ANTECEDENTS AND OUTCOMES OF RICE EXPORTER'S WILLINGNESS TO ADOPT PRODUCT TRACEABILITY MECHANISM

By

Sami Ur Rehman

Fall 2021-MS L&SCM-00000362307-NBS

Supervisor

Dr. Muhammad Moazzam

Department of Operations and Supply Chain

A thesis submitted in partial fulfillment of the requirements for the degree of
MS Operations & Supply Chain (MS L&SCM)

In

NUST Business School (NBS)

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AUTHOR'S DECLARATION

I, Sami Ur Rehman declare that this master's degree's thesis entitled "Antecedents and Outcomes of Rice Exporter's Willingness to Adopt Product Traceability Mechanism" submitted to NUST Business School for the degree of Masters in Logistics and Supply Chain Management is the result of my own hard work and dedication. I have acknowledged all the material sources utilized in this research.

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DEDICATION

This work is dedicated to my beloved parents, in memory of my beloved father, Muhammad Asif Warraich. His unwavering belief, boundless wisdom, and endless support have been a constant source of inspiration throughout my academic journey. Though he is no longer with us, his legacy lives on in my heart and in this work. To my dear mother, whose unwavering love, sacrifices, and encouragement have made this achievement possible, I offer my deepest gratitude. To my siblings, I am grateful for their presence in my life. This dedication is a testament to the influence and support of these remarkable individuals in my life who have made this academic accomplishment possible. Your belief in me has been the driving force behind my dedication to this work.

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ABSTRACT

The global food supply chains face growing challenges related to safety, authenticity, and transparency. Consumers today demand greater accountability and assurance regarding the origin and quality of the products they consume. In the realm of global trade and food security, the rice sector stands as a pivotal player, particularly in countries like Pakistan. It not only contributes substantially to the country's GDP but also provides livelihoods for millions of people, from farmers to exporters and beyond. Pakistan holds a prominent position in the global rice market as both a producer and an exporter of rice. As global markets become increasingly quality-conscious and demand greater transparency and traceability throughout food supply chains, the need for robust traceability mechanism in the rice export sector becomes evident. This study delves into the willingness of rice exporters in Pakistan to adopt product traceability mechanism, considering their implications for ensuring the quality and safety of rice exports. Understanding the antecedents and outcomes of this willingness is essential for enhancing food safety, supply chain transparency, and overall industry performance. Due to the lack of studies on the willingness of rice exporters to adopt traceability mechanism, the major objective of this study was to explore the antecedents of rice exporters' willingness to adopt traceability mechanism. This study develops a hypothesised framework to address a gap in the literature. A sample of 157 rice exporting companies was selected through random sampling. A survey questionnaire was developed for the measurement of constructs, gauging responses on a five-point Likert scale. Structural equation modelling (SEM) is the primary data analysis technique used in this study. IBM SPSS statistical software was employed to conduct descriptive analysis, and SmartPLS 4.0 software was employed to evaluate the predictive capacity of the structural model and the relationships between constructs. The study's structural equation model revealed several significant relationships among key variables. These comprehensive findings provide robust empirical evidence in favour of all hypotheses, demonstrating statistically significant and meaningful relationships between the respective independent and dependent variables in the research model. This study adds to the prevailing literature by developing and testing an underexplored framework within the scope of product traceability in food supply chains. As the rice export industry continues to evolve in an increasingly globalised marketplace, our research serves as a foundation for making informed decisions, policy development, and future exploration. The pursuit of efficient, secure, and transparent supply chains remains paramount, ensuring the well-being of consumers and the sustainability of the rice export industry.

Keywords: rice supply chain, product traceability, service level, market pressure, trust, structural equation modelling

CHAPTER 1. INTRODUCTION

This chapter discusses the global food supply chain and provides an overview of the rice supply chain in Pakistan, discussing its production, consumption, and export trends. Its further sections are the problem statement, research objectives and questions, and scope of study. Finally, the organisation of chapters has been briefly described.

1.1 Global Food Supply Chain Management

The global food supply chains face growing challenges related to safety, authenticity, and transparency. Consumers today demand greater accountability and assurance regarding the origin and quality of the products they consume (Qian, Dai, Wang, Zha, & Song, 2022). In response to these demands, traceability mechanism have gained prominence as vital tools in ensuring food safety and supply chain integrity (Astill et al., 2019). Traceability allows for the tracking of a product's journey from its source to the end consumer, providing a comprehensive record of its production, handling, and distribution (FAO, 2020).

1.2 Rice Supply Chains

In the realm of global trade and food security, the rice sector stands as a pivotal player, particularly in countries like Pakistan. With its fertile lands and favorable climate, Pakistan boasts a rich agricultural tradition, making it one of the world's leading rice-producing nations (Herforth et al., 2020). The significance of rice production and exports in Pakistan's economic landscape cannot be overstated. As the global demand for rice continues to rise, propelled by growing populations and shifting dietary preferences, understanding the dynamics of the rice export industry becomes imperative. The rice sector is a cornerstone of Pakistan's agriculture and economy. It not only contributes substantially to the country's GDP but also provides livelihoods for millions of people, from farmers to exporters and beyond. Pakistan's diverse agro-ecological zones allow for the cultivation of various rice varieties, which cater to a broad spectrum of domestic and international preferences.

The industry is essential in ensuring food security within the nation, serving as a staple food for a significant portion of the population (Arif et al., 2021). The journey of rice from the supply chain to exports involves several stages and processes. Rice production begins with cultivation in paddies or upland fields. Farmers plant rice seeds and manage the crop, including irrigation, fertilization, and pest control. When the rice reaches maturity, it is harvested using machinery or manual labor (Athira, Bahurudeen, & Appari, 2019). After harvesting, the rice paddy undergoes post-harvest processing, which includes threshing to separate rice grains from the straw and husk (Officer, 2016). The harvested rice can be stored as rough rice or further processed into various types, such as white rice or parboiled rice.

Rice mills play a crucial role in processing rice for export. The milling process involves cleaning, hulling, polishing, and sorting the rice grains. Quality control measures are implemented to meet international standards. Export-quality rice undergoes rigorous quality inspections and grading to ensure it meets the required standards for export. Inspectors check for factors such as moisture content, foreign matter, and grain size. Exported rice is typically packaged in bags or containers suitable for transportation and storage. Rice intended for export is stored in warehouses where climate control systems are installed to ensure appropriate temperature and humidity levels (Mahroof, Omar, Rana, Sivarajah, & Weerakkody, 2021). Proper storage is essential to prevent spoilage and maintain quality. Figure 1.1 provides a complete rice supply chain from plant to plate.

Exporters prepare the necessary documentation, including certificates of origin, phytosanitary certificates, and other export permits. These documents are essential for customs clearance and compliance with import regulations in destination countries. Rice is transported from processing centers or warehouses to ports or distribution hubs. Rice is shipped to international markets by sea, air, or land, depending on the destination and urgency. Exported rice reaches its destination, where it is distributed to wholesalers, retailers, or further processed into consumer-ready products. Exporters must ensure that the exported rice complies with the importing country's regulations and quality standards (Bandumula, 2018).

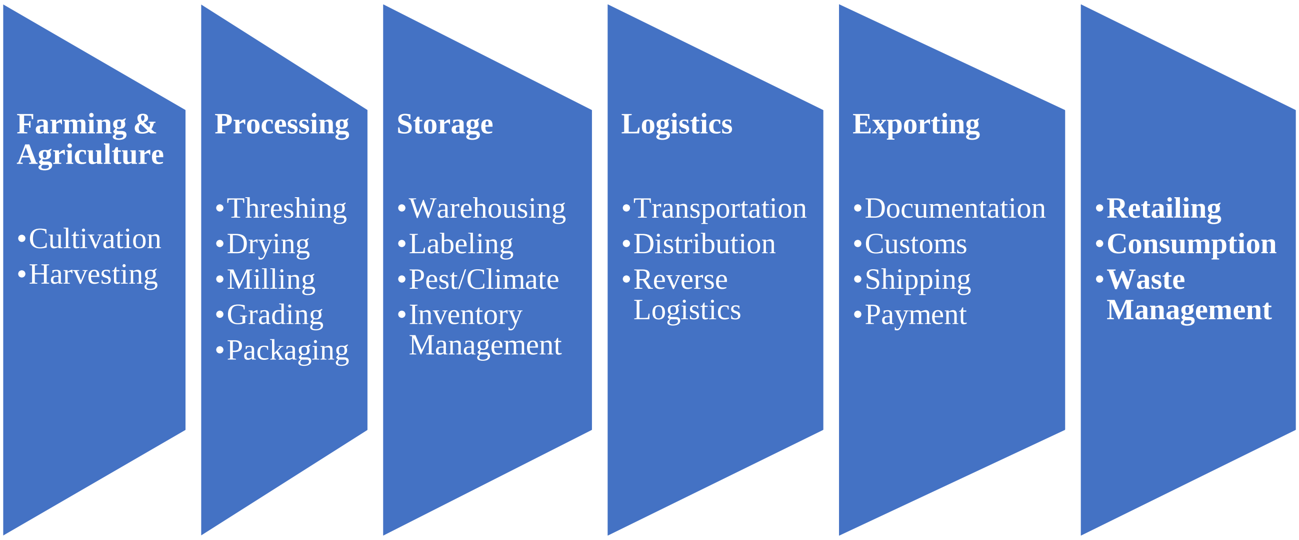

Figure 0.1: Rice Supply Chain Diagram

1.1.1 Rice Production

Rice production is a big agricultural activity in Pakistan that plays a vital role in its economy and food security. Pakistan is among the world's leading rice producers and exporters. Pakistan's diverse climatic conditions are suitable for rice cultivation. The main rice-growing regions include Punjab, Sindh, and Balochistan. In the marketing year 2021-22, Pakistan achieved an all-time high rice harvest of 8.9 million metric tons, marking an increase from the previous year's yield of 8.4 million metric tons. This information is reported in a document from the Global Agricultural Information Network, a division of the US Department of Agriculture (USDA).

Pakistan cultivates a variety of rice types, including basmati and non-basmati varieties. Basmati rice is renowned for its aroma, long grains, and exceptional flavor. It is a premium variety and one of Pakistan's flagship rice exports. Non-Basmati varieties are also grown for domestic consumption and export. Farmers use modern farming practices, including improved seeds, mechanized planting, and efficient irrigation systems (Chandio, Magsi, & Ozturk, 2020). The government has implemented policies and initiatives to support rice farmers, enhance productivity, and promote exports. Challenges in rice production include water scarcity, pest and disease management, post-harvest losses, and changing weather patterns. Pakistan's agricultural research institutions work on developing high-yielding resistant to pests and illnesses rice variants (Shakoor, Saboor, Baig, Afzal, & Rahman, 2015).

1.1.2 Rice Consumption

Rice is a staple food in Pakistan that forms the foundation of various traditional and regional dishes. Rice serves as a significant source of carbohydrates in the Pakistani diet. It provides essential energy and is an integral part of daily meals. Its domestic consumption is high. The United States Department of Agriculture (USDA) stated that for the years 2021-22, domestic rice consumption stands at 3.7 million metric tons, resulting in an available surplus for export of 7.3 million metric tons. The government and private sector work to ensure a stable supply of rice for domestic consumption.

1.1.3 Rice Exports

Pakistan holds a prominent position in the global rice market as both a producer and an exporter of rice. The country's geographical location and agro-climatic conditions favor rice cultivation, which makes it one of the largest rice producers in world. Over the years, the rice export industry in Pakistan has undergone substantial expansion, establishing the country as a major player in the international rice trade (Irshad, Xin, & Arshad, 2018).

The importance of rice exports to Pakistan's economy cannot be overstated. Rice is one of the country's most significant agricultural exports, contributing substantially to foreign exchange earnings. The export of rice not only bolsters the national economy but also supports the livelihoods of millions of people engaged in various stages of the rice supply chain, from farming and milling to trading and transportation (Javed, Ghafoor, Ali, Imran, & Ashfaq, 2015). In 2021, Pakistan recorded rice exports worth $2.26 billion, ranking as the fourth-largest global exporter of rice. During the same year, rice stood as Pakistan's second most exported commodity. The primary recipients of Pakistan's rice exports included China ($382 million), Kazakhstan ($127 million), Malaysia ($127 million), the United Arab Emirates ($122 million), and Afghanistan ($121 million) (Finance, 2023).

