerns about required resources as no further configuration or action would be needed once connected, and inviting suppliers to participate in the blockchain process may help fast-track the implementation of blockchain solutions (de Boissieu et al., 2021). Additionally, to control the spread of information within the network, luxury brands may implement permissioned blockchains instead of public blockchains (de Boissieu et al., 2021). This entails access to the blockchain can be restricted, and participants therefore need permission to join and interact with the blockchain network.

3 Theoretical framework

In this chapter a theoretical framework is introduced including proposed hypotheses and an overview of the research model. The framework draws upon two overarching theoretical concepts relevant to the research at hand; risk theory and the theory of planned behaviour (TPB). Risk theory enables the exploration of perceived risk as it pertains to the authentication method and consumer purchase intention. The theory of planned behaviour facilitates assessment of attitudes, subjective norms, and perceived behavioural control in relation to authentication method and consumer purchase intention.

3.1 Risk Theory

The model titled “Risk taking in consumer behaviour,” presented by Taylor, (1974), describes uncertainty about the outcome and uncertainty about the consequences as two primary types of risk that consumers consider before participating in purchase behaviours, which are described as inherently risky (Taylor, 1974; Bauer, 1960). The model then illustrates the two types of consequences that buyers are concerned about; psycho/social loss and functional/economic loss (Taylor, 1974; Bauer, 1960). The luxury goods resale industry fits this illustration as perceived risk is one of the major contributors to consumer hesitance regarding the purchase of second-hand goods (Turunen & Leipämaa-Leskinen, 2015). It has been found that particularly social risk; the fear of the negative social implications of owning a counterfeit luxury item, dominates consumer concern in this industry (Amatulli et al., 2018; Gistri et al., 2009). Functional/economic loss is another key concern in this industry as luxury items typically bear a considerable financial cost. Consumers frequently view luxury purchases as an investment, citing resale value, and discovering the unintentional purchase of a counterfeit item could result in loss of said investment (Jiachen, 2022). Purchasing online is additionally perceived as riskier than in a physical retail outlet (Lee & Tan, 2003; Tan, 1999) partly due to not being able to physically see, touch, or examine the product prior to purchase (Tan, 1999).

The model presented by Taylor, (1974) further presents that these risks can be mitigated. The author elaborates that consumers reduce uncertainty (of outcome) through the acquisition and handling of information and reduce potential consequences by reducing the amount they put at stake. The model then shows that when risks are reduced through these measures, consumers are more likely to make the decision to buy (increased purchase intention) (Taylor, 1974). Authentication methods contribute to the acquisition and handling of information by making information that is perceived to be reliable available regarding the authenticity of an

item, thus relieving the uncertainty of outcome, and therefore, according to this model, increasing purchase intention. However, the primary aim of this study is to examine whether blockchain technology is considered by consumers to be a more favourable authentication method than the traditional paper certificates. As theorized in relation to the “Risk taking in consumer behaviour” model, authentication methods should increase purchase intention through the reduction of perceived risk. Furthermore, an authentication method which is perceived to be more favourable (measured through the TPB factors) by a consumer would theoretically then provide information which is perceived as more trustworthy. This would therefore mitigate risk and consequently increase purchase intention to a greater degree than a method perceived as inferior.

Based on these findings the following hypotheses are formulated:

H1: Blockchain authentication method affect Perceived Risk such that Perceived Risk will be lower when using blockchain authentication methods rather than Paper Authentication methods.

H5: If an individual has a lower Perceived Risk, then he or she will have increased Purchase Intention.

H10: Perceived Risk will have a mediating effect on the relationship between authentication method and Purchase Intention such that as Perceived Risk decreases, Purchase Intention will increase.

3.2 Theory of Planned Behaviour

The theory of planned behaviour (TPB) stems from the theory of reasoned action (TRA) that was developed by Ajzen & Fishbein, (1975). The theory of reasoned action present two variables, attitudes and subjective norms, that have been found to have an impact on behavioural intention and the actual behaviour. The theory focuses on the relationship between these attitudes and subjective norms and their effect on the way an individual acts depending on the presumed outcome and their motivation to perform an action. This model was then further elaborated upon and developed by Ajzen, (1985) to include the individuals perceived behavioural control, introducing what is now known as the theory of planned behaviour. The introduction of perceived behavioural control encompasses an individual's belief in their ability to carry out the behaviour in question, considering both internal and external factors. These factors - attitudes, subjective norms, and perceived behavioural control – then interact to determine an individual’s intention to engage in a particular behaviour.

3.2.1 Attitudes

The attitude variable included in the theory of planned behaviour refers to the degree of which a person evaluates a certain behaviour as favourable or unfavourable (Ajzen, 1991). The variable seeks to examine the relationship between intention to perform a certain behaviour and the attitudes that are held by, for example, a consumer, towards the behaviour. Thereby, given to what degree a person holds favourable or unfavourable attitudes towards a behaviour, the greater or lesser the chances are of them performing it (Ajzen, 1985). The theory provides a framework that claims that negative attitudes towards a behaviour will result in lower intentions to perform it, and positive attitudes towards a behaviour will in turn result in greater intentions.

Attitudes towards an act is a specific subset of attitudes that was introduced by Ajzen & Fishbein, (1970), specifically separating it from the attitudes that are usually formed in relation to a specific object. Viewing the attitudes being formed in relation to an act provides further insight into an individual's decision-making process. The attitude towards an act involves the formation of beliefs about what consequences might come from performing the act, as well as the subjective evaluation of those consequences. This means, according to the authors, that attitudes towards an act is tied to a behaviour in a specific and given situation that requires individual choice. The attitudes rendered in relation to an act then has an impact on purchase intention.

Furthermore, attitudes are claimed to serve as an important variable in social functions given that they impact behaviour (Bian & Forsythe, 2012). This is especially true for luxury consumption where the social aspect of attitude formation is central according to Bian & Forsythe, (2012). Additionally, in regard to luxury consumption, the authors claim that attitudes have been proven to be of great importance in relation to an individual's decision-making process.

Based on previous studies indicating the advantages of blockchain technology's ability to achieve authentication in a more secure, efficient, and enduring manner (de Boissieu et al., 2021; Noonan & Doran, 2021; Shih, Bick & Murawski, 2022; Thanasi-Boçe et al., 2022), the inference is made that blockchain authentication would therefore have a more positive impact on consumer attitudes. Authenticity and uniqueness are shown to be important drivers within luxury resale consumption (Amatulli et. al. 2018; Cervellon & Carey, 2012; Turunen & Leipämaa-Leskinen, 2015) and, therefore, the method applied to achieve authenticity would theoretically play an important part towards making a favourable evaluation, as attitude refers to the degree of which a person evaluates a certain behaviour as favourable or unfavourable (Ajzen, 1991).

Based on these findings the following hypotheses are formulated:

H2: Blockchain authentication methods will generate positive attitudes related to authentication method to a higher degree than Paper authentication methods.

H11: Attitudes will have a mediating effect on the relationship between authentication method and Purchase Intention such that as Attitudes increase, Purchase Intention will increase.

3.2.2 Subjective norms

The subjective norm variable included in the theory of planned behaviour refers to the social pressures, that are associated with the perceived expectations that an individual experiences, in relation to the act of performing or not performing a certain behaviour (Ajzen, 1991). The social pressures can be associated with an individual's need or want to seek social approval, a sense of belonging or a desire to belong to a particular group (Ajzen, 1985). The variable of subjective norms can be grouped into descriptive norms and injunctive norms (Cialdini, Kallgren & Reno, 1991; Larimer et al., 2004; Rhodes & Courneya, 2003). Injunctive norms can according to Manning, (2009) be defined as social pressures to act in a specific manner due to how you perceive that other people want you to behave. Descriptive norms can in turn be defined as the perceived social pressures that stem from observed behaviour of others. These social pressures then inevitably have an impact on the behaviours that individuals choose to partake in, given the individual's desire to align their behaviour to the desired outcome in relation to the subjective norms they adhere to (Ajzen, 1991; Manning, 2009).

Social pressures take on a particularly significant role in relation to luxury consumption, since consumption of these types of goods often stem from a desire to portray or associate oneself with prestige brands, given what they represent through their manifested associations (Vigneron & Johnson, 1999; Wilcox, Kim & Sen, 2009). This is also true for the desire of signalling group belonging through the mode of consumption of luxury items, as luxury items are often used to impress or to signal one's standing within a social setting (Penz & Stöttinger, 2012; Wiedmann, Hennigs & Siebels, 2009).

In relation to luxury consumption and subjective norms, the topic of counterfeit consumption is also highly relevant. Penz & Stöttinger (2012) found that in the consumption of counterfeit products, there was a social element tied in with the behaviour. The authors claim that a considerable drawback from a social perspective for consumers is the fear and shame of being found consuming and using counterfeit products. Due to the individual image associations and the utilization of luxury brands to display a desired sense of self to signal group belonging, as well as the fear of social repercussions when accidentally or intentionally consuming inauthentic goods, a case can be made for the significance of and need for secure authentication methods. Since blockchain technology is seen as an effective counter measure towards counterfeit products in its ability to securely provide authentication (de Boissieu et al., 2021; Noonan & Doran, 2021; Shih, Bick & Murawski, 2022; Thanasi-Boçe et al., 2022), this study therefore infers the method would have a beneficial impact on subjective norms.

Given the previously proven impact of subjective norms on an individual's intentions, the nature of luxury consumption presented above, and the social considerations related to accidental or intentional consumption of inauthentic goods, we believe that authentication

method's impact on purchase intention will be partially dependent on the subjective norms that the individual is surrounded by. Therefore, the following hypotheses are formulated:

H3: Blockchain authentication methods will have a positive impact on Subjective Norms related to authentication method to a higher degree than Paper Authentication methods.

H12: Subjective Norms will have a mediating effect on the relationship between authentication method and Purchase Intention such that as Subjective Norms increase, Purchase Intention will increase.

3.2.3 Perceived Behavioural Control

The perceived behavioural control (PBC) variable included in the theory of planned behaviour refers to how a person perceives the ease or the difficulty of performing the specific behaviour. A person's perception of this is influenced both by past experiences as well as by anticipated obstacles that might occur in conjunction with the behaviour in the future (Ajzen, 1991). Additionally, the perception of behavioural control is also influenced by second-hand information about the specific behaviour that an individual receives from the people they are surrounded with and their experiences (Ajzen & Madden, 1986).

This variable includes measures for both self-efficacy as well as controllability, two concepts that form the unitary and interrelated variable of perceived behavioural control (Kraft et al., 2005). According to Ajzen, (2002) the self-efficacy component investigates the ease or difficulty that an individual assigns to a specific behaviour. The controllability component focuses on what level of control over the behaviour an individual has in terms of their choice to perform or to not perform the behaviour in question. These two aspects of perceived behavioural control then form a general perception about the level of control an individual holds in relation to a behaviour, in this case purchase intention, making them more or less inclined to take action. The perceived behavioural control is posed to have both an indirect and direct impact on the intentions to perform a behaviour according to (Ajzen & Madden, 1986). The indirect impact affects behaviour through intentions, whilst the direct impact affects behaviour through acting as a substitute for a measure of actual control according to the authors.

Furthermore, Westjohn et al., (2009) propose that consumers who identify with cosmopolitanism and as globally oriented individuals, are more likely to use technology and exhibit a higher degree of technology readiness. As the second-hand luxury industry is highly global in its nature and the introduction of e-commerce has allowed for furthering a global consumption behaviour, it is feasible to assume that the core consumers within the second-hand luxury industry, specifically within e-commerce, identify as globally oriented individuals and are therefore also might exhibit higher technology readiness. In this paper, this would directly translate towards the perceived behavioural control associated with usage of blockchain technology authentication methods. Additionally, earlier findings in regard to

blockchain technology proved that it was perceived as more secure and less risky, which could in turn also lead to an increase in perceived behavioural control (de Boissieu et al., 2021; Noonan & Doran, 2021; Thanasi-Boçe et al., 2022).

In this study, we pose that authentication methods will have an impact on the level of control that an individual perceives to have in relation to their consumption of second-hand luxury goods. The perceived level of behavioural control will in turn affect their purchase intentions towards the specific item in accordance with the theory of planned behaviour. This study poses that, due to the secure nature of blockchain technology and the inability for outside parties to tamper with the digital ledger, that the blockchain authentication method will be perceived to increase the level of control an individual feel they possess over the proof of authenticity for the product they have purchased as well as over their proof of ownership. Therefore, the following hypotheses are formulated:

H4: Blockchain authentication methods will generate greater Perceived Behavioural Control related to authentication method than Paper Authentication methods.

H8: If an individual has more positive Perceived Behavioural Control then he or she will have increased Purchase Intention.

H13: Perceived Behavioural Control will have a mediating effect on the relationship between Authentication Method and Purchase Intention such that as Perceived Behavioural Control increase, Purchase Intention will increase.

3.2.4 Purchase Intention

Ajzen & Fishbein, (1977) suggest intention may be the main predictor of any behaviour. Purchase intention refers to the degree to which a consumer is likely to buy a particular product or service in the near future (Howard & Sheth, 1967). According to Howard & Sheth, (1967) purchase intent makes up the last stage in the customer journey before an actual purchase is made.

There are several studies reviewing factors influencing consumer's online purchase intentions (Amaro & Duarte, 2015; Bianchi & Andrews, 2012; Forsythe et al., 2006). In the case of this study, behaviour is related to the individual's intention to purchase online in relation to the method of authentication that the second-hand luxury e-commerce platform has chosen to implement or offer their consumers. Depending on the attitudes, subjective norms, and perceived behavioural control, that an individual holds towards the concept of authentication of a second-hand luxury item, a potential impact on the consumers purchase intention may be seen as a result. In addition to the theory of planned behaviour by Ajzen, (1985) proving that attitudes, subjective norms, and PBC have an impact on intended behaviour, previous studies confirm these variables may affect online purchase intent (Bian & Forsythe, 2012; Bianchi & Andrews, 2012; Foucault & Scheufele, 2002; Kim & Karpova, 2009; Laohapensang, 2009).