The global demand for Pakistani rice continues to rise, driven by its quality, diversity, and competitive pricing. Basmati rice, a premium aromatic variety, is a particular source of pride for Pakistan and is highly sought after in international markets. Pakistani Basmati rice has earned a reputation for its distinctive aroma, long grains, and exceptional taste, making it a preferred choice for consumers worldwide (Akmal, Akhtar, Shah, Niazi, & Saleem, 2014). However, as global markets become increasingly quality-conscious and demand greater transparency and traceability in food supply chains, the need for robust traceability mechanism in the rice export sector becomes evident. This study delves into the willingness of rice exporters in Pakistan to adopt product traceability mechanism, considering its implications for ensuring the quality and safety of rice exports.

1.3 Research Problem

The willingness of rice exporters to adopt product traceability mechanism is a pivotal factor that influences the effectiveness of traceability systems within the rice supply chain. Understanding the antecedents and outcomes of this willingness is essential for enhancing food safety, supply chain transparency, and overall industry performance. While various studies have explored traceability adoption in different contexts, there is a notable gap in the literature concerning the specific factors influencing rice exporters' willingness to adopt these mechanisms and the implications of this adoption on service level within the industry.

1.4 Research Questions and Objectives

To address this research problem, this study will counter the research questions listed below:

RQ1: What are the factors affecting the willingness to adopt product traceability in the rice supply chain?

RQ2: What is the level of willingness of Rice Exporters to adopt product traceability mechanism?

RQ3: Does the willingness of rice exporters to adopt a product traceability mechanism affect trust and service level?

In line with the goal of addressing these research questions, there are four major objectives of the research:

RO1: To identify the factors affecting rice exporters' willingness to adopt traceability mechanism.

RO2: To examine the impact of the willingness of rice exporters to adopt product traceability mechanism on service level.

RO3: To test the role of government regulations, market pressure, price of technology, and trust in the relationship between willingness to adopt a traceability mechanism and service level.

RO4: To suggest policy measures to improve the adoption of product traceability in the rice supply chain.

1.5 Scope of study

To achieve these objectives, a comprehensive framework will be developed, incorporating key independent variables and a dependent variable. This framework will serve as the foundation for data collection, analysis, and the generation of insights into the antecedents and outcomes of rice exporters' willingness to adopt product traceability mechanism. This research will focus on rice exporters operating within Pakistan. The study will employ a quantitative research approach to gather data and analyze the relationships between key variables. By delving into the unique context of the rice export industry, the primary objective of this study is to provide useful insights into the elements that drive traceability adoption and its impact on service level. Traceability is not merely a buzzword but a fundamental requirement to maintain the reputation and competitiveness of Pakistani rice in the global market.

The ability to trace the journey of rice products from farm to fork offers several critical advantages. It ensures food safety, as any potential contamination or quality issues can be swiftly identified and addressed. It enhances consumer trust, as transparent supply chains inspire confidence in the products. Additionally, traceability supports regulatory compliance, which is essential for continued access to international markets (Teixeira et al., 2018). Understanding the factors influencing the willingness of rice exporters to adopt product traceability mechanism and their consequences for the industry is of significant importance. The conclusions of this study can help policymakers, industry stakeholders, and rice exporters themselves about strategies to enhance food safety, supply chain transparency, and overall competitiveness in the global rice market.

1.6 Organization of Chapters

The rest of this thesis is structured in further four chapters. The second chapter will provide a thorough assessment of the literature, exploring traceability mechanism, their adoption factors, and the implications for various industries. The research methodology will be presented in Chapter 3, detailing the data gathering and analysis techniques. The findings of the study's empirical analysis will be presented in Chapter 4, and, at last Chapter 5, which will offer a comprehensive discussion and conclusion based on these findings and will also present the limitations of the study and make recommendations for future research.

CHAPTER 2. LITERATURE REVIEW

2.1 Product Traceability

Product traceability has received more attention recently in the food supply chains (Appelhanz, Osburg, Toporowski, & Schumann, 2016). The numerous catastrophic and expensive food crises that drew widespread media attention about at the turn of the century were the primary motivators for an improved food traceability system (Olsen & Borit, 2013). Food traceability systems stand apart from other types of enterprise systems in a variety of ways. Due to the nature of food items and the requirements for food safety, food supply chains are dynamic and complicated processes. (Duan, Miao, Wang, Fu, & Xu, 2017). Several recent studies have investigated the factors influencing the mechanism for adopting traceability in the food supply chains. For example, A. Zhang, Mankad, and Ariyawardana (2020) conducted a study to identify the drivers and barriers to adopting blockchain-based traceability systems in the food business in Australia. The study found that the perceived benefits of traceability, such as improved supply chain visibility and enhanced consumer trust, were key drivers of adoption. However, concerns around cost, complexity, and interoperability were identified as major barriers to adoption.

These papers collectively discuss the topic of product traceability. Y. Zhang, Jin, Zheng, and Li (2020) proposes a blockchain-based platform for product traceability, highlighting the advantages of decentralization and data integrity. Xiang 2022 presents a manufacturing product traceability system based on a B/S architecture, aiming to improve information transmission and retention while ensuring data confidentiality. Benatia, Baudry, and Louis (2022) focuses on detecting counterfeit products through frequent pattern mining, emphasizing the importance of traceability in supply chain management. Schuitemaker and Xu (2020) provides a technical review of product traceability systems in manufacturing, highlighting the complexity of implementation and the integration of traceability into manufacturing execution systems. In summary, these papers emphasize the significance of product traceability in various industries and propose different approaches and technologies to enhance traceability systems.

Overall, these studies suggest that the adopting product traceability in food supply networks is influenced by different factors, including perceived benefits, cost, complexity, regulatory requirements, and stakeholder collaboration. Advanced technologies, such as blockchain and IoT, can enhance traceability and improve supply chain efficiency. However, involving stakeholders in the designing and implementing the traceability systems and promoting supply chain integration are critical to ensuring successful adoption.

2.2 Traceability adoption in Food Supply Chains

The implementation of traceability measures within food supply networks has become increasingly important in recent years as a result of food safety concerns, globalization of supply chains, and increasing consumer demand for transparency and accountability. Here is a literature review on traceability adoption in food supply chains with recent references: Several studies have investigated the adoption of product traceability systems in food supply chains. For example, Demestichas, Peppes, Alexakis, and Adamopoulou (2020) conducted a study to evaluate the adoption of traceability system in the Chinese pork supply chain. The study found that the adoption of traceability systems was positively related to food safety performance and supply chain performance. Another study by Knoll et al. (2017) also investigate traceability mechanism in the Brazilian beef supply chain. The study found that the adopting traceability improved supply chain transparency and increased consumer trust, but also required significant investments and collaborations among stakeholders.

In addition, recent research has focused on the adoption of advanced technologies, such as blockchain, in traceability systems (Saurabh & Dey, 2021). For example, Paul, Islam, Mondal, and Rakshit (2022) conducted a study to evaluate the implementation of blockchain-based traceability systems in the Chinese tea supply chain. The study found that the adoption of blockchain technology improved traceability and transparency, but also required significant investments in technology and personnel. The ambiguity of the food supply chain may be monitored with the aid of a traceability system. Traceability implementation doesn't happen all at once along the supply chain. At various points throughout the supply chain, numerous players must make a decision. Every level's decision to construct a traceable system is influenced by risk, capital investment, political regulations, technical advancements, and social and environmental issues (Gupta et al., 2023). Since that agri-food supply chains have become more complicated and globally linked, traceability of the agricultural supply chain has become a key regulatory response to assuring food safety (Duan et al., 2017).

These papers collectively highlight the importance of traceability adoption in food supply chains for safety, quality, and consumer confidence. Potter (2022) emphasizes that traceability boosts operational efficiency, inventory management, product quality, and food safety. Casino, Kanakaris, Dasaklis, Moschuris, and Rachaniotis (2019) proposes a model utilizing blockchain technology and intelligent contracts for decentralized and automated traceability in food supply chains. Aung and Chang (2014) emphasizes that traceability systems aid in reducing the manufacturing and distribution of dangerous or low-quality products, ensuring food safety and quality. Kemény and Ilie-Zudor (2016) discusses the introduction of traceability regulations and the development of national, regional, and global networks to enable end-to-end traceability. Winkelhuijzen and Van Burik emphasizes the benefits of high traceability, including food safety, sustainability, and transparency, and suggests improving traceability through coherence and governance, certification, and the use of new technologies and traceability systems.

Overall, these studies suggest that the traceability adoption in food supply chains can improve food safety, supply chain performance, transparency, and consumer trust. However, the successful adoption of traceability systems requires careful planning, collaboration among stakeholders, and investments in technology and personnel.

2.3 Service Level

Adopting food traceability systems can have a significant impact on the service level of a company in the food industry. Traceability systems can improve supply chain visibility, reduce the risk of foodborne illness, and enhance consumer trust. However, the implementation of traceability systems can also involve significant costs and complexity, which can impact the service level of a company (Tan, Gligor, & Ngah, 2020). Several recent studies have investigated the effect of adopting food traceability on the service level of companies in the food industry. A study by Yan, Chen, Yuan, and Zhou (2020) investigated the impact of adopting radio-frequency identification (RFID) technology on the service level of fresh food companies in China. The study found that the implementation of RFID-enabled traceability systems improved product quality and reduced waste, which enhanced the service level of companies.

Literature collectively suggests that adopting food traceability systems can have a significant impact on the service level of a company in the food industry. Corallo, Latino, and Menegoli

(2020) proposes a business process modeling approach to support traceability in the food industry, highlighting the importance of transparency and accountability in meeting consumer and market needs. Mahajan 2019 emphasizes the importance of traceability in the meat industry to track products back to their animal of origin, ensuring reliability and providing information like country of origin and species. Kafetzopoulos (2023) discusses the architecture, attributes, and enabling technologies of traceability systems, providing insights for effective management and enhancing the value of products and food companies. Bitzer, Brinz, and Ollig (2021); Garaus and Treiblmaier (2021) highlights the increasing requirements in order to ensure the safety and quality of food products, and the role of traceability in managing and ensuring the quality of food products.

In addition, Ding, Liu, Yang, and Ma (2022) conducted a study to analyse the effect of adopting traceability systems on the service level of seafood companies in China. The study found that the implementation of traceability systems improved the accuracy and speed of product recalls, which enhanced the service level of companies. Overall, these papers support the idea that implementing food traceability systems can positively impact the service level of a company in the food industry by enhancing transparency, accountability, reliability, and quality assurance. Studies suggest that the adoption of food traceability systems can have a positive impact on the service level of companies in the food industry, which can improve service quality and customer satisfaction. However, the successful adoption of traceability systems requires careful planning and stakeholder collaboration.

2.4 Trust

Trust is a broad attitude of confidence in the competence and willingness of the trade partner to carry out their stated duties (Dong, Saito, Hoa, Dan, & Matsuishi, 2019). Choe, Park, Chung, and Moon (2009) investigated the effect of adopting a traceability mechanism on customers trust in the Japanese rice supply chain. And it founds that the adoption of the supply chain traceability system improved consumer trust by providing information on the origin and production process of the rice.

The papers collectively suggest that adopting a traceability mechanism, particularly through the use of blockchain technology, can positively impact customers' trust. Garaus and Treiblmaier (2021) found that the utilization of blockchain technology for the traceability of food items increased consumers' trust in retailers, especially for less familiar retailers.

Additionally, informing consumers about specific blockchain benefits strengthened the positive effects of traceability systems. Leteane and Ayalew (2022) proposed a framework leveraging blockchain smart contracts and a trust model to improve the reliability of traceability data within supply chains. This flexible and expandable framework aimed to address changing trust requirements.

Matzembacher, do Carmo Stangherlin, Slongo, and Cataldi (2018) also highlighted the importance of traceability elements, such as disease/pest and inputs traceability, in increasing consumers' trust in food safety. Wallbach, Lehner, Roethke, Elbert, and Benlian (2020) conducted an experimental study and found that the immutability and traceability features of blockchain positively influenced trust in the technology. Sund and Lööf (2019);Kusuma, Rejeki, Robiyanto, and Irviana (2020) did not directly address the effect of traceability mechanism on customer trust, their research highlighted the importance of trust in supply chains and reputation systems in influencing buying interests and trust in e-commerce platforms.

Similarly, Cavite et al. (2022) investigated the effect of traceability information on consumer trust in the Thai rice supply chain. The study found that traceability information, including production process and quality control measures, positively influenced consumer trust. In addition, a study by Jin and Zhou (2014) investigated the effect of rice traceability on consumer trust in the Japanese market. The study found that rice with traceability information had a higher price premium and was preferred by consumers who valued safety and quality attributes. A study by R. Liu, Gao, Nayga Jr, Snell, and Ma (2019) investigated the effect of rice traceability on consumer trust in the Chinese market. The study found that traceability information positively influenced consumer trust and willingness to pay for premium rice products. Maaya, Meulders, Surmont, and Vandebroek (2018) investigated consumer willingness to pay a premium price for traceable organic vegetables in Ethiopia. The study found that consumers exhibit a willingness to pay a premium for organic vegetables that provide traceability because of the perceived health benefits and reduced food safety risks.

Furthermore, a study by Kalogeras, Valchovska, Baourakis, and Kalaitzis (2009) investigated Dutch customers are ready to pay a premium for traceable olive oil. The study found that there was a shown willingness among consumers to pay a premium for olive oil that could be traced back to its source, especially when the traceability information was linked to quality attributes and environmental sustainability. While knowledge of the traceability system can affect consumers' sentiments toward it, confidence and faith in the system's capacity to accomplish its objective will also be crucial (Murphy et al., 2022). People are more inclined to embrace a new system or technology if they are certain that it will accomplish the goals for which it was created. This is especially true if they think a new system or technology can deliver on those goals (A. Zhang et al., 2020).

Overall, these studies suggest that adopting traceability systems in the rice supply chain can improve consumer trust by providing information on the origin and production process of rice products. Traceability information positively influences consumer trust and willingness to pay for premium rice products. Therefore, the adoption of traceability systems in the rice supply chain can provide significant benefits for rice producers, processors, and consumers (Wu, Zhang, van Klinken, Schrobback, & Muller, 2021).

2.5 Antecedents of Willingness to adopt Product Traceability

The decision of organizations to adopt traceability mechanism is influenced by various antecedents, including government regulations, market pressure, and the price of technology. Understanding how these factors shape the willingness to adopt traceability is crucial for comprehending the dynamics of traceability adoption within supply chains.

2.5.1 Government Regulations

The implementation of food traceability in the supply chains for rice is greatly influenced by governmental restrictions. Shikder, Siddique, Ratul, and Tabassum (2022) looked into how Bangladesh's rice supply chain was using food traceability technologies. According to the study, adoption of food traceability systems was significantly impacted by governmental laws. In particular, the study discovered that the adoption of traceability systems in the rice supply chain was being influenced by the government's initiatives to increase food safety through legislation, such as obligatory testing for pesticide residues and labeling requirements.

Similar to this, Kshetri and Loukoianova (2019) study looked into how China's rice supply chain was using food traceability technologies. The study discovered that the adoption of traceability systems was significantly influenced by governmental legislation. The study indicated that rice producers and processors were more likely to use traceability systems as a result of the government's efforts to enhance food safety and quality through legislation, such as obligatory traceability requirements and product labeling. A study by Dandage, Badia-

Melis, and Ruiz-García (2017) looked into the adoption of food traceability systems in the Indian rice supply chains. According to the study, governmental restrictions had a significant impact on whether traceability systems were adopted. In particular, the study discovered that the adoption of traceability systems in the rice supply chain was being influenced by government initiatives to enhance food safety and quality through regulations, such as obligatory labeling requirements and the introduction of food safety standards.

Government regulations perform a pivotal role in driving the adoption of traceability mechanism in various industries, including agriculture and food supply chains (Rajput & Singh, 2020). Regulatory bodies often impose requirements and standards to ensure the safety, quality, and authenticity of products. In the context of traceability, governments around the world have enacted legislation that mandates the implementation of traceability systems. These regulations act as a compelling antecedent, as organizations are legally obligated to comply. For instance, the European Union (EU) has established stringent regulations regarding food traceability (European Commission, 2021). Under EU law, food businesses must implement traceability systems to track and trace products at all stages of production and distribution. Non-compliance can result in severe penalties, making it imperative for organizations to adopt traceability mechanism to meet regulatory requirements (Barilla, 2015).

Research on the impact of government regulations on the adoption of food traceability system in the food supply chains across Pakistan is limited. However, there is some literature that discusses the broader issue of food safety regulations in Pakistan, which can give some light on the potential impact of government regulations on the adoption of food traceability systems. A study by Nadeem, Surienty, and Haque (2022) investigated the implementation of food safety regulations in Pakistan. The study found that although food safety regulations existed in Pakistan, their implementation was weak due to poor enforcement and lack of resources. The study also found that there was a lack of awareness among food businesses regarding the importance of complying with food safety regulations, which further hindered their implementation.

Similarly, a study by Raza et al. (2021) examined the food safety practices of street food vendors in Pakistan. The study found that although regulations were in place to assure that street food is safe, their implementation was weak due to poor enforcement and lack of awareness among vendors regarding the importance of complying with regulations. For the purpose of improving the safety of street cuisine, street food vendors must be trained on food safety and quality. Pakistan's government should enact proper regulatory measures to ensure food safety and quality. These studies suggest that the implementation of government regulations related to food safety in Pakistan is weak, which could potentially hinder the adoption of food traceability systems. Without proper enforcement and awareness among food businesses regarding the importance of complying with regulations, it may be challenging to encourage the adoption of product traceability systems in the food supply chain across Pakistan.

The papers collectively suggest that government regulations play a significant role in the adoption of product traceability. Farne (2020);Stefano (2020) highlights how European Union regulations on food safety have made traceability a cornerstone requirement for agri-food companies. Bruneau and Ugochukwu (2021) analyzes the impact of traceability and country-of-origin labeling regulations on consumer welfare, showing that mandatory traceability regulations can improve consumer welfare as long as associated costs are low. Kros, Liao, Kirchoff, and Zemanek Jr (2019) emphasizes the importance of traceability in supply chain operations and explores factors that drive firms to implement traceability initiatives beyond legal requirements. Mania et al. (2018) discusses the need for mandatory traceability in food packaging materials to ensure consumer safety and confidence.

Overall, these studies point to the importance of government rules in determining how food traceability is adopted throughout the rice supply chain. With the promotion of food safety and quality, the establishment of necessary traceability criteria, and the imposition of labeling requirements, government laws can influence rice farmers and processors to use traceability systems (Gupta et al., 2023). These results underline how crucial it is for the government to encourage the implementation of product traceability technologies in the rice supply chain in order to raise food quality and safety.

2.5.2 Price of Technology

A study by Panghal, Manoram, Mor, and Vern (2023) examined that there are various factors that exert effect on the adoption of technology in different contexts in the Indian food processing industry. The study found that the cost of technology was a significant factor in the adoption decision. Small and medium-sized enterprises (SMEs) were more sensitive to the cost of technology than larger firms and tended to adopt cheaper technology solutions. The study also found that SMEs were more likely to collaborate with universities and research institutions to access the latest technology. Similarly, a study by Anastasiadis, Manikas, Apostolidou, and Wahbeh (2022) investigated the adoption of traceability systems in the Spanish agri-food industry. The study found that the adoption of traceability technology was impeded by the substantial cost associated with its implementation, particularly for small and medium-sized enterprises. The study also found that collaboration between firms, public institutions, and technology providers could help reduce the cost of adoption.

The papers collectively provide insights into the relationship between the price of technology and the willingness to adopt product traceability. Zhang (2022) finds that the more time it takes for product traceability, resulting in lower price of online traceable products, which benefits the manufacturer. Fan (2023) shows that traceability affects quality and price competition, with increased traceability leading to higher product quality and enhanced quality competition. Blaettchen (2021) focuses on the adoption of traceability technology in supply chain networks and highlights the interdependence of adoption decisions throughout the chain. The papers suggest that the price of technology, such as the cost of implementing traceability, can influence the willingness of firms to adopt product traceability measures (Zhang, 2022; Fan, 2023; Blaettchen, 2021).

These studies suggest that technology's cost is a significant factor in the adoption decision, particularly for small and medium-sized enterprises. High technology prices can hinder the adoption of food traceability systems, particularly for small and medium-sized firms with limited resources (Young, Joowon, Miri, & Junghoon, 2008). Collaboration between firms, public institutions, and technology providers may help reduce the cost of adoption and encourage more widespread adoption of traceability systems. Overall, further research is needed to understand the impact of technology prices specifically related to food traceability on the willingness to adopt traceability system in the food supply chain.

2.5.3 Market Pressure

In the present era, consumers exhibit a heightened awareness of traceable products, leading to a growing demand for the widespread adoption of traceability measures. (Li, Du, Li, & Shahzad, 2023). Market dynamics compel businesses to implement traceability mechanisms, as industries strive to meet all the regulatory requirements stemming from normative pressures. (Tieman, 2007; Kamaruddin and Jusoff, 2009). Market pressures, such as changing consumer preferences and global competition, have been identified as true reason for adoption of traceability in the food supply chains. Market pressure can also be generated by industry peers and competitors. Organizations often adopt traceability mechanism to stay competitive within their sector. For instance, a food manufacturer may choose to adopt traceability in response to a competitor's successful implementation, fearing a loss of market share if they do not follow suit (Sarpong, 2014).

According to Chen et al. (2015), Fernando et al. (2014), Applying standards to meet customer needs and desires, in order to address the market and establish a lasting customer relationship, poses a challenging task for companies. (Najmi, 2023). A study by Corallo, Latino, Menegoli, and Striani (2020) investigated the adopting traceability in the Italian agri-food sector. The study found that market pressures, such as the increased demand for ensuring food safety, maintaining quality, and addressing the necessity to meet regulatory requirements were the primary drivers for the adoption of traceability systems. The study also found that firms that adopted traceability systems enjoyed a competitive advantage in the market.

Xiong, Liu, Chen, and Zheng (2017) investigated the adopting a food-safety management systems, which include traceability, in Chinese food firms. The study found that market pressure, including increasing consumer demand for food quality and, its safety, was a significant enabler for the adoption of FSMS. The study also found that firms that adopted FSMS enjoyed a higher market share and profitability. Kataike and Gellynck (2018) investigated the adopting traceability mechanism in the European fresh produce sector. The study found that market pressures, such as the increased demand for food safety and quality, as well as the requirement to differentiate products in a competitive market, were key enablers for adopting traceability mechanism. The study also found that traceability adoption was positively related to firm performance, including increased sales and profitability.

The papers collectively suggest that market pressure plays a significant role in the willingness to adopt product traceability. R. Zhang, Xia, and Liu (2022) found that the adoption of blockchain technology for product traceability can benefit both manufacturers and retailers, with longer traceability time leading to lower prices of traceable products. Yao and Zhu (2020) highlighted the importance of traceability in combating product label misconduct, although the adoption of traceable label systems may incur higher costs without proper management mechanism. Hoque, Akhter, and Chowdhury (2022) focused on consumer preferences for traceability information in seafood safety, revealing that consumers value attributes such as production mode and safety control claims, and are willing to pay a premium for this information. Finally, Potter 2022 emphasized the increasing importance of supply chain traceability in improving product quality, ensuring food safety, and meeting consumer and regulatory demands.

In summary, market pressure, including consumer demand and the need to combat misconduct, drives the willingness to adopt product traceability. The increasing demand for safety and integrity of food, regulatory requirements, and the need to differentiate products in a competitive market are key factors that motivate firms to adopt traceability systems. Firms that adopt traceability systems can enjoy a competitive advantage in the market, including increased market share and profitability.

2.6 Research Gap

While numerous studies have explored the antecedents of willingness to adopt traceability mechanism across diverse sectors, there remains a need for more sector-specific investigations. Each industry possesses its unique characteristics and challenges that can influence willingness differently. Additionally, there is limited research on the outcomes of willingness to adopt, such as its impact on supply chain performance, environmental sustainability, or consumer trust, which presents opportunities for further exploration.