In alignment with the previous descriptions of TPB variables, this study therefore suggests that more positive Attitudes, Subjective Norms, and perceived behaviour control in relation to Blockchain Authentication methods offered by an e-commerce platform will lead to increased purchase intention among consumers. Therefore, the following hypotheses are formulated:

H6: If an individual has more positive Attitudes then he or she will have increased Purchase Intention.

H7: If an individual has more positive Subjective Norms then he or she will have increased Purchase Intention.

H8: If an individual has more positive Perceived Behavioural Control then he or she will have increased Purchase Intention.

Furthermore, due to the secure nature of blockchain technology and its potential to reduce risk, which may increase purchase intent as supported by risk theory (Taylor, 1974; Bauer, 1960) and its subsequent strengths as a method of providing authenticity (de Boissieu et al., 2021; Shih, Bick & Murawski, (2022); Thanasi-Boçe et al., 2022), an important antecedent to purchase of second-hand luxury products (Amatulli et. al. (2018); Cervellon & Carey, 2012; Turunen & Leipämaa-Leskinen, 2015); the study suggests the following hypothesis:

H9: Purchase Intention will be higher when using blockchain authentication methods.

3.3 Research Model

Figure 3.1 is a visualization of the proposed theoretical model and a compiled list of the proposed hypotheses.

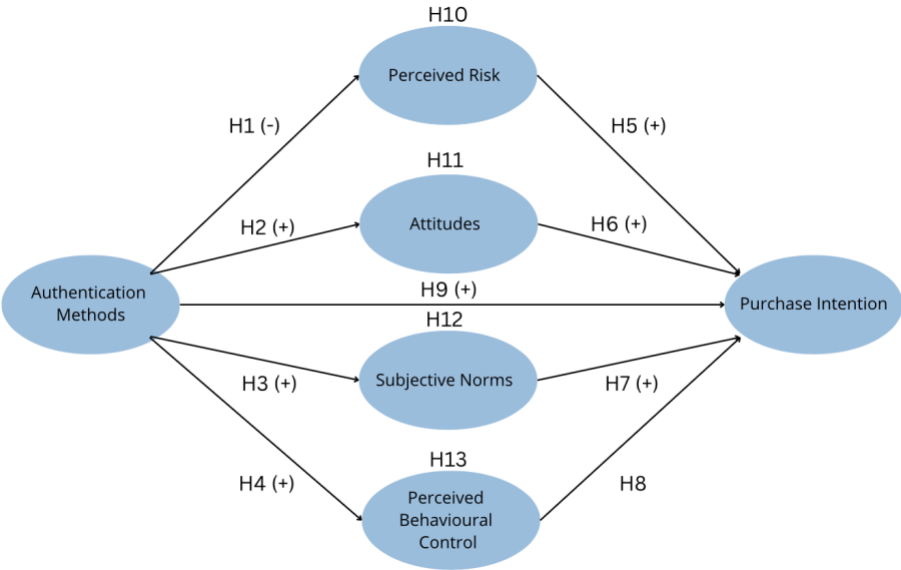


Figure 3.1: Proposed Theoretical Model

H1: Blockchain Authentication methods affect Perceived Risk such that Perceived Risk will be lower when using Blockchain Authentication methods rather than Paper Authentication methods.

H2: Blockchain Authentication methods will generate positive Attitudes related to authentication method to a higher degree than Paper Authentication methods.

H3: Blockchain Authentication methods will have a positive impact on Subjective Norms related to authentication method to a higher degree than Paper Authentication methods.

H4: Blockchain Authentication methods will generate greater Perceived Behavioural Control related to authentication method than Paper Authentication methods.

H5: If an individual has a lower Perceived Risk, then he or she will have increased Purchase Intention.

H6: If an individual has more positive Attitudes then he or she will have increased Purchase Intention.

H7: If an individual has more positive Subjective Norms then he or she will have increased Purchase Intention.

H8: If an individual has more positive Perceived Behavioural Control then he or she will have increased Purchase Intention.

H9: Purchase Intention will be higher when using Blockchain Authentication methods.

H10: Perceived Risk will have a mediating effect on the relationship between authentication method and Purchase Intention such that as Perceived Risk decreases, Purchase Intention will increase.

H11: Attitudes will have a mediating effect on the relationship between authentication method and Purchase Intention such that as Attitudes increase, Purchase Intention will increase.

H12: Subjective Norms will have a mediating effect on the relationship between authentication method and Purchase Intention such that as Subjective Norms increase, Purchase Intention will increase.

H13: PBC will have a mediating effect on the relationship between authentication method and Purchase Intention such that as PBC increase, Purchase Intention will increase.

4 Methodology

The following chapter describes the methodological approach of the study at hand including research philosophy, research design, and how the research was conducted. This includes a description of how data was collected, the sample used, the validity and reliability of the study, as well as any limitations to the research method.

4.1 Research Approach

This thesis applies a quantitative research approach to conduct the testing of hypotheses H1 through to H13. The purpose of this approach is to test the proposed model built from previous theory and explain the consumers perception regarding authentication methods and their impact upon purchase intention, with further research into the potential mediating effects of risk perception and theory of planned behaviour principles on purchase intentions from the perspective of the consumer.

A quantitative research method implies that a focus is placed upon the quantification of collection and analysis of data, seeking to explain relationships and patterns rather than just understand human behaviour through subjective and contextual aspects. Bell, Bryman & Harley, (2022) claim that this method is particularly suitable when attempting to measure occurrences and when the aim is to test already existing theories. Stemming from this, the authors also claim that a deductive approach is suitable, and this approach will be applied throughout this thesis. This means that the research stems from previously existing and established theories, which in turn are tried and tested further by research building upon these, instead of inductive where the opposite is true (Bell, Bryman & Harley, 2022).

The thesis' epistemological perspective is positivism, meaning that assumptions about the social reality can be studied from the same methods, principles and perception of reality as within the natural sciences and our ontological point of view is objectivism (Easterby-Smith, Thorpe & Jackson, 2015) The chosen research object are consumers, and the thesis is aimed at actors within the second-hand luxury goods e-commerce industry (Bell, Bryman & Harley, 2022). An experimental research design is used to test the hypotheses previously mentioned. This implies that an experimental group will be compared to a control group and the participants will be randomly assigned to each group.

4.2 Research Design

For this study, an experimental research design has been chosen as this method is an effective and systematic way of testing the probability that a causal relationship exists and is, according to Söderlund, (2018), one of the most reliable methods of doing so (Easterby-Smith, Thorpe & Jackson, 2015; Söderlund, 2018). Experimental research design is therefore ideal in assessing the relationship between authentication method and Purchase Intention with the four additional variables from a mediation perspective as well as comparing these relationships under the use of blockchain in luxury good authentication compared to traditional paper authentication methods (Easterby-Smith, Thorpe & Jackson, 2015; Söderlund, 2018). To assess the difference between the two types of authentication methods, two different online surveys were constructed and then dispersed. Before launching the online surveys, the accuracy of the questions, in regard to the specific phenomenon that was researched, were tested using pilot tests (Bryman & Bell, 2011). Pilot tests are important according to Bryman & Bell (2011) due to the insights gained in regard to the nature of the responses to the survey questions from the respondent's perspective. Pilot tests allow for the rephrasing of questions where responses might indicate that they are not perceived in a correct manner, thereby ensuring that the responses are accurate in relation to the phenomenon that the survey aims to investigate. Upon disbursement of the surveys, respondents were randomly assigned to either the control or experiment group to avoid bias, therefore supporting the legitimacy of the results (Easterby-Smith, Thorpe & Jackson, 2015). The group that received the survey measuring the traditional method was to be considered the control group while the blockchain survey was the experiment group.

The most frequently cited disadvantages of the experimental research design are practical and ethical concerns (Easterby-Smith, Thorpe & Jackson, 2015). Ethical concerns are relatively obsolete in this study as responding to the survey should not cause any physical or emotional harm to participants due to the nature of the study. Additionally, practical concerns regarding random sampling have little basis in this study due to the randomisation automation linking used for dispersion, thereby eliminating the need for a quasi-experimental design (Easterby-Smith, Thorpe & Jackson, 2015). In terms of the survey method, the advantage of designing a web survey is that a larger sample can be reached despite budget and time constraints. Furthermore, the experiment can be performed with an automatic randomization of participants as mentioned previously. The use of questionnaires, unlike interviews, means that an interviewer effect can be ruled out and that there is no risk that the interviewer will skew or affect the results, that the wording of questions will be different from time to time and that errors in results occur because of transcription, as the answers are automatically collected (Bryman & Bell, 2011). The anonymity that a web survey provides can also give respondents a reassuring feeling, which in turn leads to them answering the questions more honestly (Bryman & Bell, 2011). On the other hand, with an online survey it is impossible to know for sure who is answering the questions and that the respondents are who they claim to be. Nor can the person answering a survey get help if the questions are difficult to understand or if

any questions should arise during. Finally, respondents often tire of surveys more quickly, which increases the risk of non-response when there are too many questions (Bryman & Bell, 2011). In weighing the pros and cons of this method, it was established that the research design utilised is appropriate and effective for the purposes of this study.

Finally, before distributing the survey to respondents, the results of the pilot test were used to perform a power analysis to determine minimum sample size for reliable results. The α value set for this study was 5% (.05) while the β value was set at 10% (.10) creating a statistical power of 90%, which is above the standard (SP=80%) (Uttley, 2019). The power analysis revealed that to reach this statistical power, the minimum number of respondents was 86 per survey group.

4.3 Data Collection Method

4.3.1 Questionnaire Design

In this study, the experiment consists of two different questionnaires randomly assigned to participants through a link randomizer program. The web questionnaires contain the same questions and look the same with the only difference being that the authentication method described at the beginning and referenced throughout (See Table 4.1) varied between the two questionnaires. This ensured that the experiment was consistent for both the experimental and control group.

Söderlund, (2018) believes that one should avoid giving clues to the participants of an experiment that make them understand what the experiment is about. On the other hand, Bryman & Bell, (2011) believe that a good introduction that describes the purpose of the survey leads to an increase in the response rate when it comes to surveys. It was necessary for this research to have an introduction that effectively introduced blockchain technology and its potential for these purposes, as it is an emerging technology and participant knowledge may be limited.

The introductions provided to participants are outlined in the chart on the following page:

Table 4.1: Survey Introductions

<p>Blockchain Authentication Method</p> <p>A common concern in the luxury fashion resale industry is the issue of counterfeit goods being deceptively listed as authentic. Blockchain technology is being examined as a new strategy for storing authentication certification for secondhand luxury items, as it has already begun being implemented in the luxury fashion industry for this purpose.</p> <p>Blockchain authentication entails the registration of an authentic item to a secure database. This allows resellers and potential buyers to view the purchase history of the item and trace it back to an authenticator or, in the future, the manufacturer. For secondhand items that are currently in circulation, registration to the blockchain would be completed by an authenticator when the item is deemed authentic, prior to it being listed for resale on the e-commerce platform.</p> <p>The registration of an item on the blockchain serves as a guarantee that the item being advertised is authentic. This is then included in the product description on secondhand e-commerce platforms to communicate the legitimacy of the product to potential buyers. The aim of this study is to assess the attitudes that consumers of secondhand luxury goods have towards this process.</p> <p>The following survey takes approximately up to 5 minutes to complete.</p>
<p>Traditional Authentication Method</p> <p>A common concern in the luxury fashion resale industry is the issue of counterfeit goods being deceptively listed as authentic. Traditionally, secondhand luxury goods are certified as authentic through the presence of a paper certificate from either the manufacturer, or, in the absence of this, from an authenticator.</p> <p>The certificate serves as a guarantee that the item being advertised is authentic. This is then included in the product description on secondhand e-commerce platforms to communicate the legitimacy of the product to potential buyers. The aim of this study is to assess the attitudes that consumers of secondhand luxury goods have towards this process.</p> <p>The following survey takes approximately up to 5 minutes to complete.</p>

4.3.2 Survey Questions

Before any of the main survey questions were visible, demographics were taken. Age, gender, and nationality were collected and participants under 18 were not allowed to continue due to laws governing data collection in some countries. Additionally, there was a question that screened for interest in the topic, as our target was people who participated in luxury second-hand e-commerce. Those who answered that they had not and had no intention of participating in such activities were forced to submit the survey without answering any of the other questions.

The survey items were retrieved from previous academic research to ensure their validity in assessing their respective variables. The questions were then adapted to fit the needs of this study and are outlined in the chart below. The questions for Perceived Risk were obtained from (Corbitt, Thanasankit & Yi, 2003) and Purchase Intention from Pavlou, (2003). These questions and scales were further used and tested in Chang & Chen, (2008). The questions for The theory of planned behaviour (Perceived Behavioural Control, Subjective Norms, and Attitudes) were retrieved from Aboelmaged, (2010).