From literature a lot of research was found on the importance product traceability in food supply chain. Different authors measure relationship between different variables associated with product traceability in food supply chain. Lin & Chang, (2021) developed a relationship between level of trust and service level, Corallo et al. (2020) interpreted the role of market pressure in adopting traceability and its impact on service level. (Albert & Gligor, 2022) (Navnidhi & Jaglan, 2018) focuses on government regulations and its impact on service level and the price of technology for adopting traceability mechanism.. Table 2.1 below shows the field of study of different authors. In literature, willingness of rice exporters in adopting product traceability mechanism is not addressed properly and what are the factors affecting the willingness to adopting product traceability. So, this research tends to find the willingness and will also address that what factors affect the relationship between companies' willingness of adopting food traceability mechanism and its service level.

Table 2.1 : A Review of Past Research and Contribution to Body of Knowledge

Author	Government Regulations	Market Pressure	Price of Technology	Willingness	Trust	Service Level	Methodology
Lin & Chang, (2021)					✓	✓	Partial Least Square
Corallo et al. (2020)		✓				✓	Structural Equation Modeling
Gupta et al. (2023)	✓		✓				Game theory
Yan et al. (2020)			✓			✓	Regression Analysis
Jin et al. (2017)					✓		Contingent valuation
Cavite et al. (2022)		✓			✓		Logistic regression
Albert & Gligor, (2022)	✓					✓	Cluster Analysis
Navnidhi & Jaglan, (2018)	✓	✓					Structural Equation Modeling
Raza et al. (2021)	✓						Inferential statistics
Yao and Zhu (2020)			✓				Simulation Modeling
Dong et al. (2019)				✓	✓		Structural Equation Modeling
Xiong et al. (2017)		✓			✓		Structural Equation Modeling
This Study	✓	✓	✓	✓	✓	✓	Structural Equation Modeling

2.7 Proposed Framework

To address these research gaps and shed light on the factors influencing rice exporters' willingness to adopt product traceability mechanism, this study proposes a comprehensive framework. This framework incorporates government regulations, the price of technology, market pressure, as antecedents of willingness. Additionally, it examines the relationship between willingness to adopt traceability mechanism and its outcomes, particularly its impact on service level within the rice export industry. This research takes “Government Regulations”, “Market Pressure”, “Price of Technology”, “Willingness to adopt product traceability mechanism” and “Trust” as independent variables. “Service Level” is taken as dependent variable. Figure 2.1 shows the schematic diagram of proposed framework.

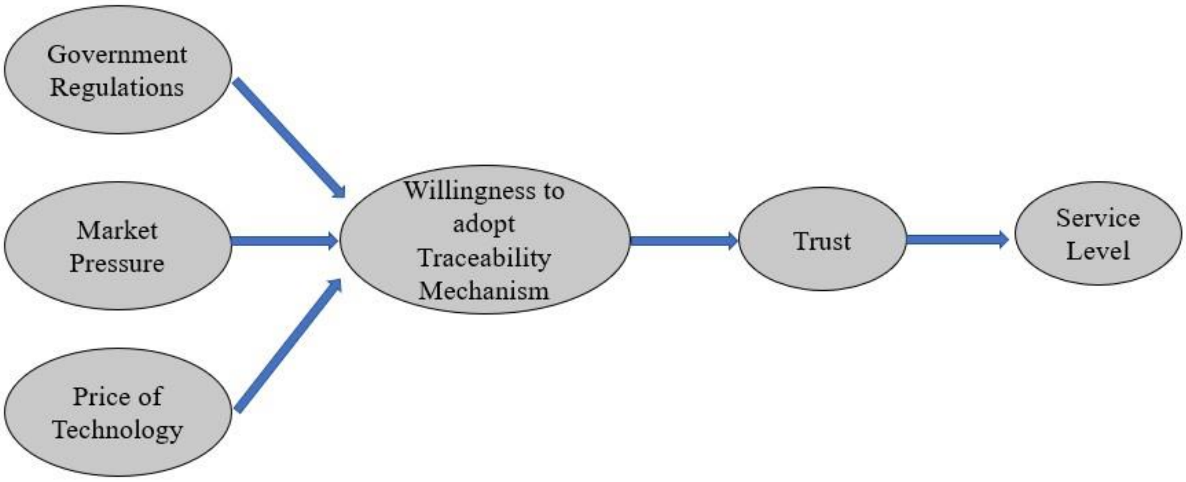

Figure 2.1: Schematic Diagram of Proposed Framework

The following twelve hypothesis are built based on the proposed framework are as following:

Hypothesis measuring direct path:

H_1: Government regulations have a significant effect in the willingness to adopt food traceability.

H_2: Market pressure is an important driver for the willingness to adopt food traceability mechanism.

H_3: The price of technology is a significant factor for the willingness to adopt food traceability system.

H_4: Willingness to adopt food traceability mechanism plays a significant role in building Trust.

H_5: Trust has a significant effect on service level.

Hypothesis measuring specific indirect effects:

H_6: Government Regulations → Willingness → Trust

H_7: Market Pressure → Willingness → Trust

H_8: Price of Technology → Willingness → Trust

H_9: Market Pressure → Willingness → Trust → Service Level

H_{10}: Willingness → Trust → Service Level

H_{11}: Price of Technology → Willingness → Trust → Service Level

H_{12}: Government Regulations → Willingness → Trust → Service Level

CHAPTER 3. METHODOLOGY

The research methodology chapter in a thesis is a critical component provides an overview of the research methodology, strategies utilized in the study. It furnishes an in-depth depiction of the methodology, the process of data collection, subsequent analysis, and limitations of study. The methodology chapter is essential in establishing the credibility and validity of the research findings. This chapter outlines the methodologies employed in this study to address the research questions and accomplish its objectives.

This chapter is structured into six distinct sections, with the initial section being discussed first discusses the philosophical underpinnings of the research. It explains whether the study follows a positivist, interpretive, constructivist, or other philosophical approach. Second section provides detail of the research approach chosen for this study, such as quantitative, qualitative, or mixed methods. The third section provides a comprehensive description of the sampling strategy employed, encompassing the target population, sample size, and method of sampling (such as random sampling, purposive sampling, or stratified sampling). Then the next section explains the specific data collection method and tools used to collect data. Then the next section discusses how the validity and reliability of data is ensured. It describes steps taken to minimize bias, errors, and measurement issues. And the last section explains the methods and techniques employed to analyse the collected data. Figure 3.1 provides a view of methodology used.

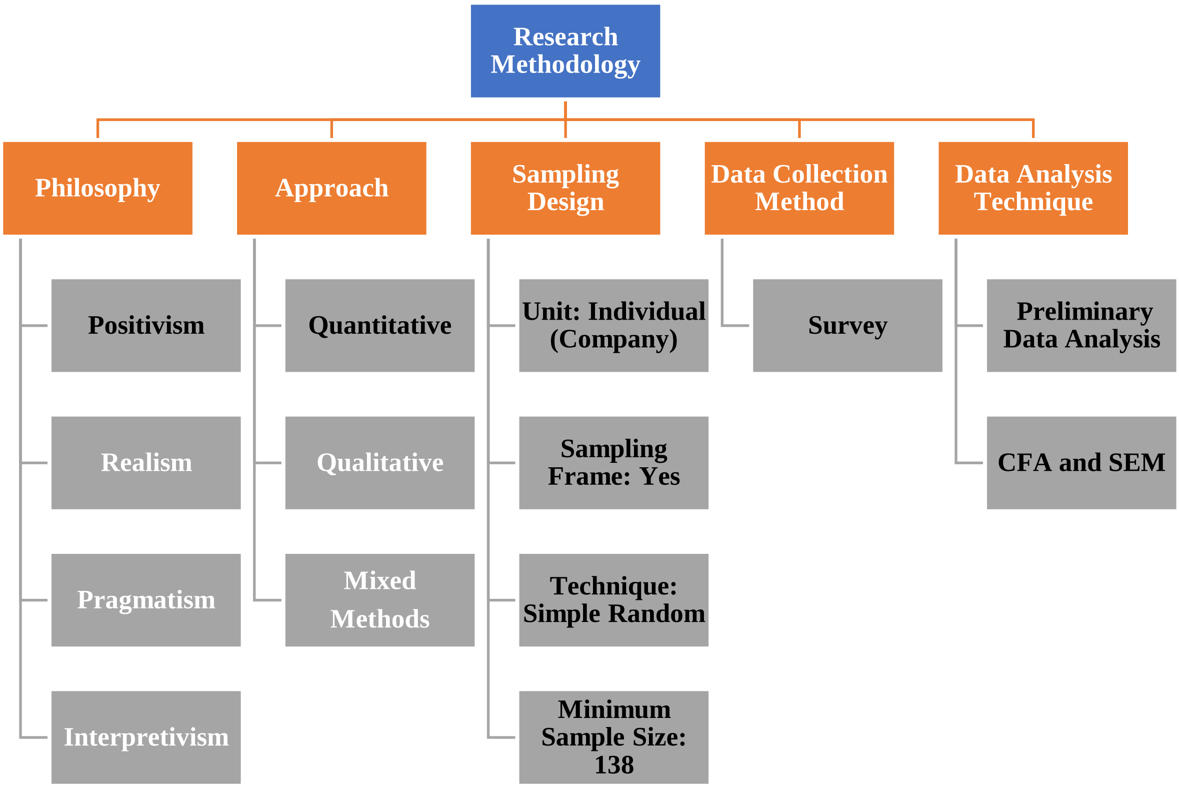

Figure 3.1: Research Methodology Overview of proposed study

3.1 Philosophy

There are different research philosophies that guide the methodology, methods, and techniques used in research. Choosing the appropriate research methodology depends on various factors, including the research question, research design, the required data type, and the available resources. The research philosophy for this study is positivism. According to the positivist ideology, observation and experimentation can be used to learn more about the world. According to positivists, it is best to steer clear of subjective interpretations and views when conducting scientific research because they might cause bias and reality distortions (Saunders, Lewis, & Thornhill, 2012). Food traceability systems require standardized methods and procedures to ensure accuracy and consistency. A positivist approach provides a framework for developing and testing these methods and procedures. A positivist approach can help to establish the validity and reliability of these systems through rigorous testing and evaluation (R. Liu, Gao, Nayga Jr, & Snell, 2019).

3.2 Approach

3.2.1. Deductive/Quantitative

Deductive research approach is a type of research that starts with a theory, then empirical observation and data collecting are used to test that theory. The process involves developing a hypothesis based on a theory and then testing that hypothesis through research. The approach is often associated with quantitative research methods, where the data is collected through structured questionnaires, surveys, or experiments, and statistical techniques are used to analyse the data(Blackstone, 2012). One of the strengths of the deductive research approach is that it allows researchers to test a specific theory or hypothesis in a systematic and rigorous way. This approach is also useful in identifying cause-and-effect relationships, as it is based on the idea that a specific set of conditions will lead to a predictable outcome.

However, a potential limitation of this approach is that it may overlook important variables or factors that were not included in the initial theory or hypothesis (Dudovskiy, 2011). This study relies on Quantitative research. A large sample of participants is often surveyed or given a questionnaire as part of this sort of research to gather data. The data is then statistically examined to find trends, patterns, or correlations between the variables (Bloomfield & Fisher, 2019).

3.3 Sampling Design

Selecting an appropriate sampling design is crucial for ensuring that research results are representative of the population being studied. The sample design is divided into three components, sample unit, technique, and its size. The term "sampling frame" refers to a comprehensive roster of all persons or units within a population from which a sample is to be selected (Newman & Covrig, 2013). It is the basis for selecting a sample and should be as accurate, complete, and representative as possible. The quality of the sampling frame is critical to the validity and reliability of the research result (X. Liu, Yan, & Song, 2020).

3.3.1 Sampling Unit

Sampling unit is the individual element or group of elements that is selected from a population for the purpose of collecting data. The sampling unit selected for this study is individual, one company is counted as a single sample. A designed questionnaire was assigned to each rice exporting company and was requested to answer the questions.

3.3.2 Sampling Technique

In quantitative research, there are different types of sampling techniques that can be used depending on the research question, population size, and available resources. In this research we use simple random sampling because the sampling frame was available. The list of registered rice exporting companies was available on Rice Exporters Association of Pakistan (REAP), if sampling frame was not available then would be using nonprobability sampling technique (purposive sampling). Simple Random Sampling is used when the population is relatively homogeneous, this implies that each individual within the population possesses an equivalent likelihood of getting chosen (Aguinis & Cronin, 2022). It entails randomly selecting a sample from the entire population. often using random number generators. It is a basic and widely used technique for selecting a representative sample.

Stratified Random Sampling is also a probability sampling technique, but it is employed when the population is heterogeneous, meaning it can be divided into distinct subgroups or strata. Within each stratum, A simple random sample is collected. This strategy ensures that each subgroup is represented in the final sample, making it useful for studying characteristics within subpopulations. An in-depth view of sampling techniques (probability and nonprobability) is given in Figure 3.2.

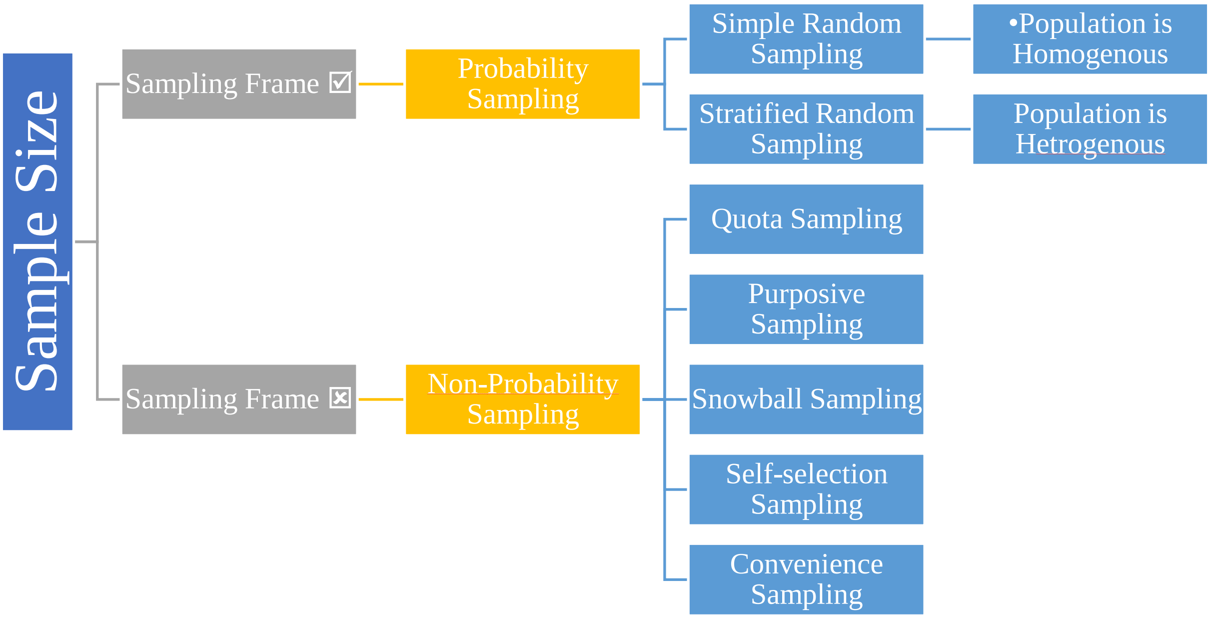

Figure 3.2: Simple Random Sampling Technique

3.3.3 Sampling Size

There are numerous sampling calculators, and software exists. The G*-Power software was employed to decide the minimum required sample size. According to (Yong, Yusliza, Ramayah, & Fawehinmi, 2019). G*Power, a thorough power analysis software commonly utilized in computer and social research for statistical testing, requires the specification of four variables—effect size, significance level (α), statistical power, and the total number of predictors—to perform a power analysis. (Memon, 2020; Yusliza et al., 2020). According to G*power analysis, to obtain an effect size of 0.15, with 0.95 power, having five predictors, the minimum sample size is 138. G*Power f test result for sample size can be seen in Figure 3.3.

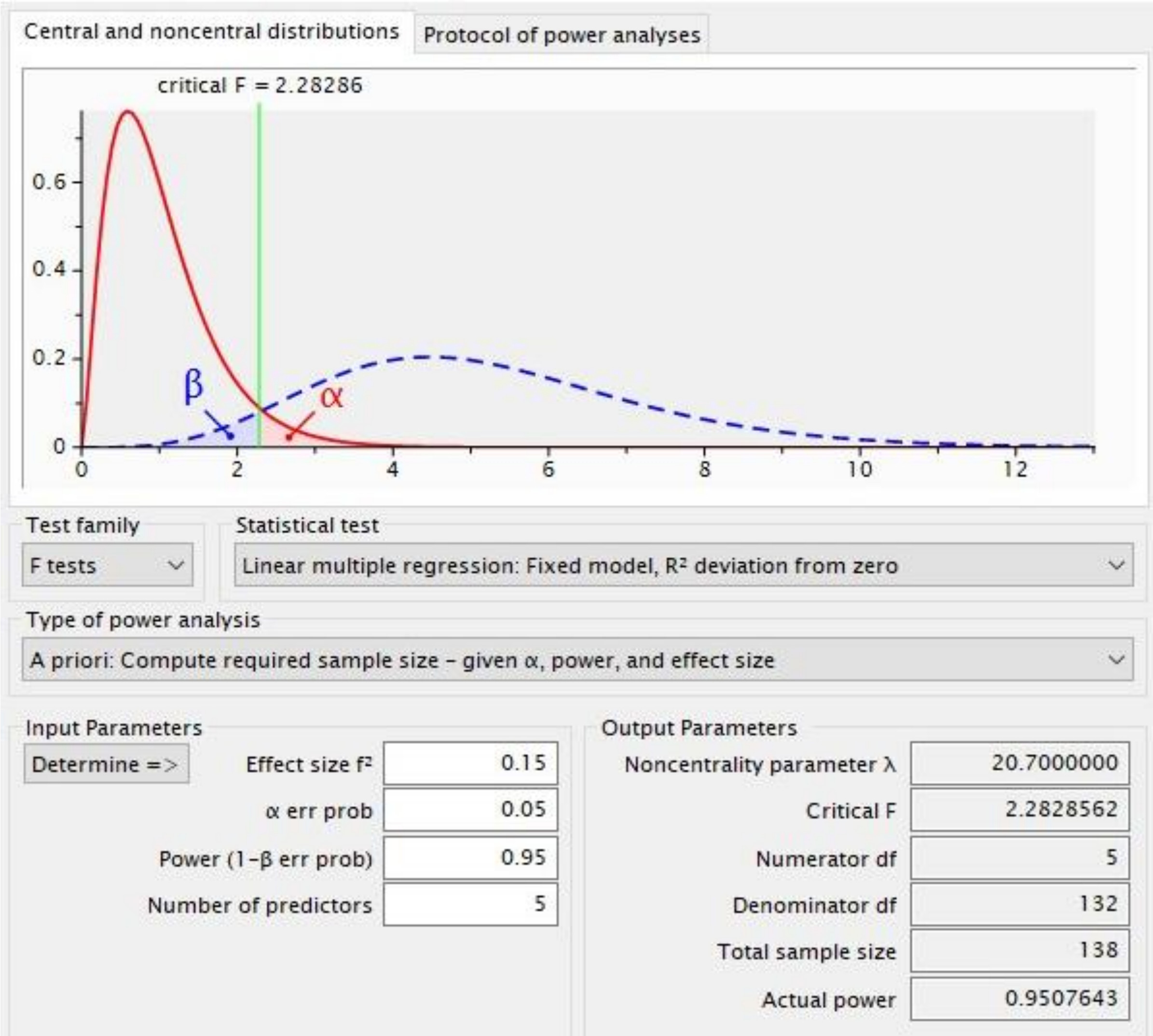

Figure 3.3: Minimum sample size of G*Power

Wu et al. (2021) conducted a study to examine the variables that influence customers' willingness to pay for food traceability information. They used a sample size of 400 participants, which they determined using a desired power of 0.8 for analysis and the significance level is 0.05. Shi et al. (2021) performed a study to look into the factors that affect consumers' trust in online food traceability systems. They used a sample size of 579 participants, which they determined using 0.8 as the desired power for the power analysis, and 0.05 is the significance level. Wadhera et al. (2020) did a study to look into the effectiveness of blockchain-based food traceability systems in reducing foodborne illness. They used a sample size of 200 participants, which they determined based on previous studies in the field. Sun et al. (2020) conducted a survey to identify the aspects that have an impact consumers' acceptance of blockchain-based food traceability system. They used a sample size of 400 participants, which they determined using 0.8 as the desired power for the power analysis, and 0.05 is the significance level.

These studies suggest that sample size calculation in quantitative research related to food traceability depends on the research question, the statistical power desired, and the significance level. Researchers should use appropriate methods, such as power analysis or previous studies, to determine an adequate sample size for their specific research question. In our study the sample unit is individual and minimum sample size is 138.

3.4 Data Collection Method

It may not come as a surprise that one of the most often used data collection methods when using a survey strategy is the questionnaire. By requesting the same set of replies from every participant (respondent), responses from a large sample can be quickly obtained prior to a quantitative analysis. Be sure It will gather the precise information you need to finish research goals and respond to your research questions.. (Saunders et al., 2012). The data collection approach employed in this study is a survey and an appropriate questionnaire helped in obtaining all necessary data that this study needs from the respondents. Questionnaire Survey for "Antecedents and Outcomes of Rice Exporters' Willingness to Adopt Product Traceability Mechanism" (Appendix A) was developed.

First, a short project brief was given to give research background to the respondent. Then the informed consent was taken that the respondent is participating in this survey by his/her free will. The questionnaire started with a qualifying question and was divided into two sections. The initial section comprises questions related to both dependent and independent variables, which are elaborated in detail in Table 3.1. In this section, all constructs were evaluated using Likert scales, a popular way for evaluating many latent constructs. A five-point Likert scale was utilized for all items pertaining to both the dependent and independent variables. The subsequent section focused on gathering demographic information from the respondents.

Table 3.1: Structure of Designed Questionnaire for this Study

Constructs	Dependent/Independent	No. of Items
Willingness of rice exporters to adopt a product traceability mechanism.	Independent	11
Trust	Independent	6
Service Level	Dependent	10
Government Regulations	Independent	8
Market Pressure	Independent	10
Price of Technology	Independent	8

Following the survey's design, a pilot test was conducted involving five respondents. Pilot testing serves the purpose of evaluating the suitability and comprehensibility of the questionnaire items intended for the actual study, with input from a limited number of respondents, as explained by Sekaran and Bougie (2016). The primary objective of pilot testing is to pre-empt potential issues with data quality and minimize or prevent the need for item removal during the assessment of the measurement model, as emphasized by Mumtaz, Ting, Ramayah, Chuah, and Cheah (2017). Following the successful pilot test, the final survey was distributed to the target population, consisting of rice exporting firms, via email, LinkedIn, and WhatsApp. Data collection was carried out over a two-month period, spanning from July to September 2023. Vigilant monitoring of the data collection process was maintained to ensure that only one response was obtained from each company. In total, 157 responses were collected within the specified timeframe.

3.5 Data Validity and Reliability

Reliability describes the level of consistency in the measurement instrument. It can be measured objectively using Cronbach's alpha, this the most accepted empirical measure for reliability (Tavakol & Dennick, 2011). Cronbach alpha is commonly used in instruments where several items are employed to measure a construct. It measures the consistency among all the elements while evaluating the same construct. Reliability estimates also reflect the extent of measurement errors in a test. The acceptable range of alpha values have been reported to be 0.70 to 0.95 (Akande & Madrane, 2021). During the data collection process, it is not uncommon to encounter outliers and missing data points. These missing values can significantly reduce the amount of usable data, subsequently diminishing the study's statistical power and its capacity to yield reliable findings. Furthermore, missing data can distort the outcomes of the study, as highlighted by Kwak and Kim (2017).