Table 4.2: Survey Items

Factor/Item	Item Wording	Scale						
Perceived Risk		Source: Corbitt, Thanasankit & Yi, (2003)						
PR1	I believe that [Blockchain authentication/Paper authentication] when buying second-hand luxury products in e-commerce is risky because the services delivered may fail to meet my expectations.	1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
PR2	I believe that [Blockchain authentication/Paper authentication] when buying second-hand luxury products in e-commerce is risky because the services delivered may be inferior.	1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
PR3	I believe that [Blockchain authentication/Paper authentication] when buying second-hand luxury products in e-commerce is risky because they may lead to financial loss for me.	1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
PR4	I believe that [Blockchain authentication/Paper authentication] when buying second-hand luxury products in e-commerce is risky because they may cause others to think less highly of me.	1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
PR5	I believe that [Blockchain authentication/Paper authentication] when buying second-hand luxury products in e-commerce is risky because the services delivered may fail to fit well with my personal image or self-concept.	1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
PR6	I believe that [Blockchain authentication/Paper authentication] when buying second-hand luxury products in e-commerce is risky because they may lead to a time loss for me.	1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Purchase Intention		Source: Pavlou, (2003)						
PI1	I intend to use [Blockchain authentication/Paper authentication] when buying second-hand luxury products in e-commerce.	1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
PI2	I expect to purchase through platforms utilizing [Blockchain authentication/Paper authentication] when buying second-hand luxury products in e-commerce in the future.	1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
PI3	It is likely that I will transact with platforms utilizing [Blockchain authentication/Paper authentication] when buying second-hand luxury products in e-commerce in the near future.	1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Perceived Behavioural Control		Source: Aboelmaged, (2010)						
PBC1	I would be able to use [Blockchain authentication/Paper authentication] methods well for authentication when buying second-hand luxury items online.	1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
PBC2	Using [Blockchain authentication/Paper authentication] would be entirely within my control	1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
PBC3	I have the resources, knowledge, and ability to use [Blockchain authentication/Paper authentication] technology	1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Subjective Norms		Source: Aboelmaged, (2010)						
SN1	People who are important to me would think that I should use [Blockchain authentication/Paper authentication].	1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
SN2	People who influence me would think that I should use [Blockchain authentication/Paper authentication]	1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
SN3	People whose opinions are valued to me would prefer that I should use [Blockchain authentication/Paper authentication]	1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
Attitudes		Source: Aboelmaged, (2010)						
A1	Using [Blockchain authentication/Paper authentication] is a good idea	1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
A2	Using [Blockchain authentication/Paper authentication] would be a wise idea	1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
A3	Using [Blockchain authentication/Paper authentication] in procurement is unpleasant	1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree
A4	It is desirable to use [Blockchain authentication/Paper authentication]	1 Strongly Disagree	2	3	4	5	6	7 Strongly Agree

4.3.3 Sampling

The target population of this study was men and women who are interested in or consume second-hand luxury goods online. While luxury consumers have traditionally skewed towards

an older demographic, luxury resale consumption is increasing among younger generations, particularly those who pay attention to social and environmental matters when shopping (Statista, 2022b). In 2022 47.6% of luxury consumers worldwide who bought second hand in the first quarter of 2022 were 40+, while 43.1% were 18-39 (Statista, 2022c). Approximately half of luxury consumers in both the Americas and EMEA (Europe, Middle East, and Africa) purchase second-hand, with a lower share of 39% in the Asia Pacific region (Statista, 2022d). Looking at online luxury resale, one of the leading second-hand luxury platforms, The RealReal, reported the following customer base segmented according to generation in 2022: 5% Gen Z (10-25), 36% Millennials (26-41), 33% Gen X (42-57), 22% Baby Boomers (58-76), and 4% Silent Generation (77-94) (The RealReal, 2022). Millennials and Gen X make up the primary base, while Gen Z is shown to be the fastest growing segment. Taking the aforementioned information into account, and the limited time and resources for collection of data, a wider target was set including men and women worldwide with age groups divided between 18 and 55+. As previously mentioned, a survey question screened for interest in the topic to limit respondents to those who are inclined to participate in online second-hand luxury consumption to achieve a more accurate target.

Convenience sampling was applied to recruit participants from the target population. This signifies a non-probability sampling, where respondents are readily available and easy to access (Bryman & Bell, 2011). A limitation of this type of sampling is that it may not produce a representative sample of the population and can therefore not be generalizable to the larger population. However, due to time and cost constraints convenience sampling provides an efficient and cost-effective way to collect data for this study. Additionally, the respondent group was analysed to assess whether an accurate representation of the target population was achieved within the data analysis.

4.3.4 Questionnaire Distribution

Data collection was conducted through an online web-based survey, which offers advantage in cost and ability to reach participants. According to Malhotra, Nunan & Birks, (2017) the purpose of a survey is to find patterns that may be hidden in human and organizational behaviours to reveal causal relationships between concepts, therefore making it a suitable method of data collection for this type of study. The survey method utilized can be described as inferential. This type is especially dominant within academic research and focuses on establishing relationships between variables and concepts (Easterby-Smith, Thorpe & Jackson, 2015). Data was collected for a period of three weeks, during the months of April and May 2023. The participants were recruited through Reddit and Facebook communities relating to second hand luxury consumption.

To assure random sampling, the links to both surveys were submitted to a link randomiser program called Allocate. The randomised link was then posted in several Reddit forums including r/Handbags (35k members), r/Vintage (132k members), r/VintageFashion (260k

members), r/femalefashionadvice (3.4m members), and r/thriftstorehauls (2.6m members) (Reddit, 2023). Additionally, the same link was posted in Facebook communities, namely “Second Hand Louis Vuitton, Chanel, Hermes, Authentic Only,” (24k members) and “Vina Olsen World of Luxury Style” (85k members) (Facebook, 2023).

As previously stated, a pilot study was conducted on a small group of people to pre-test and refine the survey as needed prior to sending the survey to the target population. This is important to make sure the survey is feasible as well as clear, easy to understand, and free of any mistakes, which otherwise might prevent participants from responding accurately and honestly. (Malhotra, Nunan & Birks, 2017).

4.4 Measurement & Scaling

As seen in Table 4.2, each question in the survey was measured using a 7-point Likert Scale. This is a non-comparative scale, meaning that items are each assessed individually, rather than by how they compare to each other (Malhotra, Nunan & Birks, 2017). This is one of the most common types of measurement used in survey-based research (Bell, Bryman & Harley, 2022; Malhotra, Nunan & Birks, 2017). Each item corresponded to the factor that it was intended to measure, with the intention for them to be combined into computed variables after the Confirmatory Factor Analysis was performed. This is done for ease of comparison in the T-Test and mediation analysis.

4.5 Validity and Reliability

4.5.1 Validity

Validity is defined as “The extent to which a measurement represents characteristics that exist in the phenomenon under investigation” (Malhotra, Nunan & Birks, 2017, p.160). Bryman & Bell, (2011) describe two categories of validity: internal and external. According to the authors, internal validity assesses whether the phenomenon being assessed is caused by the factors being measured while external validity is concerned with the generalizability of the results of the study. To address internal validity, content and construct validity were considered across all aspects of the research design. To ensure content validity, the survey questions used in this study were adapted from previous reputable academic studies that focused on similar research areas. Construct validity was also assessed to determine whether the survey instrument effectively measured the intended constructs. Confirmatory factor analysis (CFA) was conducted to evaluate the hypothesized factor structure of the survey items and examine the strength of the relationships between the items and the underlying constructs. Additionally, face validity was assessed through a pilot test where the survey's

clarity, understandability, and feasibility were assessed based on participants' feedback. Minor modifications to the wording of the survey items were made based on the pilot study results, enhancing the face validity of the instrument.

Although convenience sampling is not ideal for generalizability according to Malhotra, Nunan & Birks, (2017), steps were taken to improve external validity as much as possible. As outlined above, the online survey was distributed within forums that were related to the target population and eliminating questions were placed at the beginning of the survey to limit respondents to those who fit the target population. Additionally, respondent demographics will be compared to those of the target population to assess whether these efforts were successful.

4.5.2 Reliability

According to Malhotra, Nunan & Birks, (2017), reliability refers to how consistent results produced by a scale are when the same measurements are repeated, or, in other words, how free the results are from random error. The authors then go on to state that there are several methods which can be used to assess reliability, including test–retest reliability, alternative-forms reliability and internal consistency reliability. For this study, internal consistency reliability was performed, as the surveys consist of items which combine to measure variables in a summated scale (Malhotra, Nunan & Birks, 2017). To assess the reliability of the scales and items used in this study, Cronbach's Alpha was calculated, and the results were examined for potential inconsistencies and strength (Bell, Bryman & Harley, 2022; Malhotra, Nunan & Birks, 2017; Söderlund, 2018). The results are displayed in Table 5.8.

4.6 Limitations

The limitations of choosing a quantitative approach over a qualitative for this research are that we were unable to collect in-depth insights that could help explain the results of the survey. Performing a qualitative study could potentially have allowed for a deeper understanding of the reasoning behind the consumer perspectives. Despite this, we are confident that quantitative analysis was the correct choice as it allowed us to collect data from a larger sample and with less room for human error (Bell, Bryman & Harley, 2022; Malhotra, Nunan & Birks, 2017). Another limitation of our study was that we were unable to partner with a company in the second-hand luxury e-commerce industry. Our goal was to utilise the mailing list for a company like this as our data sample, to get the most relevant respondents. When the companies we contacted did not reach out, we were forced to use other methods of survey distribution which, while still relevant, were not ideal. Finally, since we utilised random convenience sampling, we are unable to follow up with actual consumer behaviour, limiting the extent of information we can provide in relation to the actual consumer behaviours that took place.

5 Data Analysis

This chapter provides a statistical analysis of the collected data and reports results as they pertain to the previously formulated hypotheses. The section commences with an overview of conducted preparation and tests of the data, which is followed by a more detailed evaluation. The chapter concludes with a summary of results for the proposed hypotheses.

5.1 Introduction to Data Analysis

Once data was gathered, se to prepare it for the analyses that were then run to evaluate the results of the study. To begin the analysis, descriptive statistics were performed to summarize and describe the characteristics of the dataset and identify patterns, trends, and identify outliers. This was followed by a Confirmatory Factor Analysis (CFA) to assess the model fit and establish construct validity. Cronbach's Alpha was also used to assess the reliability of the scale.

An independent sample (two-tailed) T-test was then run to assess the differences between responses to each survey, creating the Authentication Method variable, as it relates to Perceived Risk, Subjective Norms, Attitudes, and Perceived Behavioural Control, testing hypotheses H1, H2, H3, and H4, as well as the direct relationship between Authentication Method and Purchase Intention (H9). Finally, a mediation analysis was performed to assess whether Perceived Risk, Subjective Norms, Attitudes, and Perceived Behavioural Control have a mediating effect on the relationship between Authentication Method and Purchase Intention (H10, H11, H12, H13). The path estimates for these mediation analyses were also used to test H5, H6, H7, and H8.

5.2 Data Preparation

Data was collected via Google Forms, which gives the option to have the data converted to a Google Sheets workbook. As responses were received, the data was compiled in two sheets within a Google Sheets workbook (one for each survey). Prior to the pilot test, a Jamovi file was created for the data to be moved to for analysis. Each item in the Jamovi file was categorized and labelled appropriately in the order they appeared in the survey, making the

transition from the Google Sheet to Jamovi as seamless as possible. Once the data was collected and imported to the Jamovi file, a visual inspection was performed to ensure that there were no missing values or outliers and that the data was imported correctly (Bell, Bryman & Harley, 2022). The survey was designed such that every question was required to be answered before the program would allow the respondent to submit, reducing the risk of incomplete responses and non-response errors (Malhotra, Nunan & Birks, 2017). Once the spreadsheet was examined for potential human error, A3 was reverse coded, as it has a negative connotation while all other questions for Attitudes are positive. This made it so that these items could be reliably combined with the other items measuring their respective factors.

5.3 Descriptive Statistics

The following descriptive statistics are used to provide insight into the survey population, central tendencies, correlation, and frequency of results.

5.3.1 Survey Population

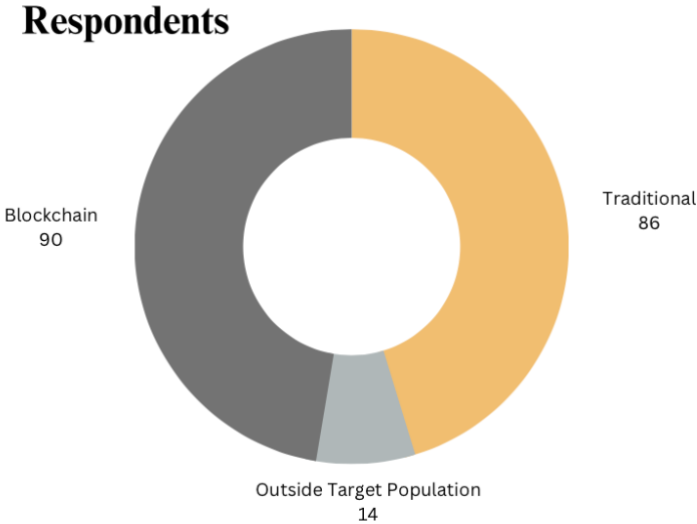


Figure 5.1: Respondents By Survey

A total of 190 participants responded to the surveys, although 14 were deemed to be inconsistent with the target population due to their response to question 4 which inquired about interest in purchasing second-hand luxury items from e-commerce platform. These respondents answered no, and their forms were immediately submitted without responding to the survey questions. This resulted in 176 relevant responses which were split between the

survey representing Traditional Authentication methods (86 respondents, 48.9%) and Blockchain Authentication methods (90 respondents, 51.1%).

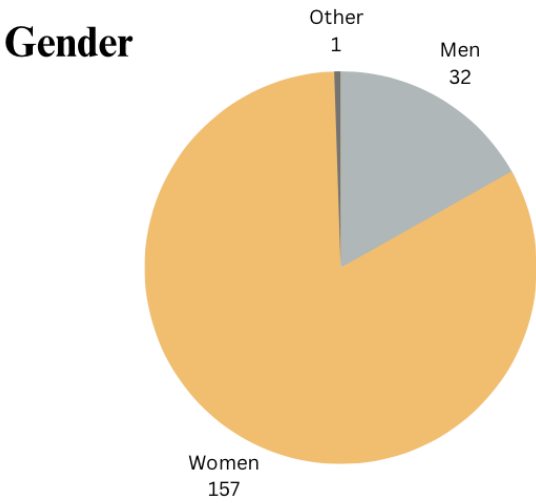


Figure 5.2: Gender of Survey Respondents

The first descriptive for the data set is illustrated in the pie chart above. The gender distribution for this study skews majority female, with 157 female participants making up 82.6% of the population compared to 32 men (16.8%) and 1 respondent who identified as “other”. This disbursement was anticipated, as the second-hand luxury resale market is heavily dominated by women, indicating that our sample fits the target population. (Stokburger-Sauer & Teichmann, 2013).