To assess the reliability of indicators, it is crucial to ensure that they accurately measure what they are intended to measure. Indicator reliability examines the extent to which these indicators align with their intended measurements, as explained by Urbach and Ahlemann (2010). In this study, a significance value of 0.5 was applied as a cut-off criterion for each indicator, following the guidance of (Hair, Black, Babin, & Anderson, 2010). Indicators exhibiting loading levels that are equal to or greater than 0.5 are deemed acceptable, particularly when their loadings contribute to the substantial loading scores, the resulting Average Variance Extracted (AVE) scores surpass the threshold of 0.5., in accordance with Byrne (2016). Convergent validity, a measure that confirms the relatedness of two measures intended to assess the same construct, was also examined by Urbach and Ahlemann (2010). For convergent validity to be established in Partial Least Squares (PLS), the AVE of a construct should ideally be at least 0.5, as emphasized by Fornell and Larcker (1981).
To ensure that the data did not introduce bias into the regression results, the study evaluated structural relationships and identified potential collinearity issues. Collinearity concerns can arise when predictor constructs exhibit Variance Inflation Factor (VIF) values exceeding 5, although some sources suggest that VIF values in the range of 3 to 5 could also indicate collinearity problems (Becker et al., 2015;Mason and Perreault Jr (1991). Thus, striving for VIF values of 3 or lower is recommended. Addressing collinearity can involve creating theory-supported models with higher-order constructs, as suggested by Hair, Hult, Ringle, Sarstedt, and Thiele (2017).

Hypothesis testing in this study involved employing bootstrapping, a nonparametric test within PLS. Bootstrapping involves the replacement of the original sample with several random samples in order to derive standard errors for the purpose of hypothesis testing. In this study, the bootstrapping procedure followed the recommendations of Chin (2009), utilizing 10,000 resamples to generate t-statistics for all of the path relationships. The level of significance for bootstrapping was set at 0.05, with a one-tailed test and 10,000 subsamples. The explanatory power of the model was assessed through the R^2 value, which measures the proportion of variance accounted by each endogenous construct. This coefficient, span a range from 0 to 1., indicates the model's predictive and explanatory capabilities. According to Shmueli and Koppius (2011), R^2 reflects a model's explanatory power, while Hair, Ringle, and Sarstedt

(2013) noted its relevance for in-sample predictive accuracy. A higher R^2 value signifies improved predictive accuracy, as asserted by Hair, Hult, Ringle, and Sarstedt (2017).

3.6 Data analysis technique

3.6.1 Statistical Analyses

Attributing data to constructs and building links between them are part of the data analysis process. The information received from the completed surveys was analyzed using a series of techniques. The data was first processed (edited, coded, and categorized) before being entered into the IBM SPSS statistical software. Following that, the same program was used to do descriptive analysis. Finally, SmartPLS 4.0 software was utilized to evaluate the structural model's predictive capacity as well as the correlations between constructs.

3.6.2 Statistical Analyses using SPSS

During the initial stage of data analysis, the predominant tool utilized was IBM SPSS software, which played a significant role in several tasks including data entry, data definition, and data preparation. The utilization of IBM SPSS facilitated the process of data cleansing and the detection of logical anomalies within the dataset. Prior to data file conversion, all responses were initially coded. Several data screening procedures were carried out to validate the collected data, including tests for data normality, normality of error terms, missing value analysis, descriptive statistics, and a linearity check using the Pearson correlation test.

3.6.3 Statistical Analyses using Structural Equation Model

Structural equation modelling (SEM) is the primary data analysis technique used in this study. It is a statistical technique for examining the connections between a group of variables. It is a type of multivariate analysis that allows researchers to test complex theoretical models by examining the interrelationships between variables. Along with SEM as major technique, confirmatory factor analysis (CFA) was also used as secondary or minor technique. The measurement and structural model are two basic parts of SEM. Structural model delineates the relationships among the variables, whereas the measurement model specifies how the variables are measured. Typically, the route diagram used to depict the structural model demonstrates the causal connections between the variables (Mueller & Hancock, 2019).

In a study by Schiefer et al. (2018), SEM was used to analyze the elements that affect adoption of food traceability system by SME's (small and medium-sized enterprises) in the food sector. Its results show the perceived benefits, perceived risks, and regulatory pressure were the main drivers of adoption, while a lack of resources and understanding were the main barriers. In a study by Verbeke et al. (2019), SEM was used to model the relationships between consumer trust, perceived risk, and willingness to spend money for food products which are traceable. From results it was seen that customers trust had a favourable effect on willingness to pay, and that perceived risk had a negative effect. In addition, the study found that perceived benefits of traceability information moderated the relationship between trust and willingness to pay.

In this study, the research model was evaluated using the Partial Least Squares Structural Equation Modeling (PLS-SEM) approach. SmartPLS specializes in PLS-SEM, which is particularly useful for complex models with latent variables and smaller sample sizes. PLS-SEM is robust when dealing with non-normal data and allows for both formative and reflective measurement models (Mukherjee, Lim, Kumar, & Donthu, 2022). PLS-SEM is less sensitive to sample size than other SEM methods like covariance-based SEM (CB-SEM), making it suitable for studies with limited data. SmartPLS uses bootstrapping as a resampling technique, enabling researchers to estimate standard errors and confidence intervals for model parameters. This enhances the robustness of the results. Assumptions of the Measurement Model are mentioned in figure 3.4 and Assumptions of the Structural Model are mentioned in figure 3.5.

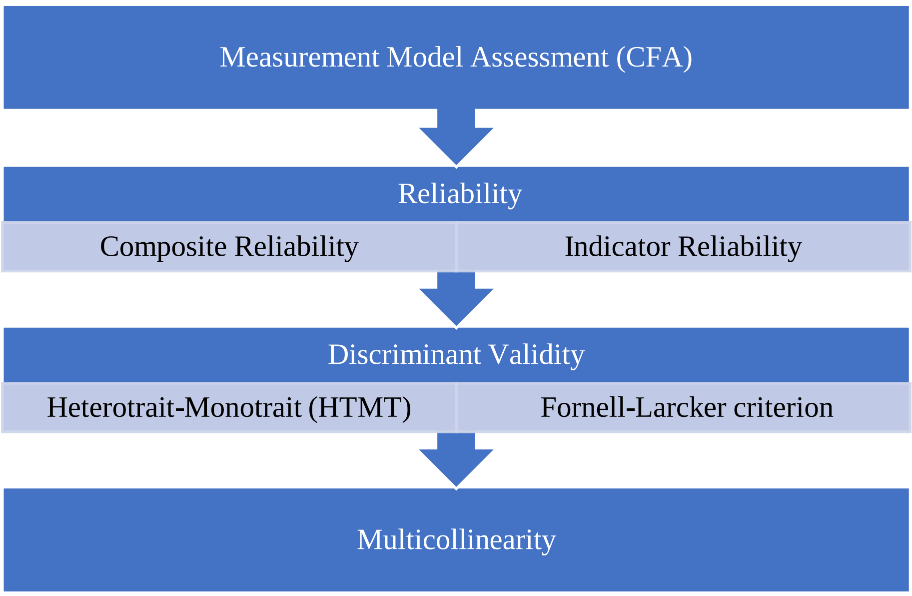

Figure 3.4: Assumptions of the Measurement Model

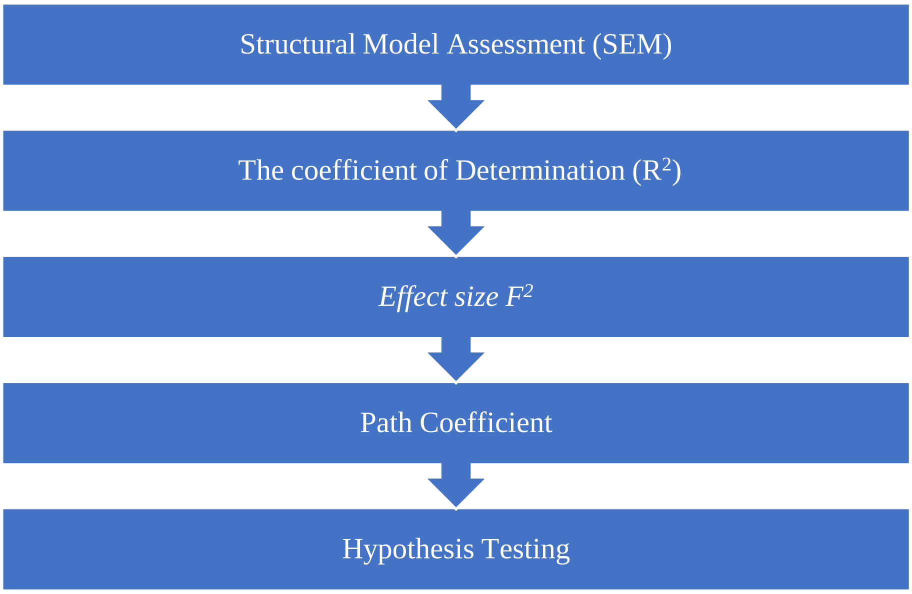

Figure 3.5: Assumptions of the Structural Model

CHAPTER 4. RESULTS

This chapter discusses the findings of the statistical analysis conducted on Smart PLS and SPSS. The section is divided into five sub-sections. The first subsection, demographic characteristics of respondents, which include the demographic analysis, and the next subsection data preparation, review the results of the preliminary analysis, missing value analysis, and tests of normality, reliability, validity, linearity, and correlation. The next two subsections deliver an in-depth understanding of the findings of confirmatory factor analysis (CFA) and structural equation modeling (SEM), as well as their implications. The last subsection of the summary of the analysis is discussed in detail in this chapter, with support from literature.

4.1 Demographic Characteristics of Respondents

Responses amounting to 157 were collected from 157 rice exporting firms, with one response from each firm. The demographics of the respondents were revealed through the demographic analysis. 91.7% of the respondents were male, and 8.3% were female (see Figure 4.1). The highest level of education of 7 respondents was higher secondary school certification: 114 with a bachelor's degree, 35 with a master's degree, and 1 with a Ph.D. (see Figure 4.2). 26.3% of respondents had an overall experience of 1 to 5 years, 36.9% had an experience of 6 to 10 years, 22.9% had an experience of 11 to 15 years, whereas 16.6% had experience above 15 years (see Figure 4.3).

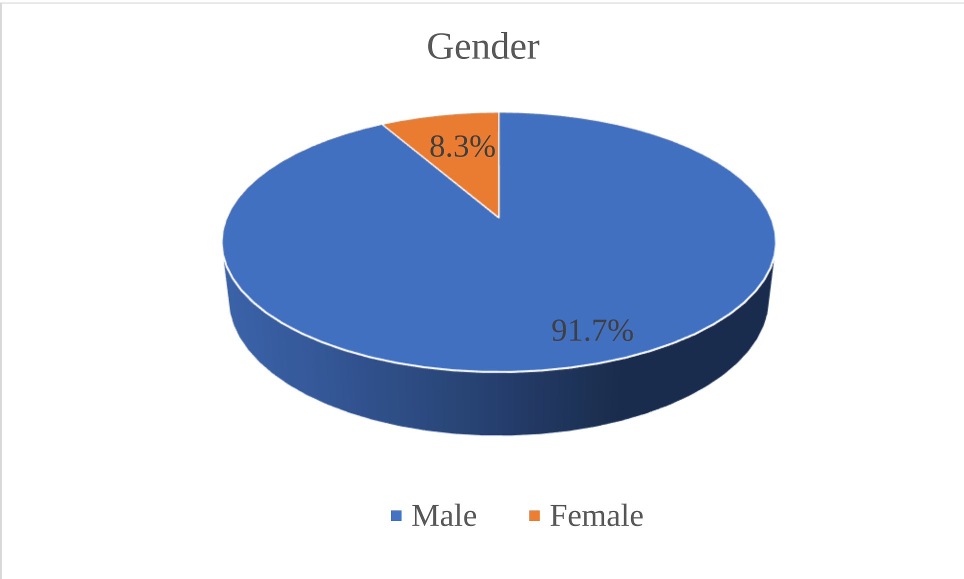

Figure 4.1: Demographics Characteristics of Respondents (Gender)

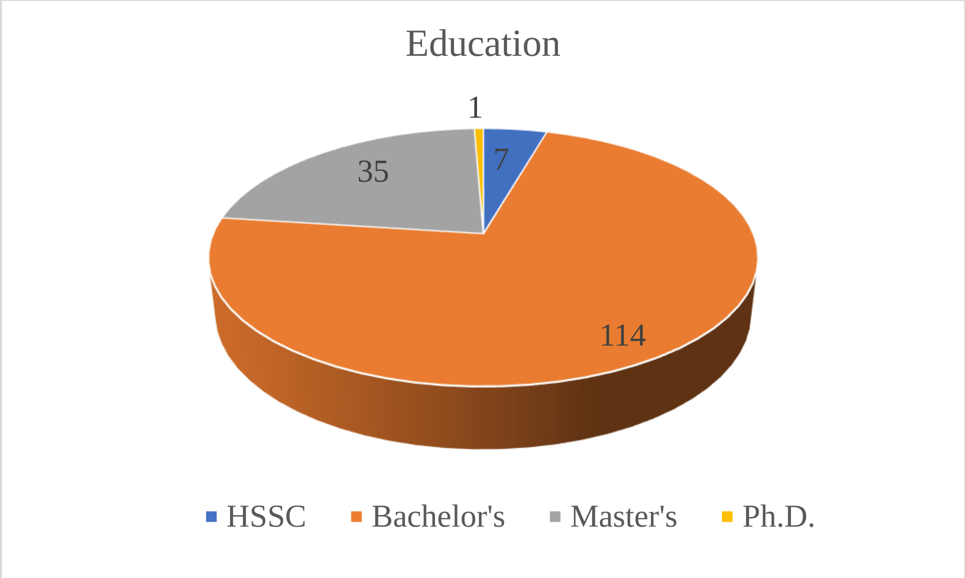

Figure 4.2: Highest Education Degree obtained by Respondents.

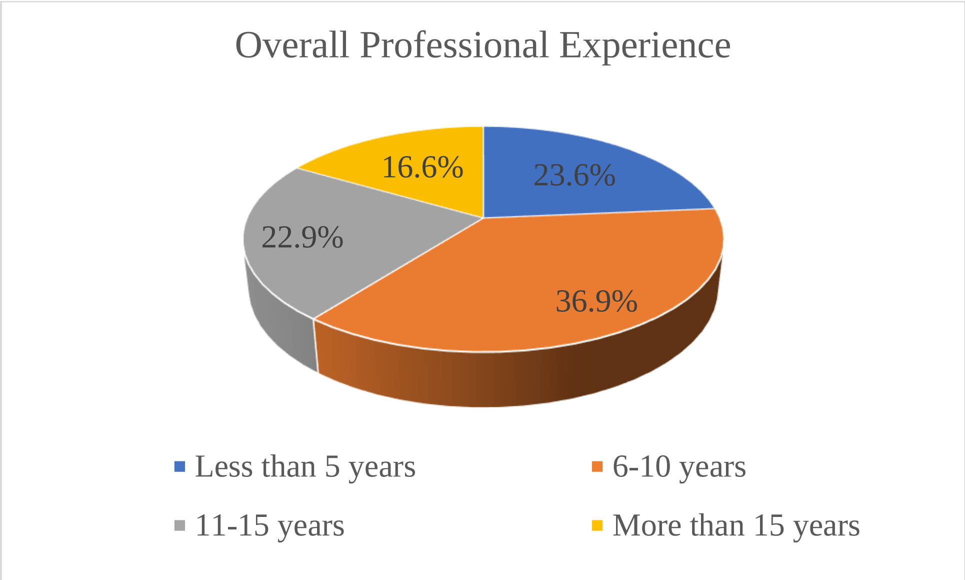

Figure 4.3: Overall Professional Experience of Respondents

The responding firms were of different sizes. 6.4% had 0 to 20 employees, 25.5% had 21 to 40 employees, 39.5% had 41 to 80 employees, 20.4% had 81 to 100 employees, and 8.3% had more than 100 employees (see Figure 4.4). 7.6% of firms had an age of less than 5 years, 27.4% were 6 to 10 years old, 38.2% were 11 to 15 years old, and 26.8% had been in business for more than 20 years (see Figure 4.5). The firms were established under five different structures. 4.5% were sole proprietorships, 15.3% were partnerships, 76.4% were private limited companies, 2.5% were public limited companies, and 1.3% were registered as corporations (see Figure 4.6).

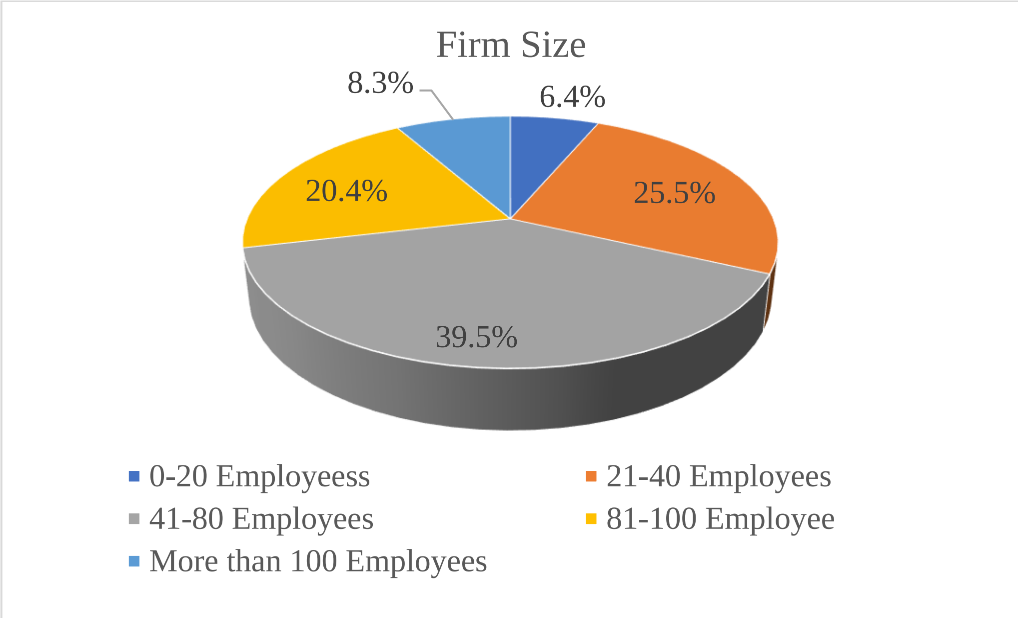

Figure 4.4: Firm Size of Responding Firms

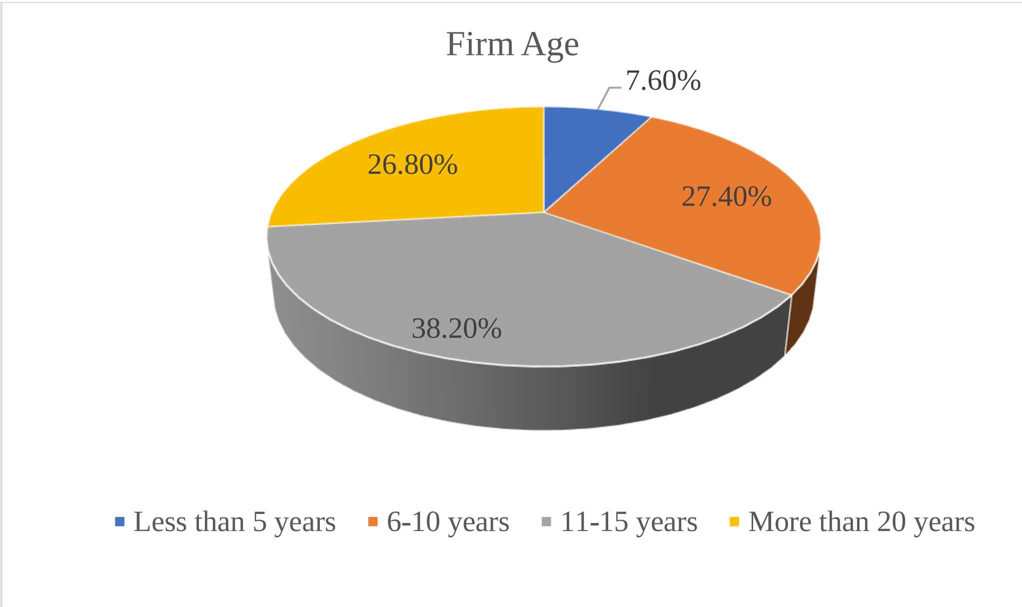

Figure 4.5: Firm Age of Responding Firms

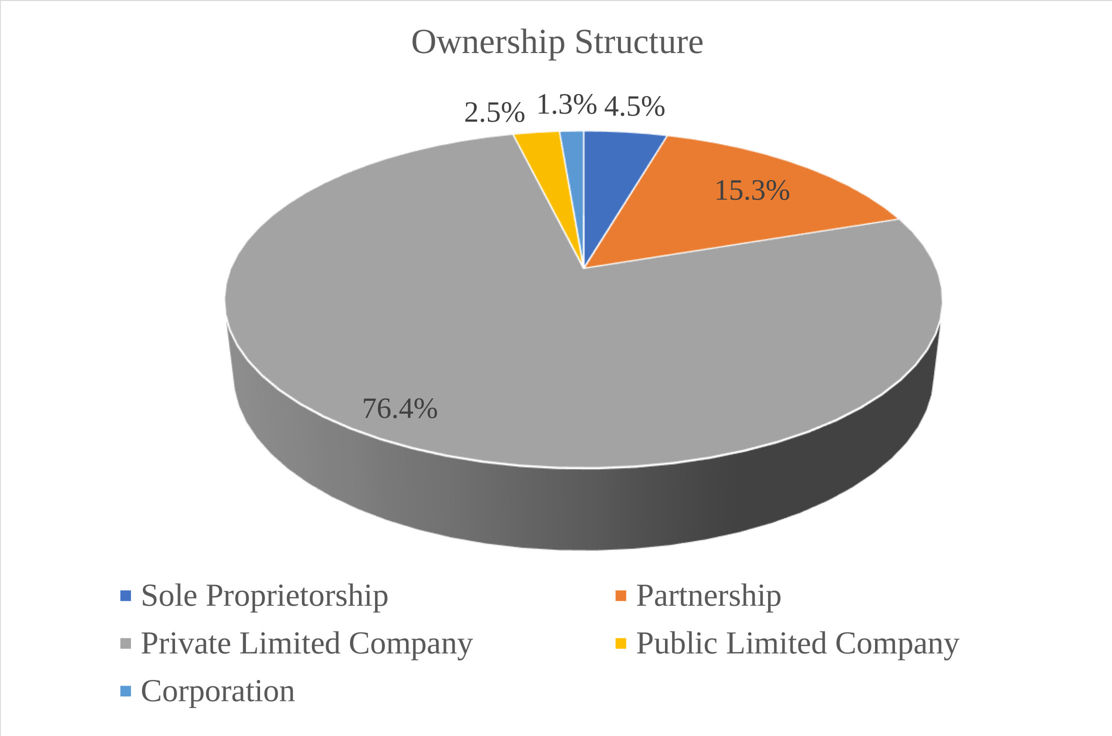

Figure 4.6: Ownership Structure of Responding Firms

4.2 Data Preparation

Before assessing the research model, it is necessary to do a thorough evaluation. The initial step in data analysis involves data preparation. This crucial phase encompasses tasks such as editing, coding, and data entry, all aimed at enhancing data accuracy and completeness (Cooper & Schindler, 2014).

4.2.1 Data Screening

To initiate the data cleaning process, the first task involves identifying and addressing blank responses within the collected questionnaires. Microsoft Excel was employed to execute this procedure.