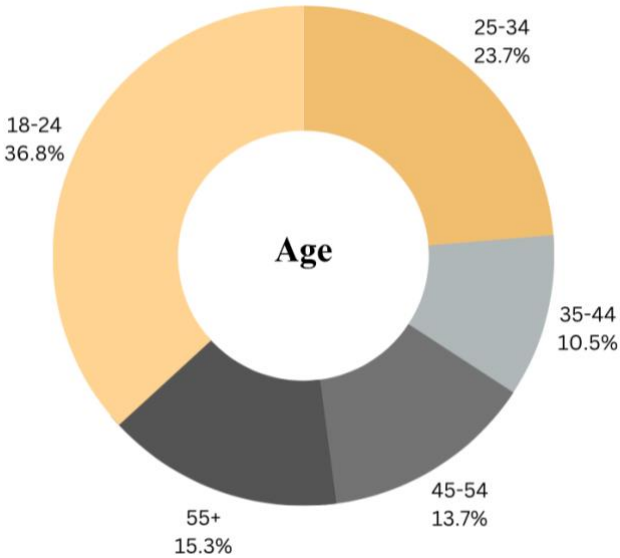


Figure 5.3: Age of Survey Respondents

Age of respondents was dispersed relatively even, with the 18-24 age group representing 36.8% (70 respondents), while 25-34 represents 23.7% (45 respondents). This was anticipated as the survey was distributed online, and these two age groups comprise the majority of internet users (Statista, 2023b). This is also representative of this study’s target population as it focuses on e-commerce as a marketplace for second-hand luxury resale and was thus intended to reach the primary users of the internet.

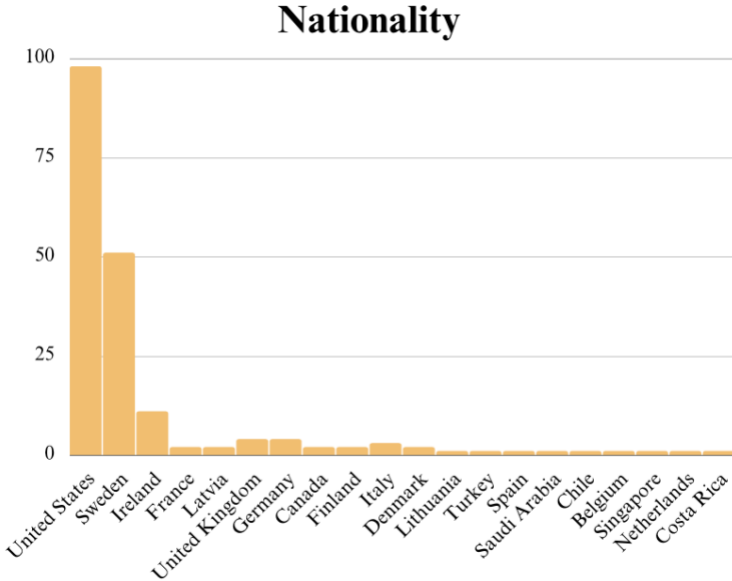


Figure 5.4: Nationality of Survey Respondents

Twenty countries were represented in this study, with the most dominant presences being from the United States (98 respondents, 51.6%), Sweden (51 respondents, 26.8%), and Ireland (11 respondents, 5.8%). The chart above shows the relative frequency of the 17 additional nationalities represented in this study including the U.K, Germany, Italy, Denmark, Saudi Arabia, Singapore, and Costa Rica. Receiving respondents from diverse backgrounds helps the generalizability of the study, and the high turnout from the United States and EMEA is also consistent with the luxury fashion resale market (Statista, 2023).

5.3.2 Measures of Central Tendency

Table 5.1: Central Tendency Measures

Descriptives						
	N	Mean	Median	SD	Minimum	Maximum
PR1	176	4.10	4.00	1.68	1	7
PR2	176	4.18	4.00	1.64	1	7
PR3	176	4.01	4.00	1.83	1	7
PR5	176	2.67	2.00	1.57	1	7
PR6	176	3.11	3.00	1.73	1	7
PI1	176	4.26	4.00	1.61	1	7
PI2	176	4.63	5.00	1.58	1	7
PI3	176	4.27	4.00	1.65	1	7
PBC1	176	4.21	4.00	1.59	1	7
PBC2	176	3.95	4.00	1.73	1	7
PBC3	176	3.40	3.00	1.94	1	7
SN1	176	3.77	4.00	1.77	1	7
SN2	176	3.81	4.00	1.73	1	7
SN3	176	3.76	4.00	1.71	1	7
A1	176	5.00	5.00	1.61	1	7
A2	176	4.89	5.00	1.62	1	7
A3	176	3.02	3.00	1.61	1	7
A4	176	4.73	5.00	1.56	1	7

The chart above shows the measures of central tendency as related to each of the survey items. Below, is a chart separating the measures by survey, to show the differential between those who received the Traditional Authentication survey as opposed to Blockchain. Since a 1-7 scale was used for this study, the risk of outliers skewing the results is slim. Frequency tables for these questions can be found in Appendix A, revealing the distribution of answers for each question.

Table 5.2: Central Tendency by Survey

Descriptives							
	Authentication Method	N	Mean	Median	SD	Minimum	Maximum
PR1	Traditional	86	4.81	5.00	1.55	1	7
	Blockchain	90	3.42	4.00	1.51	1	6
PR2	Traditional	86	4.86	5.00	1.37	2	7
	Blockchain	90	3.52	4.00	1.61	1	7
PR3	Traditional	86	4.41	5.00	1.79	1	7
	Blockchain	90	3.63	4.00	1.80	1	7
PR4	Traditional	86	2.13	2.00	1.46	1	7
	Blockchain	90	2.20	2.00	1.55	1	7
PR5	Traditional	86	2.67	2.00	1.64	1	7
	Blockchain	90	2.67	2.50	1.51	1	7
PR6	Traditional	86	3.43	4.00	1.82	1	7
	Blockchain	90	2.81	3.00	1.58	1	7
PI1	Traditional	86	4.37	4.00	1.46	1	7
	Blockchain	90	4.16	4.50	1.75	1	7
PI2	Traditional	86	4.70	5.00	1.57	1	7
	Blockchain	90	4.56	5.00	1.59	1	7
PI3	Traditional	86	4.31	4.00	1.70	1	7
	Blockchain	90	4.22	4.00	1.61	1	7
PBC1	Traditional	86	4.05	4.00	1.38	1	7
	Blockchain	90	4.37	4.00	1.76	1	7
PBC2	Traditional	86	3.66	4.00	1.48	1	7
	Blockchain	90	4.23	4.00	1.90	1	7
PBC3	Traditional	86	3.13	3.00	1.71	1	7
	Blockchain	90	3.67	4.00	2.11	1	7
SN1	Traditional	86	3.85	4.00	1.72	1	7
	Blockchain	90	3.70	4.00	1.82	1	7
SN2	Traditional	86	3.93	4.00	1.66	1	7
	Blockchain	90	3.70	4.00	1.79	1	7
SN3	Traditional	86	3.84	4.00	1.59	1	7
	Blockchain	90	3.68	4.00	1.83	1	7
A1	Traditional	86	5.07	5.00	1.52	1	7
	Blockchain	90	4.93	5.00	1.69	1	7
A2	Traditional	86	5.06	5.00	1.48	1	7
	Blockchain	90	4.72	5.00	1.74	1	7
A3	Traditional	86	2.90	3.00	1.56	1	7
	Blockchain	90	3.13	3.00	1.65	1	7
A4	Traditional	86	4.70	5.00	1.50	1	7
	Blockchain	90	4.77	5.00	1.62	1	7

5.4 Inferential Statistics

Inferential statistics were then used to assess reliability of survey items and the model. The results are presented below:

5.4.1 Confirmatory Factor Analysis

In order to confirm the relationship between the survey items and their respective factors, a confirmatory factor analysis (CFA) was performed (Suhr, n.d.). This was done in lieu of an exploratory factor analysis as the items used to measure each variable were derived from previous research.

Table 5.3: CFA Factor Loadings

Factor Loadings						
Factor	Indicator	Estimate	SE	Z	p	Stand. Estimate
Perceived Behavioural Control	PBC1	1.374	0.1027	13.38	<.001	0.868
	PBC2	1.329	0.1166	11.40	<.001	0.771
	PBC3	1.379	0.1358	10.16	<.001	0.712
Subjective Norms	SN1	1.634	0.1018	16.06	<.001	0.927
	SN2	1.610	0.0987	16.31	<.001	0.936
	SN3	1.543	0.1004	15.37	<.001	0.904
Attitudes	A1	1.482	0.0928	15.98	<.001	0.923
	A2	1.571	0.0902	17.42	<.001	0.970
	A3	0.872	0.1137	7.67	<.001	0.543
	A4	1.220	0.0990	12.33	<.001	0.784
Perceived Risk	PR1	1.436	0.1103	13.01	<.001	0.857
	PR2	1.374	0.1086	12.66	<.001	0.841
	PR3	1.387	0.1234	11.24	<.001	0.759
	PR4	0.771	0.1210	6.37	<.001	0.514
	PR5	0.883	0.1246	7.09	<.001	0.563
	PR6	1.054	0.1276	8.26	<.001	0.612
Purchase Intention	PI1	1.451	0.1006	14.42	<.001	0.902
	PI2	1.394	0.0992	14.06	<.001	0.887
	PI3	0.950	0.1191	7.98	<.001	0.577

For this study, there were 5 computed factors measured by their respective survey items. For example, Perceived Behavioural Control was measured with three items (PBC1, PBC2, PBC3). The relationships are observed within the table above. All 19 items have a significant p-value ($p < .001$) and a Z-value greater than zero, meaning all items contribute to the model (Navarro & Foxcroft, 2022). 14 items demonstrate an ideal fit (Stand. Estimate = $> .700$), (Stand. Estimate = .868, .771, .712, .927, .936, .904, .923, .970, .784, .857, .841, .759, .902, .887) with the remaining 5 items representing an acceptable fit (Stand. Estimate = $> .500$) (.543, .514, .563, .612, .577). Accompanying p-values of $< .001$ across the board consistently demonstrates the strength by which these items measure their intended factors (Tavakol & Wetzel, 2020).

These relationships are further visualised by the path diagram on the following page:

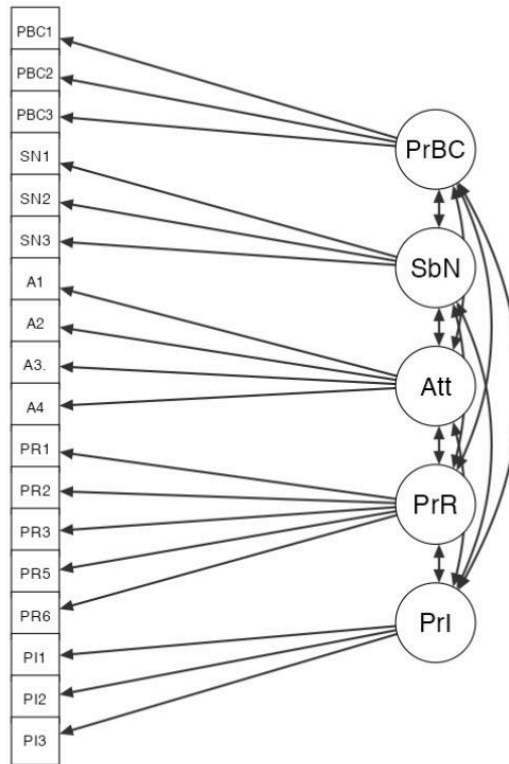


Figure 5.5: Path Diagram

Factor Estimates

Table 5.4: Factor Covariances

Factor Covariances		Estimate	SE	Z	p	Stand. Estimate
Perceived Behavioural Control	Perceived Behavioural Control	1.000 ^a				
	Subjective Norms	0.570	0.0611	9.33	<.001	0.570
	Attitudes	0.656	0.0523	12.53	<.001	0.656
	Perceived Risk	-0.541	0.0657	-8.23	<.001	-0.541
	Purchase Intention	0.630	0.0590	10.68	<.001	0.630
Subjective Norms	Subjective Norms	1.000 ^a				
	Attitudes	0.561	0.0561	10.00	<.001	0.561
	Perceived Risk	-0.156	0.0807	-1.94	0.053	-0.156
	Purchase Intention	0.571	0.0599	9.54	<.001	0.571
Attitudes	Attitudes	1.000 ^a				
	Perceived Risk	-0.463	0.0680	-6.81	<.001	-0.463
	Purchase Intention	0.731	0.0425	17.20	<.001	0.731
Perceived Risk	Perceived Risk	1.000 ^a				
	Purchase Intention	-0.342	0.0765	-4.46	<.001	-0.342
Purchase Intention	Purchase Intention	1.000 ^a				

^a fixed parameter

The standard estimate reported in the factor covariances table above represents the correlation coefficient (r). Ideally, values of $<|.80|$ are ideal, as anything greater suggests that the

variables may be too strongly correlated to be manipulated independently (Taylor, 1990). None of the variables in the survey demonstrate a concerning correlation coefficient as they are all significantly below $|.80|$ ($r = .570, .656, .541, .630, .561, .156, .571, .463, .731, .342$).

5.4.2 Model Fit

Table 5.5: Test for Exact Fit

Test for Exact Fit		
χ^2	df	p
466	142	<.001

A significant p-value ($p = <.001$) on a test for exact fit indicates a low chance of a Type 1 error within the theoretical measurement model (Sallis et al., 2021).

Table 5.6: Fit Measures

Fit Measures				
CFI	TLI	RMSEA	RMSEA 90% CI	
			Lower	Upper
0.870	0.843	0.114	0.102	0.125

The Comparative Fit Index (CFI) ($CFI = .870$) and Tucker Lewis Index (TLI) ($TLI = .843$) scores both indicate a less than ideal fit as they fall below the general threshold for a good fit ($>.95$). The Root Mean Square Error of Approximation (RMSEA) value ($RMSEA = .114$) is also less than ideal ($RMSEA <.06$). The lower and upper Confidence Interval values are both outside the ideal fit threshold, indicating that it is unlikely for the results to show an ideal RMSEA any time it is run ($<90\%$) (Hu & Bentler, 2009; Navarro & Foxcroft, 2022).

After analysing the loadings from the CFA and model fit analyses, it became apparent that the PR4 item was negatively impacting the reliability of the model. This item was thus removed, and the following adjusted figures were computed:

Table 5.7: Adjusted Model Fit Indices

Test for Exact Fit		
χ^2	df	p
320	125	<.001

Fit Measures				
CFI	TLI	RMSEA	RMSEA 90% CI	
			Lower	Upper
0.916	0.897	0.0942	0.0815	0.107

The Chi-squared value dropped significantly, indicating a more ideal fit (McHugh, 2012; Navarro & Foxcroft, 2022). The P-value also remains low, which continues to support a low chance of Type 1 error. Additionally, The CFI (.916) and TLI (.897) scores both increased, approaching the threshold for a good fit (>.95). The RMSEA value (.0942) also decreased significantly, approaching the ideal fit (RMSEA <.06), with the lower confidence interval getting even closer (LCI=.0815) and the upper (UCI=.107) falling significantly. These loadings present more promising results, supporting the removal of PR4 (Hu & Bentler, 2009; Navarro & Foxcroft, 2022). Through the removal of this item, a better model fit was acquired.

5.4.3 Cronbach's Alpha

Table 5.8: Cronbach's Alpha Loadings By Factor

Factor	Items	Cronbach's α
Perceived Risk	PR1, PR2, PR3, PR5, PR6	0.847
Purchase Intention	PI1, PI2, PI3	0.828
Perceived Behavioural Control	PBC1, PBC2, PBC3	0.822
Subjective Norms	SN1, SN2, SN3	0.944
Attitudes	A1, A2, A3, A4	0.878

Cronbach's Alpha quantifies how consistent responses are between items that make up a factor, an acceptable score ($\alpha= 0.7-0.95$) is recorded for all factors measured ($\alpha= .847, .828, .822, .994, .878$). Satisfactory scores indicate strong internal consistency between the items under each factor, however not so strong that items could be considered too similar (Tavakol & Dennick, 2011). The results of this test indicate a strong internal consistency for this study's items.

5.5 Two-Tailed T-Test

A Two Tailed T-test is performed below, comparing the results of the Traditional and Blockchain authentication method surveys to examine whether authentication method has an observable effect on Perceived Risk, Purchase Intention, Perceived Behavioural Control, Subjective Norms, and Attitudes.

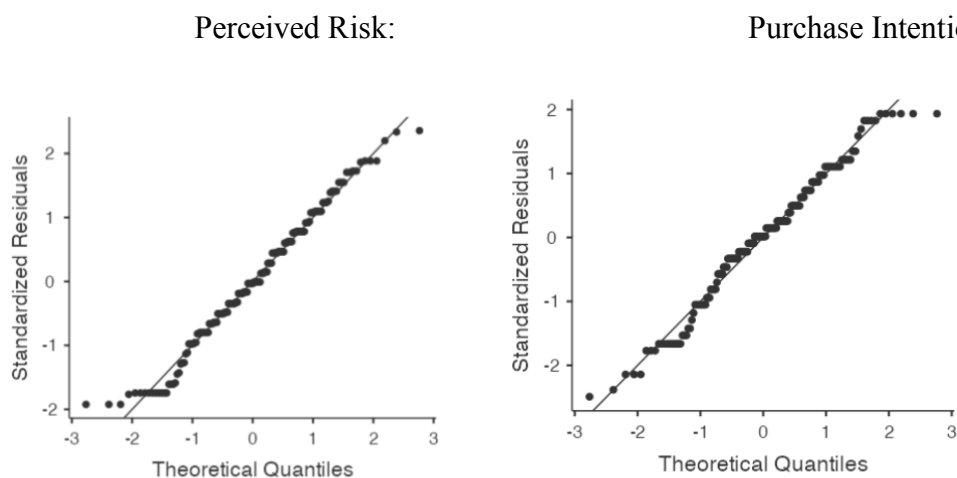
5.5.1 Assumptions

Two assumptions were first evaluated in regard to an independent sample t-test: the assumptions of normality and homogeneity of variance.

Table 5.9: T-Test Normality Test

Normality Test (Shapiro-Wilk)		
	W	p
Perceived Risk	0.984	0.036
Purchase Intention	0.980	0.013
Perceived Behavioural Control	0.987	0.114
Subjective Norms	0.955	<.001
Attitudes	0.972	0.001

The results for the Normality Test report significant p-values ($p < .05$) for every factor except PBC, which suggests that the assumption of normality has been violated for the remaining factors. This implies that the sample does not follow a normal distribution, however, the Q-Q plots below illustrate normal distribution, as they appear as relatively straight lines for all variables (Ghasemi & Zahediasl, 2012).



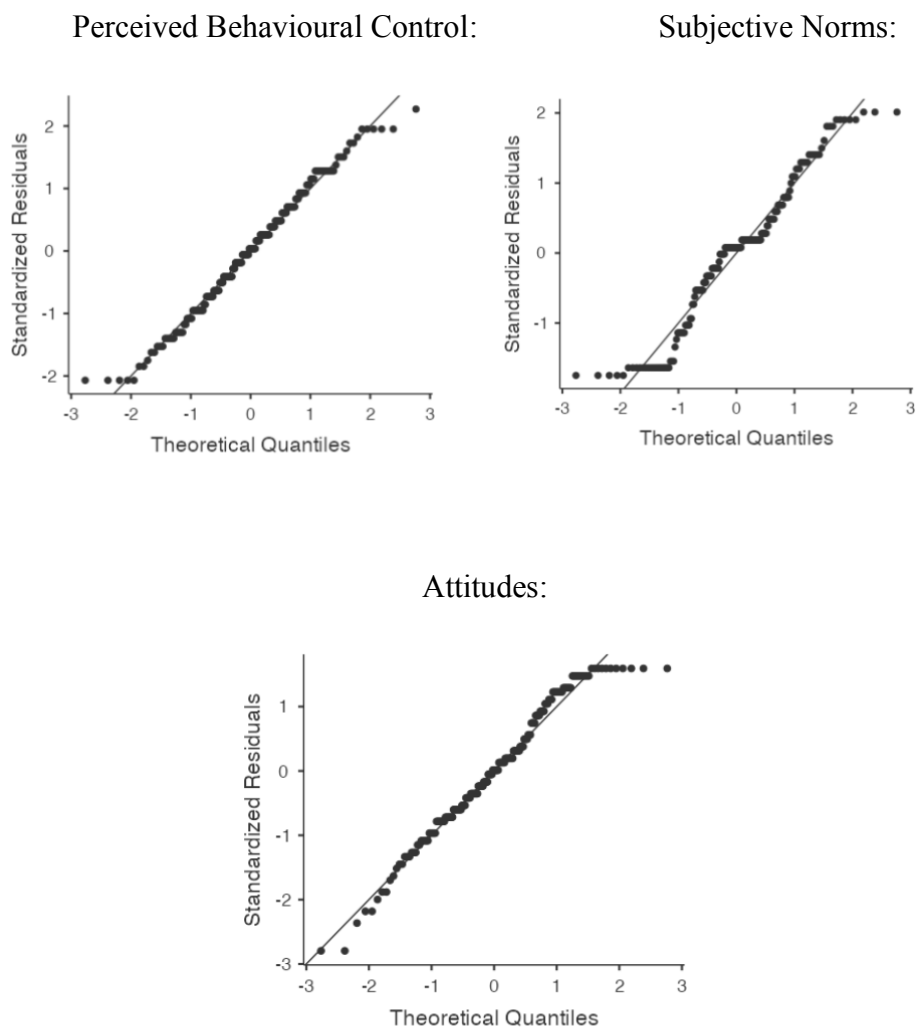


Figure 5.6: Q-Q Plots By Variable

The normal distribution visualised by the Q-Q plots above, suggests that there could be a failure to reject the null hypotheses for H1, H2, H3, H4, and H9 (Ghasemi & Zahediasl, 2012).

Table 5.10: T-Test Homogeneity of Variance Test

Homogeneity of Variances Test (Levene's)				
	F	df	df2	p
Perceived Risk	1.7293	1	174	0.190
Purchase Intention	0.0184	1	174	0.892
Perceived Behavioural Control	14.1187	1	174	<.001
Subjective Norms	0.9938	1	174	0.320
Attitudes	0.5278	1	174	0.469

The second assumption is Homogeneity of Variances. A low p-value ($p < .001$) indicates a violation of the assumption of equal variances, which means that the results for Perceived Behavioural Control ($p < .001$) vary significantly between respondents. The other 4 factors report much higher values ($p = .190, .892, .320, .469$), indicating that the assumption of equal variances is supported, and the results are reliable (Starkweather, 2010)

5.5.2 Descriptives

The group descriptives table below reports the measures of central tendency. The means reported for each survey are then used to compute the p-value for the independent sample t-test.

Table 5.11: T-Test Descriptives

Group Descriptives						
	Group	N	Mean	Median	SD	SE
Perceived Risk	Traditional	86	3.72	3.67	1.16	0.125
	Blockchain	90	3.04	3.00	1.30	0.137
Purchase Intention	Traditional	86	4.46	4.33	1.33	0.143
	Blockchain	90	4.31	4.33	1.45	0.153
Perceived Behavioural Control	Traditional	86	3.61	3.67	1.23	0.132
	Blockchain	90	4.09	4.00	1.71	0.181
Subjective Norms	Traditional	86	3.87	4.00	1.55	0.167
	Blockchain	90	3.69	4.00	1.74	0.183
Attitudes	Traditional	86	4.98	5.00	1.32	0.143
	Blockchain	90	4.82	4.75	1.42	0.149

5.5.3 Results

Table 5.12: T-Test Results

Independent Samples T-Test						
		Statistic	df	p		Effect Size
Perceived Risk	Student's t	4.309	174	<.001	Cohen's d	0.650
Purchase Intention	Student's t	0.714	174	0.476	Cohen's d	0.108
Perceived Behavioural Control	Student's t	-2.111 ^a	174	0.036	Cohen's d	-0.318
Subjective Norms	Student's t	0.722	174	0.471	Cohen's d	0.109
Attitudes	Student's t	0.775	174	0.439	Cohen's d	0.117

The p-values for Purchase Intention, Subjective Norms, and Attitudes ($p = .476, .471, .439$) are all well above the acceptable threshold ($p < .05$), indicating the lack of an effect between authentication type and these factors. These results are consistent with the Normality Test, demonstrating a failure to reject the null hypotheses for H2, H3, and H9. However, Perceived Risk ($p < .001$) demonstrates a highly significant p-value, and therefore a strong effect, with

Perceived Risk being lower in the Blockchain Authentication survey respondents compared to Traditional. This supports H1 and rejects the null hypothesis. Perceived Behavioural Control ($p=.036$) also demonstrates a significant p-value, and according to the descriptives table (Table 5.11), PBC was increased in respondents who received the Blockchain survey compared to Traditional, an effect that is consistent with what was hypothesised in H4.

5.6 Mediation Analysis

Finally, a mediation analysis was run to assess the presence of a mediation on the relationship between Authentication Method and Purchase Intention through Perceived Risk, Attitudes, Subjective Norms, and Perceived Behavioural Control (H10, H11, H12, & H13). Each mediation analysis was run separately and utilized bootstrapping for 5000 samples.

5.6.1 Perceived Risk

Table 5.13: Perceived Risk Variable Mediation and Path Estimates

Mediation Estimates					
Effect	Estimate	SE	Z	p	% Mediation
Indirect	0.272	0.105	2.590	0.010	39.2
Direct	-0.423	0.217	-1.949	0.051	60.8
Total	-0.150	0.209	-0.719	0.472	100.0

Path Estimates						
			Estimate	SE	Z	p
Authentication Method	→	Perceived Risk	-0.826	0.1918	-4.31	<.001
Perceived Risk	→	Purchase Intention	-0.330	0.0900	-3.66	<.001
Authentication Method	→	Purchase Intention	-0.423	0.2168	-1.95	0.051

First, the potential mediating role of Perceived Risk on the linkage between Authentication methods and Purchase Intention. The results (See Table 5.13) revealed that the total effect of Authentication Methods on Purchase Intention was not significant ($\beta = -0.150$, $p = 0.472$). With the inclusion of the mediating variable of Perceived Risk, the impact of Authentication Methods on Purchase Intention was still found insignificant ($\beta = -0.423$, $p = 0.051$). However, the indirect effect of Authentication Methods on Purchase Intention through Perceived Risk was found significant ($\beta = 0.272$, $p = 0.010$). This shows that the relationship between Authentication Methods and Purchase Intention is mediated by Perceived Risk. These results serve to support H10. Additionally, the path estimates for the path between Perceived Risk and Purchase Intention demonstrate a statistically significant relationship ($p < .001$), thereby supporting H5.

5.6.2 Attitudes

Table 5.14: Attitudes Variable Mediation and Path Estimates

Mediation Estimates					
Effect	Estimate	SE	Z	p	% Mediation
Indirect	-0.1005	0.128	-0.787	0.431	67.0
Direct	-0.0496	0.164	-0.303	0.762	33.0
Total	-0.1501	0.208	-0.723	0.469	100.0

Path Estimates						
			Estimate	SE	Z	p
Authentication Method	→	Attitudes	-0.1603	0.2033	-0.789	0.430
Attitudes	→	Purchase Intention	0.6269	0.0676	9.276	<.001
Authentication Method	→	Purchase Intention	-0.0496	0.1638	-0.303	0.762

Mediation analysis was then performed to assess the mediating role of Attitudes on the relationship between authentication methods and Purchase Intention. The results (See Table 5.14) revealed that the total effect of Authentication Methods on Purchase Intention was not significant ($\beta = -0.1501$, $p = 0.469$). With the inclusion of the mediating variable of Attitudes, the direct effects of Authentication Methods on Purchase Intention was still found insignificant ($\beta = -0.0496$, $p = 0.762$) as well as the indirect effects ($\beta = -0.1005$, $p = 0.431$). This shows that the relationship between Authentication Methods and Purchase Intention is not mediated by Attitudes. These results serve to reject H11. However, the path estimates for the path between Attitudes and Purchase Intention demonstrate a statistically significant relationship ($p < .001$), thereby supporting H6.

5.6.3 Subjective Norms

Table 5.15: Subjective Norms Variable Mediation and Path Estimates

Mediation Estimates					
Effect	Estimate	SE	Z	p	% Mediation
Indirect	-0.0804	0.110	-0.731	0.465	53.6
Direct	-0.0697	0.175	-0.398	0.691	46.4
Total	-0.1501	0.210	-0.716	0.474	100.0

Path Estimates						
			Estimate	SE	Z	p
Authentication Method	→	Subjective Norms	-0.1795	0.2444	-0.734	0.463
Subjective Norms	→	Purchase Intention	0.4480	0.0612	7.320	<.001
Authentication Method	→	Purchase Intention	-0.0697	0.1751	-0.398	0.691

Mediation analysis also was performed to assess the mediating role of Subjective Norms on the linkage between Authentication Methods and Purchase Intention. The results (See Table

5.15) revealed that the total effect of Authentication Methods on Purchase Intention was not significant ($\beta = -0.1501$, $p = 0.474$), nor was the direct ($\beta = -0.0697$, $p = 0.691$) or indirect ($\beta = -0.0804$, $p = 0.465$) effects with the addition of Subjective Norms as a mediating variable. This shows that the relationship between Authentication Methods and Purchase Intention is not mediated by Subjective Norms. These results serve to reject H12. However, the path estimates for the path between Subjective Norms and Purchase Intention demonstrate a statistically significant relationship ($p < .001$), thereby supporting H7.

5.6.4 Perceived Behavioural Control

Table 5.16: Perceived Behavioural Control Variable Mediation and Path Estimates

Mediation Estimates					
Effect	Estimate	SE	Z	p	% Mediation
Indirect	0.220	0.112	1.968	0.049	37.3
Direct	-0.370	0.190	-1.945	0.052	62.7
Total	-0.150	0.209	-0.720	0.472	100.0

Path Estimates							
				Estimate	SE	Z	p
Authentication Method	→	Perceived Behavioural Control		0.476	0.2268	2.10	0.036
Perceived Behavioural Control	→	Purchase Intention		0.461	0.0663	6.96	<.001
Authentication Method	→	Purchase Intention		-0.370	0.1902	-1.94	0.052

Finally, mediation analysis was performed to assess the mediating role of Perceived Behavioural Control on the relationship between Authentication Methods and Purchase Intention. First, the results (See Table 5.16) revealed that the total effect of Authentication Methods on Purchase Intention was not significant ($\beta = -0.150$, $p = 0.472$). With the inclusion of the mediating variable of Perceived Behavioural Control, the impact of Authentication Methods on Purchase Intention was still found insignificant ($\beta = -0.370$, $p = 0.052$). However, the indirect effect of Authentication Methods on Purchase Intention through Perceived Behavioural Control was found significant ($\beta = 0.220$, $p = 0.049$). This shows that the relationship between Authentication methods and Purchase Intention is mediated by Perceived Behavioural Control. The presence of a statistically significant indirect effect ($p = .049$) supports H13. Finally, the path estimates for the path between Perceived Behavioural Control and Purchase Intention demonstrate a statistically significant relationship ($p < .001$), thereby supporting H8.

5.6.5 Hypotheses Summary

The results of each hypothesis are collected in the table below:

Table 5.17: Hypotheses Results

Hypothesis		Results	p-value
H1	Blockchain authentication methods affect perceived risk such that perceived risk will be lower when using blockchain authentication methods rather than paper authentication methods.	Accepted	<.001
H2	Blockchain authentication methods will generate positive attitudes related to authentication method to a higher degree than paper authentication methods.	Rejected	0.439
H3	Blockchain authentication methods will have a positive impact on subjective norms related to authentication method to a higher degree than paper authentication methods.	Rejected	0.471
H4	Blockchain authentication methods will generate greater perceived behavioural control related to authentication method than paper authentication methods.	Accepted	0.036
H5	If an individual has a lower perceived risk, then he or she will have increased purchase intention.	Accepted	<.001
H6	If an individual has more positive attitudes then he or she will have increased purchase intention.	Accepted	<.001
H7	If an individual has more positive subjective norms then he or she will have increased purchase intention.	Accepted	<.001
H8	If an individual has more positive Perceived Behavioural Control then he or she will have increased Purchase Intention.	Accepted	<.001
H9	Purchase intention will be higher when using blockchain authentication methods.	Rejected	0.476
H10	Perceived Risk will have a mediating effect on the relationship between Authentication Method and Purchase Intention such that as Perceived Risk decreases, Purchase Intention will increase.	Accepted	0.010
H11	Attitudes will have a mediating effect on the relationship between Authentication Method and Purchase Intention such that as Attitudes increase, Purchase Intention will increase.	Rejected	0.469
H12	Subjective Norms will have a mediating effect on the relationship between Authentication Method and Purchase Intention such that as Subjective Norms increase, Purchase Intention will increase.	Rejected	0.474
H13	Perceived Behavioural Control will have a mediating effect on the relationship between Authentication Method and Purchase Intention such that as Perceived Behavioural Control increase, Purchase Intention will increase.	Accepted	0.049

6 Discussion

In the following chapter, the results of the proposed hypotheses as presented in the data analysis are evaluated and expanded upon as they relate to theory and previous research literature to gain further insights. The chapter begins by discussing the findings regarding the relationship between authentication method, Perceived Risk and Purchase Intention. This is followed by a discussion of the findings regarding the relationship between authentication method, the theory of planned behaviour and Purchase Intention. Finally, the direct relationship between authentication method and Purchase Intention is explored.

6.1 Authentication Method – Perceived Risk – Purchase Intention

The findings of this study as related to the Perceived Risk variable are consistent with what was hypothesised in the research model; Blockchain Authentication would result in lower levels of Perceived Risk than Traditional Authentication methods. Hypothesis 1: *Blockchain Authentication methods affect Perceived Risk such that Perceived Risk will be lower when using Blockchain Authentication methods rather than Paper Authentication methods*, is therefore accepted.

In relation to the theory used to form this hypothesis, the survey items used to measure Perceived Risk (Table 4.2) examined both types of risk discussed; psycho/social and functional/economic (Bauer, 2001; Taylor, 1974). This approach allowed the Perceived Risk variable to be assessed from the angles most relevant to second-hand luxury consumption. The significant relationship between Authentication Method and Perceived Risk also supports the theory presented by Taylor, (1974) in his model outlining consumer risk and the ways in which it can be mitigated. The author states that perceived risk can be reduced through the availability of information. In the case of this study, the information regarding the authenticity of a second-hand luxury item is provided through one of two authentication methods. Blockchain was considered less risky by the respondents of our survey, which was expected due to the quality of information available with this method as opposed to traditional methods. This is supported by research which describes the technology as secure, tamper-proof, and transparent, all of which are traits not used to describe traditional paper authentication methods (de Boissieu et al., 2021; Thanasi-Boçe et al., 2022).

As previously stated, perceived risk is one of the greatest contributing factors to consumer's hesitation to purchase second-hand luxury items (Turunen & Leipämaa-Leskinen, 2015). In

addition to higher perceived risk among consumers shopping online compared to in physical outlets according to Lee & Tan, (2003) and Tan, (1999), it is no surprise that reducing perceived risk would positively impact purchase intention. The legitimacy of this relationship is supported by the results of the mediation analysis and consequent acceptance of hypothesis 5: *If an individual has a lower Perceived Risk, then he or she will have increased Purchase Intention.*

These significant effects are consistent with an indirect mediating effect which was tested and confirmed, meaning that switching from Traditional to Blockchain Authentication methods for second-hand luxury e-commerce would decrease the observed levels of Perceived Risk in consumers, consequently resulting in increased Purchase Intention. Thus, hypothesis 10: *Perceived Risk will have a mediating effect on the relationship between authentication method and Purchase Intention such that as Perceived Risk decreases, Purchase Intention will increase,* is confirmed. However, the lack of a statistically significant direct effect means that, in this case, altering the authentication method did not have an impact on Purchase Intention directly, but only through its effects on Perceived Risk.

6.2 Authentication Method – TPB – Purchase Intention

6.2.1 Attitudes

According to findings in the analysis there is no statistical difference between Blockchain Authentication and Paper Authentication in their impact on attitudes. Therefore, there is no support for hypothesis 2: *Blockchain Authentication methods will generate positive Attitudes related to authentication method to a higher degree than Paper Authentication methods.* This means that if an entity were to implement Blockchain Authentication it would not generate more favourable attitudes towards the offered authentication method than paper-based authentication. According to Ajzen & Fishbein, (1977) attitudes are shaped by a person's beliefs about the consequences of the behaviour and the subjective evaluation of those consequences. Lack of awareness and experience in regard to the Blockchain Authentication method may therefore explain why there is no significant impact on attitudes towards the authentication method. Respondents may not fully know or understand the concept of blockchain as an authentication method including its advantages due to the recency of the technology, and therefore no significant preference is created as Blockchain Authentication doesn't necessarily evoke more favourable attitudes than Paper Authentication.

The finding is further enforced by the indication that Attitudes have no significant mediating effect between the variable's authentication method and Purchase Intention, thus rejecting hypothesis 11: *Attitudes will have a mediating effect on the relationship between Authentication Method and Purchase Intention such that as Attitudes increase, Purchase Intention will increase.* This indicates that Attitudes carry no influence on the relationship between the authentication methods in general and Purchase Intention. Therefore, no matter

which of the two authentication methods is offered, there will likely not be a change in attitudes toward the chosen authentication method, with no subsequent impact on Purchase Intention. This finding potentially points to a lack of awareness in regards to the authentication methods in general among the respondents, where not enough strong attitudes towards an authentication method is generated to be able to influence Purchase Intention. Alternatively attitudes towards the offering of a specific authentication method do not weigh heavily enough when considering a purchase, thus a change in attitudes towards the authentication method would not necessarily impact the purchase intention.

However, there is a statistically significant impact between variables Attitudes and Purchase Intention, confirming hypothesis 6: *If an individual has more positive Attitudes then he or she will have increased Purchase Intention.* This aligns with the theory of planned behaviour by Ajzen, (1985), where he states that attitudes alongside subjective norms and perceived behavioural control have a direct impact on and shape individual's behavioural intentions, such that an increase in positive attitudes would increase behavioural intention. The result additionally aligns with research by Bian & Forsythe, (2012) where attitudes have a significant impact on purchase intention towards luxury brands among US and Chinese consumers. This could be because more positive attitudes enable more favourable evaluations, creating higher likelihood of purchase intention. The study at hand therefore supports the possibility of positively influencing purchase intention through consumer attitudes, though not in relation to a specific choice of authentication method.

6.2.2 Subjective Norms

Similarly to Attitudes, no support was found for the effects of Blockchain Authentication on Subjective Norms, therefore rejecting the following *hypothesis 3: Blockchain Authentication methods will have a positive impact on Subjective Norms related to authentication method to a higher degree than Paper Authentication methods.* Given that no statistically significant difference between the two methods could be identified, it thereby signals that either method is acceptable to use in relation to the Subjective Norms associated with it, within the setting of second-hand luxury e-commerce in our study. The theories presented by Ajzen, (1991 and Manning, (2009) state that subjective norms and social pressures have an impact on the behaviours that an individual chooses to partake in. The lack of engagement with Blockchain Authentication indicate that the choice of authentication method potentially does not evoke these enough to result in a certain behaviour. It is feasible to pose that there might not be enough social pressure or norms associated with the concept of authentication, at this point in time, to support the notion of one method being perceived in a significantly more favourable manner. Given that Blockchain Authentication might not evoke any strong image associations at this point, and that the group or an individual's social setting is not invested enough in the concept to care about the choices, there might not be enough pressure to render a specific preference from the individual.

Furthermore, no significant direct or indirect mediating effects of Subjective Norms could be detected between the variables of Authentication Method and Purchase Intention, thereby rejecting *hypothesis 12: Subjective Norms will have a mediating effect on the relationship between Authentication Method and Purchase Intention such that as Subjective Norms increase, Purchase Intention will increase*. This indicates an insignificant relationship between the two variables. This means that in this study, the choice of authentication method does not carry any serious repercussions in relation to their impact on subjective norms.

However, in alignment with the theory of planned behaviour developed by Ajzen, (1985), the path between the variables of Subjective Norms and Purchase Intention, described by the following *hypothesis 7: If an individual has more positive Subjective Norms then he or she will have increased Purchase Intention, was found to be statistically significant, indicating the presence of a relationship between the two variables*. This indicates that this study further supports that there is potential to increase Purchase Intention through utilizing Subjective Norms to one's favour in accordance with the previously presented theories, however, that the choice to switch from Traditional to Blockchain Authentication methods would likely not render the desired result currently.

As mentioned previously, although the theories presented by Ajzen, (1985) state that social pressures and expectations shape an individual's behaviour, it is possible that the concept of authentication methods do not evoke a strong enough social pressure or subjective norm associations to generate a strong preference for one versus the other in relation to the purchase behaviour. Another contributing factor could also be the relatively newly established prevalence of the concept of second-hand luxury e-commerce, and that the subjective norms have not yet had the opportunity to form into strong behavioural pressures. Additionally, the blockchain technology as a mode of authentication is a fairly new and somewhat foreign concept to many consumers as it has not yet become fully implemented in a manner that could be considered mainstream. If one is not thoroughly familiar with an authentication concept, it might be difficult for an individual or a group to develop a strong enough preference for it. If more time was given and an increased familiarization with the concept of blockchain technology was allowed to be established in the mainstream, it could potentially cause norms and social expectations to perform a behaviour to develop in the future.

6.2.3 Perceived Behavioural Control

In relation to Perceived Behavioural Control, the data shows that there is a statistically significant difference of the variable between the Blockchain Authentication method and the Traditional Paper Authentication method, where the Blockchain Authentication method resulted in higher Perceived Behavioural Control. This supports the following hypothesis, *H4: Blockchain Authentication methods will generate greater Perceived Behavioural Control relation to authentication method than Paper Authentication method*. Thereby, this study found that Blockchain Authentication methods increased the level of perceived behavioural control for the participants of the study. This is in alignment with the proposition formed in

the theory section where the security of Blockchain Authentication methods was suggested to, in accordance with Kraft et al., (2005), increase the level of controllability an individual perceives.

Through the mediation analysis, a statistically significant indirect mediating effect of Perceived Behavioural Control between perceived authentication method and Purchase Intention was found. The same statistical significance was found for the relationship between Perceived Behavioural Control and Purchase Intention, which is aligned with the theory of planned behaviour presented by (Ajzen, 1991). This supports the following hypotheses, *H13: Perceived Behavioural Control will have a mediating effect on the relationship between authentication method and Purchase Intention such that as Perceived Behavioural Control increase, Purchase Intention will increase*, as well as *H8: If an individual has more positive Perceived Behavioural Control, then he or she will have increased Purchase Intention*. The statistically significant indirect mediating effect indicates that the relationship between Blockchain Authentication methods and Purchase Intention is mediated through Perceived Behavioural Control. The direct effect proved to be statistically insignificant, meaning that authentication methods alone do not have a statistically significant effect on Purchase Intention in this study. The path between authentication method and Perceived Behavioural Control was proven to be statistically significant, indicating that there is a positive relationship between these variables where authentication methods have a positive impact on the perceived behavioural control of the participants in the study. The same is true for the path between Perceived Behavioural Control and Purchase Intention, as this relationship was proven to be statistically significant, which is in alignment with the theory of planned behaviour presented by Ajzen, (1985). This further strengthens the theory that Perceived Behavioural Control has a positive impact on Purchase Intention. However, the path between authentication methods and Purchase Intention was not statistically significant, indicating no direct relationship between the variables.

A potential explanation for the results, where Blockchain Authentication method rendered higher levels of Perceived Behavioural Control than Traditional Authentication methods, could be the concept presented by Westjohn et al., (2009), where consumers who identify with the concept of cosmopolitanism and as global individuals have an increased readiness for technology usage. Potentially due to the global nature of the second-hand luxury industry, specifically within e-commerce where shopping is not limited by borders or the availability of stock in a local store, it could be posed that the consumers within this marketplace have a higher readiness to use technology. Additionally, since blockchain technology has been found to be perceived as secure in recent studies, it could also have an impact on the result of blockchain technology rendering a higher degree of perceived behavioural control (de Boissieu et al., 2021; Noonan & Doran, 2021; Thanasi-Boçe et al., 2022). A higher technology readiness paired with the secure nature of blockchain technology, results in higher perceived behavioural control amongst this study's participants. Given that this study has specified its participants towards individuals who have an interest in or experience with second-hand luxury e-commerce, there is a possibility that the results could look different given a different industry and a different consumer base.

6.3 Authentication Method – Purchase Intention

Though blockchain technology is seen as lowering perceived risk and increasing PBC, which in turn increase Purchase Intention, the Blockchain Authentication method has interestingly no direct impact on Purchase Intention. Therefore, there is no support for the hypothesis 9: *Purchase Intention will be higher when using Blockchain Authentication methods*. Though no previous studies have been conducted on the impact of Blockchain Authentication methods specifically on Purchase Intention within second hand luxury e-commerce, the result is surprising when reviewing the previously mentioned studies pointing to the importance of authenticity when purchasing second hand luxury goods, particularly online (Amatulli et. al. (2018); Cervellon & Carey, 2012; Sihvonen & Turunen, 2016; Turunen & Leipämaa-Leskinen, 2015), alongside the described strengths and advantages of blockchain technology as an authentication method (de Boissieu et al., 2021; Noonan & Doran, 2021; Shih, Bick & Murawski, 2022; Thanasi-Boçe et al., 2022). The result could potentially be due to the fact that the respondents are not fully aware of blockchain technology as it's relatively new, nor fully understand how blockchain-based authentication works or its significance in verifying authenticity. Though authentication methods reduce perceived risk, where Blockchain Authentication reduce perceived risk to a higher extent than Paper Authentication, there may be other factors such as seller reputation or customer service that play a role on the intention to purchase, where the authentication method alone is not enough to ensure complete trust and thereby directly influence purchase intention.

7 Conclusion

The following chapter concludes the thesis by assessing the accomplishment of the research aims and objectives established in the introduction. This is followed by an evaluation of theoretical as well as managerial implications of this. Finally, limitations of the study are outlined, forming the recommendations for future research.

7.1 Research Aim & Objectives

Motivated by the rapid expansion of second-hand luxury e-commerce and the recent application of blockchain as a method of authentication within the luxury industry, the aim of this study is to gain a better understanding of the use of blockchain authentication methods within the online luxury resale market from a consumer standpoint. The objective was to gather and compare data on proven antecedents to behavioural intention, such as attitudes, subjective norms, and perceived behavioural control in relation to blockchain and paper authentication methods, as well as the role of perceived risk, and examine potential impact on purchase intention to confirm any advantages of offering blockchain authentication over paper authentication. Through an independent sample T-test and mediation analyses on the survey data gathered we were able to accomplish this goal and conclude that Blockchain Authentication decreased risk and increased Perceived Behavioural Control, subsequently increasing Purchase Intention. However, discussion of results leads to the conclusion that this technology may not be established enough to render consumer preferences in comparison to paper authentication and in relation to attitudes and subjective norms. This indicates a need for further consumer education in regard to the concept of blockchain technology as an authentication method. The research study accomplishes its purpose of providing valuable consumer insights to companies in the vintage luxury e-commerce industry to better understand application of this developing technology, while filling a research gap where consumer perceptions in the context of this study have previously not been considered. The following theoretical and managerial implications of these findings are outlined below.

7.2 Theoretical Implications

This study presents theoretical contributions by expanding research literature on the use of blockchain technology as an authentication method for second-hand luxury e-commerce platforms. Previous research has mainly focused on the use of blockchain technology to

combat counterfeits in new luxury production (Choi 2019; de Boissieu et al., 2021) and other industries such as medicine (Mani, Prakash & Lai, 2022) and retail in general (Pun, Swaminathan & Hou 2021; Shen, Xu & Yuan, 2020). Due to the recent boom in resale of luxury goods (Statista, 2023a) alongside a continuous increase in counterfeits, and the nascent, but growing application of blockchain technology as an authentication method (de Boissieu et al., 2021), the research purpose of this study is highly relevant and important in order to further knowledge on the use of blockchain-based authentication methods within second-hand luxury e-commerce.

Rather than examining blockchain-based authentication purely from a more common back-end point of view, as done by the studies mentioned in the previous paragraph, this research paper investigates consumer perceptions in regard to authentication methods; whether blockchain-based authentication may be more beneficial than paper authentication and how this may impact purchase intention towards second hand luxury goods online. This represents a highly unexplored area of research thus far, and additionally creates a foundation for further consumer-based research within the field. To achieve the aim, the theory of planned behaviour was applied to measure authentication methods impact on attitudes, subjective norms, and perceived behavioural control, and the subsequent impact on intended purchasing behaviour. Though Blockchain Authentication methods had no effect on Attitudes and Subjective Norms, they in turn had significant impact on Purchase Intention, which aligns with and supports the theory of planned behaviour (Ajzen 1985). This does not mean that the theory of planned behaviour is misplaced in our study but may rather indicate that the lack of awareness regarding authentication methods, especially blockchain authentication, prevents evocation of attitudes and subjective norms. Thus, the research shows further education regarding the blockchain-based authentication method may be needed before impact on these variables as related to Blockchain Authentication can be fully understood. This indicates a replication of the study could be done once blockchain authentication has become more mainstream. As previously mentioned, the variables in turn, including Perceived Behavioural Control, had significant impact on Purchase Intention, supporting the theory as a predictor of behaviour within the study. Additionally, Blockchain Authentication was shown to result in higher Perceived Behavioural Control, which aligns with theory and confirms the study by Kraft et al. (2005), where blockchain authentication methods may increase the level of perceived controllability. This is further strengthened by the significant indirect mediating effect indicating that the relationship between Blockchain Authentication methods and Purchase Intention is mediated through Perceived Behavioural Control.

The study additionally contributes to research literature by confirming through use of risk theory that consumers view blockchain-based authentication as lowering perceived risk to a greater extent than paper authentication, and that this in turn increases purchase intention. Due to previous research revealing perceived risk as a primary concern among consumers regarding the purchase of second-hand luxury goods (Turunen & Leipämaa-Leskinen, 2015; Amatulli et al., 2018; Gistri et al., 2009). Risk theory is implemented based on the model of risk taking in consumer behaviour by Taylor (1974) to understand the impact of authentication method on perceived risk among consumer's and the subsequent impact on

purchase intent. Authentication method is shown to have a significant impact on perceived risk, where blockchain-based authentication lowers perceived risk more than paper authentication. The perceived risk in turn is shown to have a significant impact on Purchase Intention. These relationships are strengthened by confirmation of perceived risk having a mediating effect on the relationship between authentication method and Purchase Intention. Therefore, the research paper not only confirms and supports the use of risk theory, but also the consumer perception of blockchain-based authentication as reducing risk more than paper authentication which in turn increases purchase intention.

7.3 Managerial Implications

Given the previously presented growth of the second-hand luxury market and its predicted continued growth over the coming years, this study has contributed through providing valuable insight into a topic that could be utilised from a strategic business perspective (Statista, 2023a).

As rendered by the findings in this study, a statistically significant mediating effect through both risk perception and perceived behavioural control upon Purchase Intention could be identified. Considering that one of the main consumer concerns in relation to second-hand luxury consumption according to Turunen & Leipämaa-Leskinen (2015) is the risk associated with a purchase given the prevalence of inauthentic goods in the marketplace, the results of this study provide valuable insights on how luxury e-commerce platforms may proceed in combating these fears. As proven by the results in this paper, blockchain technology decreases the risk associated with the purchase, thereby having a positive impact upon purchase intention. The same was true for perceived behavioural control, where the Blockchain Authentication method rendered increased Perceived Behavioural Control, which in turn also affected Purchase Intention in a positive manner.

Given these findings, through the implementation of blockchain technology, a business could benefit from their consumers viewing the process as less risky and perceiving themselves to have a greater amount of behavioural control. In the competitive landscape of the second-hand luxury industry, implementing blockchain could offer advantages and perhaps even create positive consumer preference in comparison to competitors that do not offer the technology. The social risk of accidentally purchasing an inauthentic item is one of the greater concerns from a consumer perspective in relation to the consumption of second-hand luxury goods, indicating the relevance of the topic (Amatulli, et al. 2018; Gistri et al., 2009). Therefore, there could be a case for first mover advantages for the companies who are willing to take a risk and start offering blockchain authentication as an additional service, given that the technology and the consumer awareness of the blockchain concept might increase and become mainstream in the future.

This study found no statistically significant mediating effect of either subjective norms or attitudes upon Purchase Intention. However, it could be argued that this does not render these variables entirely irrelevant. As previously posed in the conclusion, the absence of impact of these variables could be due to a lack of knowledge and a lack of social norms attached to the concept, which could arguably be viewed as an opportunity for these to be formed by the businesses who first implement the technology. A lack of subjective norms and attitudes could thereby become a strategic advantage if first mover businesses within the second-hand luxury industry could develop an approach to establish their desired consumer attitudes and subjective norms. As introduced in the theory section, these are often established through experiences and expectations, which could be derived by consumers through readily available knowledge distributed by the businesses who stand to gain from positive associations. Given that a business within the second-hand luxury industry considers implementing blockchain technology for the purpose of authentication and certification, the opportunity to potentially mould and shape the future attitudes and subjective norms regarding the concept should be considered.

It is, however, worth mentioning that there are aspects of the technology to consider from a strategic business perspective within the second-hand luxury industry. The two major areas of uncertainty can be narrowed down to mainly the cost efficiency of implementing the technology on a large scale across all types of products offered by e-commerce actors within the industry. In relation to the cost efficiency, if an economically sustainable business model could not be achieved, it could potentially be worth waiting on investments into the implementation of blockchain technology at this point in time. Instead, it could be more beneficial, as mentioned before, to place more efforts upon consumer education and the potential knowledge gap that is present in relation to consumers and blockchain technology. Finally, considering the privacy solutions available within blockchain and assessing for compliance with GDPR legislation in Europe and other general consumer concerns regarding privacy will be an ongoing area of interest for managers wanting to implement this technology.

To summarise, the findings presented in this study have provided a data-based foundation and further insights into consumer perspectives on blockchain authentication methods, for managers within second-hand luxury e-commerce who are considering blockchain implementation within their business management strategy.

7.4 Limitations

This study aimed to compare blockchain and traditional authentication methods in the context of second-hand luxury fashion e-commerce. While our findings offer valuable insights, it is important to acknowledge several limitations that may have influenced the results.

Firstly, the use of convenience sampling in participant selection introduced potential biases that could limit the generalizability of our findings. Although we did not encounter specific issues regarding the diversity or composition of our sample, a more targeted approach in audience selection could have enhanced the validity and applicability of our results. A stratified sampling techniques could have been employed to ensure a representative sample and examine potential cultural influences by recruiting participants from specific countries.

Secondly, the sample size of 190 respondents, while providing a reasonable basis for analysis, may have affected the statistical power of the study. A larger sample size would have allowed for more robust conclusions and increased the generalizability of the findings. Furthermore, the recruitment process presented challenges, and expanding the participant pool could have provided a more comprehensive representation of the target population.

Thirdly, the use of internet-based surveys and convenience sampling may have introduced limitations related to the reliability and validity of the collected data. While efforts were made to mitigate these limitations, such methods are susceptible to self-selection bias and may not capture the nuances of participant perspectives accurately. The study could have employed a mixed-methods approach, which would have allowed for incorporation of qualitative interviews or focus groups alongside surveys, to provide an additional and more comprehensive understanding of consumer behaviour and their reasoning in relation to authentication methods.

Another limitation of our study is its focus on comparing blockchain and traditional authentication methods, neglecting other potentially influential factors in the luxury fashion e-commerce sector. Exploring a broader range of authentication options and considering additional contextual factors, such as brand reputation or customer reviews, would yield a more comprehensive understanding of consumer behaviour in this domain. Additionally, due to constraints in time and resources, this study was unable to delve deeper into the various authentication methods. A more extensive investigations of different authentication methods and their impact on consumer decision-making could have been conducted by including the vessel by which the link to the blockchain is incorporated in the product, for example by QR code or NFC Chip. This study chose to omit this layer, as it was not the primary focus of this paper, however this information could also serve as valuable to e-commerce platforms looking to implement this technology. Additionally, the study could have included privacy as a variable, examining whether the concerns about data being stored on a blockchain outweigh the benefits that a lower perceived risk and increased behavioural control provide.

Furthermore, the varying levels of familiarity and understanding of blockchain technology among our participants posed a limitation to our study. Despite providing a brief explanation at the beginning of the survey, the lack of mainstream awareness may have hindered participants' ability to fully comprehend and respond to the survey questions. It likely would have been helpful to have performed educational interventions, such as pre-survey materials or interactive tutorials, to ensure participants have a sufficient understanding of the technologies under investigation.

Lastly, the time and resource-constraints imposed limitations on the scope and design of this study. The tight deadline prevented more extensive data gathering processes or longitudinal studies from being employed to capture participants' actual purchase behaviour over time. To increase the scope of the study, with an adequate amount of time and resources, a longitudinal design could've been considered to track changes in consumer preferences and behaviour as blockchain technology becomes more established in the luxury fashion e-commerce market.

7.5 Future Research

Based on the identified limitations, several areas for future research emerge: First, cross-cultural analyses can provide a deeper understanding of how national cultures influence consumer perceptions and adoption of blockchain and traditional authentication methods in the luxury fashion e-commerce sector. Comparative studies across different countries would shed light on the cultural nuances that shape consumer preferences and behaviours. Second, expanding the range of authentication methods beyond simply blockchain and traditional approaches would enable a more comprehensive evaluation of available options and their impact on consumer behaviour. As this study provides a foundation for blockchain authentication generally creating lower perceived risk and increased perceived behavioural control, the logical next step before implementation would be to explore the method and cost of incorporating blockchain technology. Exploring the extent of consumer concerns regarding privacy is another important focus for further research as there is research backing the prevalence of this issue and the potential for it to harm consumer perspectives on blockchain for use as an authentication method (Pun, Swaminathan & Hou, 2021).

Additionally, employing a mixed-methods approach that combines quantitative surveys with qualitative interviews or focus groups would provide a more in-depth understanding of consumer perspectives. Capturing a more robust understanding of individual experiences, motivations, and decision-making processes related to authentication methods in the luxury fashion e-commerce sector.

Another consideration for further research could be investigating the long-term impact and consumer acceptance of blockchain technology as it becomes more mainstream in the luxury fashion industry. Conducting longitudinal studies that track consumer attitudes, behaviours, and adoption rates over an extended period can provide valuable insights into the evolving landscape of authentication methods and the role of blockchain technology within it.

Finally, while this research focused on the consumer perspective, future research could adopt a managerial perspective and investigate the cost-benefit analysis of implementing different authentication methods in the luxury fashion e-commerce industry. Examining the financial implications, such as the costs associated with implementing and maintaining various

authentication systems, compared to the potential benefits for businesses, such as enhanced reputation, reduced liability, and increased customer trust, would provide valuable insights for decision-makers in the industry. By considering both the consumer and managerial perspectives, researchers can offer a more comprehensive understanding of the trade-offs and considerations involved in selecting and implementing authentication methods in the luxury fashion e-commerce sector.

In summary, future research should aim to address the limitations identified in this study by employing more targeted sampling techniques, expanding the range of authentication methods examined, incorporating mixed-methods approaches, and considering the managerial perspective. By doing so, researchers can provide more robust and nuanced insights into consumer behaviour and decision-making processes in the luxury fashion e-commerce industry, ultimately contributing to the development of more effective authentication strategies and technologies.

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Appendix A

Frequency tables for survey items:

Frequencies of PI1

PI1	Authentication Method	Counts	% of Total
1	Traditional	4	2.3%
	Blockchain	8	4.5%
2	Traditional	5	2.8%
	Blockchain	14	8.0%
3	Traditional	8	4.5%
	Blockchain	6	3.4%
4	Traditional	35	19.9%
	Blockchain	17	9.7%
5	Traditional	11	6.3%
	Blockchain	26	14.8%
6	Traditional	18	10.2%
	Blockchain	11	6.3%
7	Traditional	5	2.8%
	Blockchain	8	4.5%

Frequencies of PBC1

PBC1	Authentication Method	Counts	% of Total
1	Traditional	3	1.7%
	Blockchain	6	3.4%
2	Traditional	9	5.1%
	Blockchain	12	6.8%
3	Traditional	14	8.0%
	Blockchain	5	2.8%
4	Traditional	31	17.6%
	Blockchain	26	14.8%
5	Traditional	17	9.7%
	Blockchain	13	7.4%
6	Traditional	8	4.5%
	Blockchain	17	9.7%
7	Traditional	4	2.3%
	Blockchain	11	6.3%

Frequencies of PI2

PI2	Authentication Method	Counts	% of Total
1	Traditional	2	1.1%
	Blockchain	3	1.7%
2	Traditional	7	4.0%
	Blockchain	10	5.7%
3	Traditional	8	4.5%
	Blockchain	8	4.5%
4	Traditional	23	13.1%
	Blockchain	16	9.1%
5	Traditional	17	9.7%
	Blockchain	30	17.0%
6	Traditional	16	9.1%
	Blockchain	12	6.8%
7	Traditional	13	7.4%
	Blockchain	11	6.3%

Frequencies of PBC2

PBC2	Authentication Method	Counts	% of Total
1	Traditional	9	5.1%
	Blockchain	7	4.0%
2	Traditional	10	5.7%
	Blockchain	14	8.0%
3	Traditional	15	8.5%
	Blockchain	11	6.3%
4	Traditional	30	17.0%
	Blockchain	19	10.8%
5	Traditional	14	8.0%
	Blockchain	13	7.4%
6	Traditional	5	2.8%
	Blockchain	10	5.7%
7	Traditional	3	1.7%
	Blockchain	16	9.1%

Frequencies of PI3

PI3	Authentication Method	Counts	% of Total
1	Traditional	6	3.4%
	Blockchain	5	2.8%
2	Traditional	8	4.5%
	Blockchain	9	5.1%
3	Traditional	11	6.3%
	Blockchain	17	9.7%
4	Traditional	21	11.9%
	Blockchain	15	8.5%
5	Traditional	19	10.8%
	Blockchain	25	14.2%
6	Traditional	10	5.7%
	Blockchain	12	6.8%
7	Traditional	11	6.3%
	Blockchain	7	4.0%

Frequencies of PBC3

PBC3	Authentication Method	Counts	% of Total
1	Traditional	16	9.1%
	Blockchain	21	11.9%
2	Traditional	22	12.5%
	Blockchain	15	8.5%
3	Traditional	16	9.1%
	Blockchain	5	2.8%
4	Traditional	12	6.8%
	Blockchain	14	8.0%
5	Traditional	11	6.3%
	Blockchain	12	6.8%
6	Traditional	5	2.8%
	Blockchain	13	7.4%
7	Traditional	4	2.3%
	Blockchain	10	5.7%

Frequencies of SN1

SN1	Authentication Method	Counts	% of Total
1	Traditional	11	6.3%
	Blockchain	18	10.2%
2	Traditional	9	5.1%
	Blockchain	8	4.5%
3	Traditional	12	6.8%
	Blockchain	5	2.8%
4	Traditional	25	14.2%
	Blockchain	33	18.8%
5	Traditional	15	8.5%
	Blockchain	10	5.7%
6	Traditional	7	4.0%
	Blockchain	10	5.7%
7	Traditional	7	4.0%
	Blockchain	6	3.4%

Frequencies of A1

A1	Authentication Method	Counts	% of Total
1	Traditional	1	0.6%
	Blockchain	3	1.7%
2	Traditional	4	2.3%
	Blockchain	6	3.4%
3	Traditional	7	4.0%
	Blockchain	9	5.1%
4	Traditional	20	11.4%
	Blockchain	17	9.7%
5	Traditional	19	10.8%
	Blockchain	17	9.7%
6	Traditional	14	8.0%
	Blockchain	17	9.7%
7	Traditional	21	11.9%
	Blockchain	21	11.9%

Frequencies of SN2

SN2	Authentication Method	Counts	% of Total
1	Traditional	9	5.1%
	Blockchain	19	10.8%
2	Traditional	9	5.1%
	Blockchain	5	2.8%
3	Traditional	12	6.8%
	Blockchain	7	4.0%
4	Traditional	26	14.8%
	Blockchain	32	18.2%
5	Traditional	15	8.5%
	Blockchain	11	6.3%
6	Traditional	9	5.1%
	Blockchain	12	6.8%
7	Traditional	6	3.4%
	Blockchain	4	2.3%

Frequencies of A2

A2	Authentication Method	Counts	% of Total
1	Traditional	1	0.6%
	Blockchain	3	1.7%
2	Traditional	3	1.7%
	Blockchain	10	5.7%
3	Traditional	8	4.5%
	Blockchain	9	5.1%
4	Traditional	20	11.4%
	Blockchain	17	9.7%
5	Traditional	19	10.8%
	Blockchain	16	9.1%
6	Traditional	16	9.1%
	Blockchain	18	10.2%
7	Traditional	19	10.8%
	Blockchain	17	9.7%

Frequencies of SN3

SN3	Authentication Method	Counts	% of Total
1	Traditional	7	4.0%
	Blockchain	17	9.7%
2	Traditional	12	6.8%
	Blockchain	8	4.5%
3	Traditional	13	7.4%
	Blockchain	11	6.3%
4	Traditional	28	15.9%
	Blockchain	29	16.5%
5	Traditional	14	8.0%
	Blockchain	8	4.5%
6	Traditional	6	3.4%
	Blockchain	10	5.7%
7	Traditional	6	3.4%
	Blockchain	7	4.0%

Frequencies of A3

A3	Authentication Method	Counts	% of Total
1	Traditional	20	11.4%
	Blockchain	19	10.8%
2	Traditional	19	10.8%
	Blockchain	18	10.2%
3	Traditional	17	9.7%
	Blockchain	11	6.3%
4	Traditional	18	10.2%
	Blockchain	28	15.9%
5	Traditional	6	3.4%
	Blockchain	5	2.8%
6	Traditional	4	2.3%
	Blockchain	6	3.4%
7	Traditional	2	1.1%
	Blockchain	3	1.7%

Frequencies of A4

A4	Authentication Method	Counts	% of Total
1	Traditional	1	0.6%
	Blockchain	6	3.4%
2	Traditional	5	2.8%
	Blockchain	2	1.1%
3	Traditional	13	7.4%
	Blockchain	3	1.7%
4	Traditional	22	12.5%
	Blockchain	32	18.2%
5	Traditional	16	9.1%
	Blockchain	17	9.7%
6	Traditional	17	9.7%
	Blockchain	13	7.4%
7	Traditional	12	6.8%
	Blockchain	17	9.7%

Frequencies of PR1

PR1	Authentication Method	Counts	% of Total
1	Traditional	2	1.1%
	Blockchain	12	6.8%
2	Traditional	7	4.0%
	Blockchain	17	9.7%
3	Traditional	6	3.4%
	Blockchain	13	7.4%
4	Traditional	18	10.2%
	Blockchain	24	13.6%
5	Traditional	24	13.6%
	Blockchain	17	9.7%
6	Traditional	15	8.5%
	Blockchain	7	4.0%
7	Traditional	14	8.0%
	Blockchain	0	0.0%

Frequencies of PR4

PR4	Authentication Method	Counts	% of Total
1	Traditional	42	23.9%
	Blockchain	44	25.0%
2	Traditional	19	10.8%
	Blockchain	17	9.7%
3	Traditional	8	4.5%
	Blockchain	12	6.8%
4	Traditional	10	5.7%
	Blockchain	7	4.0%
5	Traditional	4	2.3%
	Blockchain	5	2.8%
6	Traditional	2	1.1%
	Blockchain	4	2.3%
7	Traditional	1	0.6%
	Blockchain	1	0.6%

Frequencies of PR2

PR2	Authentication Method	Counts	% of Total
1	Traditional	0	0.0%
	Blockchain	12	6.8%
2	Traditional	4	2.3%
	Blockchain	14	8.0%
3	Traditional	9	5.1%
	Blockchain	18	10.2%
4	Traditional	24	13.6%
	Blockchain	19	10.8%
5	Traditional	19	10.8%
	Blockchain	18	10.2%
6	Traditional	18	10.2%
	Blockchain	6	3.4%
7	Traditional	12	6.8%
	Blockchain	3	1.7%

Frequencies of PR5

PR5	Authentication Method	Counts	% of Total
1	Traditional	27	15.3%
	Blockchain	28	15.9%
2	Traditional	21	11.9%
	Blockchain	17	9.7%
3	Traditional	12	6.8%
	Blockchain	17	9.7%
4	Traditional	13	7.4%
	Blockchain	18	10.2%
5	Traditional	7	4.0%
	Blockchain	6	3.4%
6	Traditional	4	2.3%
	Blockchain	3	1.7%
7	Traditional	2	1.1%
	Blockchain	1	0.6%

Frequencies of PR3

PR3	Authentication Method	Counts	% of Total
1	Traditional	6	3.4%
	Blockchain	14	8.0%
2	Traditional	10	5.7%
	Blockchain	16	9.1%
3	Traditional	9	5.1%
	Blockchain	10	5.7%
4	Traditional	17	9.7%
	Blockchain	20	11.4%
5	Traditional	19	10.8%
	Blockchain	13	7.4%
6	Traditional	12	6.8%
	Blockchain	13	7.4%
7	Traditional	13	7.4%
	Blockchain	4	2.3%

Frequencies of PR6

PR6	Authentication Method	Counts	% of Total
1	Traditional	17	9.7%
	Blockchain	24	13.6%
2	Traditional	15	8.5%
	Blockchain	20	11.4%
3	Traditional	10	5.7%
	Blockchain	16	9.1%
4	Traditional	19	10.8%
	Blockchain	16	9.1%
5	Traditional	14	8.0%
	Blockchain	8	4.5%
6	Traditional	5	2.8%
	Blockchain	5	2.8%
7	Traditional	6	3.4%
	Blockchain	1	0.6%