4.2.2. Missing Value

Table 4.1: Missing Value Statistics on SPSS

		Government Regulations	Market Pressure	Price of Technology	Service Level	Trust	Willingness
N	Valid	157	157	157	157	157	157
	Missing	0	0	0	0	0	0

The presented Table 4.1 summarizes key data characteristics for six variables ("Government Regulations," "Market Pressure," "Price of Technology," "Service Level," "Trust," and "Willingness") in this study. Each variable has a consistent sample size of 157 valid observations, indicating that data collection was thorough and complete for these variables. Furthermore, there are no missing data points (i.e., the missing count is 0) for any of the variables because all of the questions for these variables in the online survey form were designed to be mandatory for respondents to complete. This completeness is crucial for conducting reliable statistical analyses and ensures the availability of the entire dataset for meaningful interpretation in the research study.

4.2.3. Descriptive Statistics of Research Variables

Table 4.2: Descriptive Statistics for Proposed Research Model Variables

Variables	Mean	Std. Deviation
Government Regulations	3.9307	0.66029
Market Pressure	4.1051	0.61141
Price of Technology	3.9912	0.58375
Service Level	4.1682	0.60405
Trust	4.1454	0.61025
Willingness	4.0475	0.62473

*N=157

In the research model, descriptive statistics were computed (Table 4.2) to summarize the key characteristics of six research variables: government regulations, market pressure, price of technology, service level, trust, and willingness. The sample size for each variable was 157, indicating the number of observations. On average, respondents rated 'Government Regulations' at approximately 3.93, 'Market Pressure' at 4.11, 'Price of Technology' at 3.99, 'Service Level' at 4.17, 'Trust' at 4.15, and 'Willingness' at 4.05 on a scale from 1 to 5. The standard deviations ranged from approximately 0.58375 to 0.66029, indicating varying levels of variability around the mean scores for each variable.

4.3 Assumption Testing

Following the data cleaning process, the next step involves testing the assumptions that underlie the statistical foundation of multivariate analysis. Two key reasons necessitate the testing of these assumptions. Initially, the complex relationships between a large number of variables may incorporate potential distortions and biases into the analysis. Second, the complexity of the analysis and its results can obscure indicators of assumption violations that are readily apparent in univariate analyses (Hair et al., 2010). This study assesses several assumptions, as elaborated below.

4.3.1. Data Normality

Table 4.3: Jarque-Bera (JB) test Results for Normality

Variables	Skewness	Kurtosis
Government Regulations	-1.298	3.332
Market Pressure	-1.768	7.193
Price of Technology	-1.660	5.953
Service Level	-2.327	9.632
Trust	-2.152	8.779
Willingness	-1.804	5.461

While numerous tests exist to confirm data conformity to a normal distribution, this study examines the normality of residuals using the Jarque-Bera (JB) test in SPSS. The JB test assesses the skewness and kurtosis of the residuals. Typically, skewness values fall within the standard range of -3 to +3, and kurtosis falls within -10 to +10 for normality. The results of the test are presented in Table 4.3. All variable residuals exhibit kurtosis values within the normal reference range, and skewness values also fall within the normal reference range. Thus, the assumption of normality is not violated. Normality curves can be seen in Appendix B.

4.3.2. Normality of the error terms

The second assumption in multivariate analysis concerns the normal distribution of error terms, which may be assessed by the utilization of the normal probability-probability (P-P) plot. Figure 4.7, displayed below, illustrates that the points closely align with the diagonal line, indicating that the error terms adhere to a normal distribution.

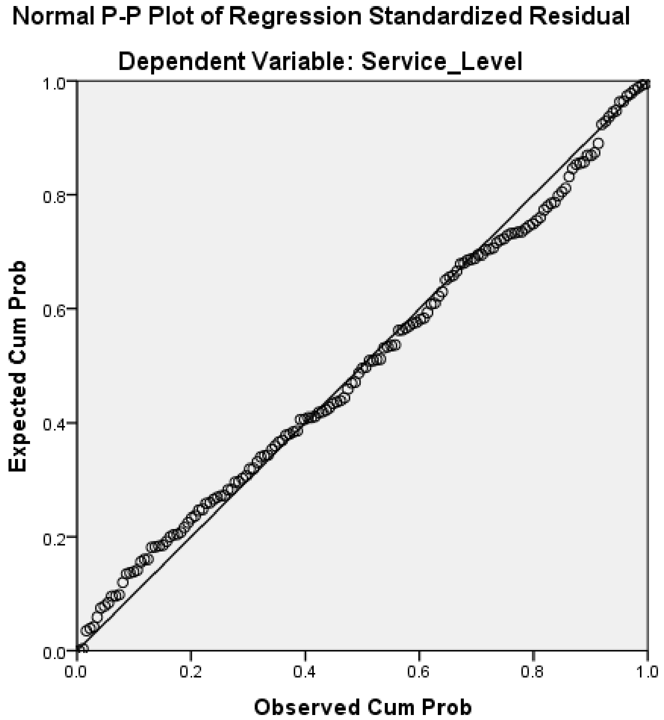

Figure 4.7: Normal P-P Plot of Regression Standardized Residuals

4.3.3. Linearity

After evaluating normality, the next assumption in multivariate analysis involves confirming the existence of a linear relationship between variables (independent and dependent). This is verified by assessing whether a straight line can be drawn on the scatter plot generated. As illustrated in Appendix C, a straight line can be drawn for each variable, confirming that the data adheres to the linearity assumption. Linear graphs are presented in Appendix C.

4.3.4. Correlation

Pearson's correlation is a frequently used method for testing the linearity of a dataset (West & Blom, 2017); (Kim & Seock, 2019). The analysis results presented in Table 4.4 reveal that the Pearson correlation for all variables is statistically significant, with p-values < 0.05 at a 99% confidence interval. Consequently, the assumption of linearity remains unviolated.

Table 4.4: Pearson Correlation Coefficients among Variables

		Willingness	Trust	Service Level	Market Pressure	Government Regulations	Price of Technology
Willingness	Pearson Correlation	1	.682**	.660**	.620**	.615**	.559**
	Sig. (2-tailed)		0.000	0.000	0.000	0.000	0.000
Trust	Pearson Correlation	.682**	1	.682**	.716**	.604**	.609**
	Sig. (2-tailed)	0.000		0.000	0.000	0.000	0.000
Service Level	Pearson Correlation	.660**	.682**	1	.679**	.613**	.622**
	Sig. (2-tailed)	0.000	0.000		0.000	0.000	0.000
Market Pressure	Pearson Correlation	.620**	.716**	.679**	1	.647**	.635**
	Sig. (2-tailed)	0.000	0.000	0.000		0.000	0.000
Government Regulations	Pearson Correlation	.615**	.604**	.613**	.647**	1	.558**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000		0.000
Price of Technology	Pearson Correlation	.559**	.609**	.622**	.635**	.558**	1
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	

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

4.4 Measurement Model Results

Data analysis is conducted using the Smart PLS software, Version 4.0. The analysis of a PLS model occurs in two stages. First, the measurement model is assessed to ensure its reliability and validity. CFA, employing PLS, is employed to scrutinize the measurement properties of multi-item constructs, encompassing reliability, and validity (convergent, discriminant). Subsequently, the proposed structural model undergoes analysis for hypothesis testing and justification. Figure 4.8 provides the measurement model with original outer loadings

Measurement Model with Original Outer Loadings

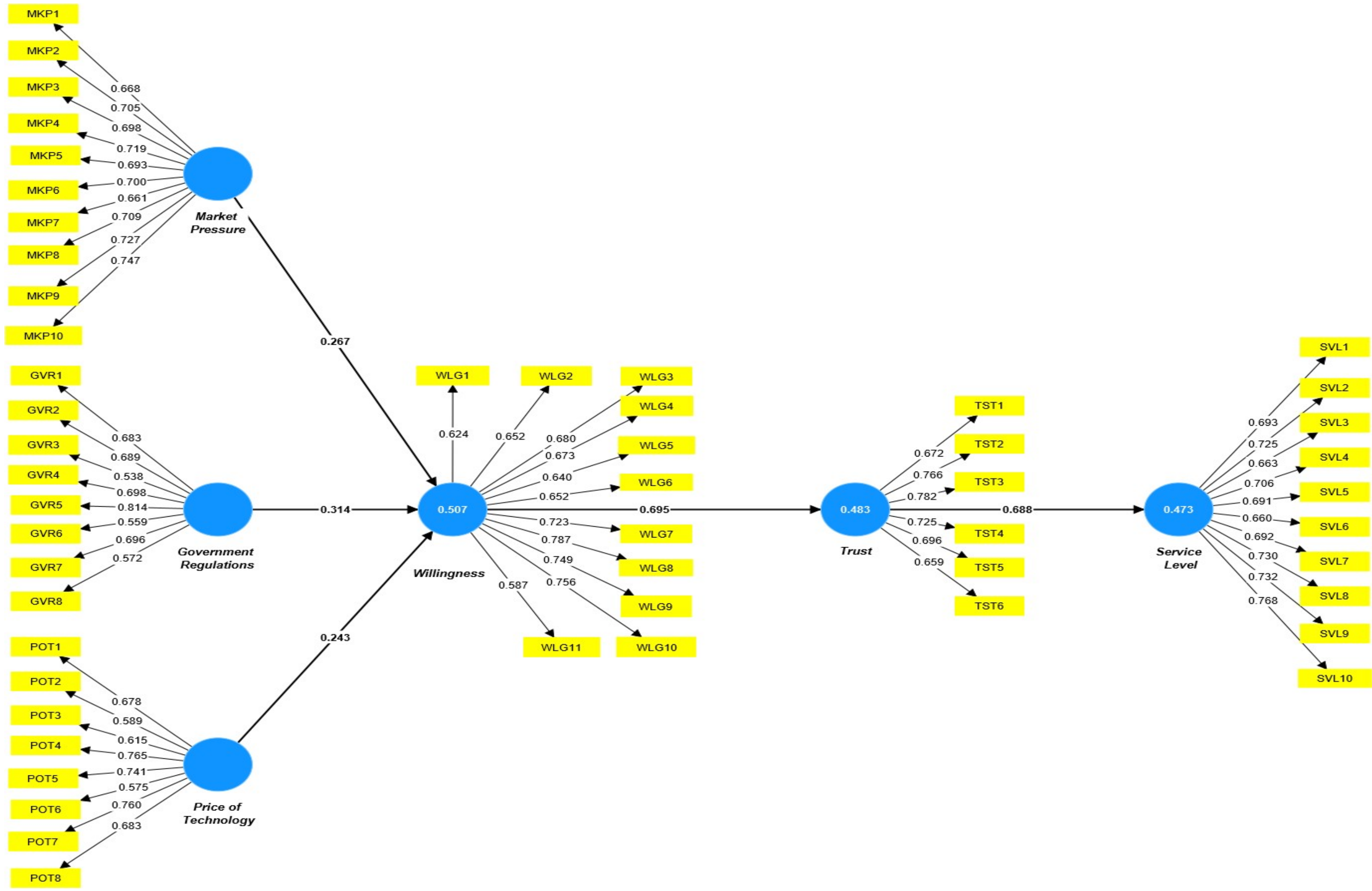

Figure 4.8: Measurement Model with Original Outer Loadings

4.4.1 Model Assessment

The AVE is a crucial statistic when evaluating the quality of your measurement model. It helps determine whether your latent construct is adequately measured by the selected indicators. If the AVE is low, it may suggest that some indicators need to be improved, added, or removed to enhance the construct's measurement quality. Convergent validity refers to the extent to which multiple indicators of the same construct are positively correlated. If you retain indicators with low factor loadings, they might not correlate strongly with other indicators and could weaken the overall convergent validity of the construct. Removing these indicators enhances convergent validity by ensuring that all remaining indicators are highly related to each other.

In our initial model assessment, all the indicators resulted in appropriate reliability for each construct, but the average/mean variance extracted (AVE) values of some constructs were less than the threshold value (0.5), which raised questions about their convergent validity. So, to make sure that the data is valid and shows convergent behavior, some of the indicators were removed. Two indicators of government regulations (GVR3, GVR6), one of market pressure (MKP7), two of price of technology (POT2, POT6), two of willingness (WLG5, WLG11), and one of service level (SVL6) were removed from the initial model. According to Toma (2023); Williams (2019); Yani et al. (2023), the minimum number of items per construct must be greater than three. To ensure the reliability and validity of a construct, it's generally recommended to have at least 3 items per construct. Our research model meets the criteria because all constructs have more than three items. Calibrated measurement model can be seen in Figure 4.9.

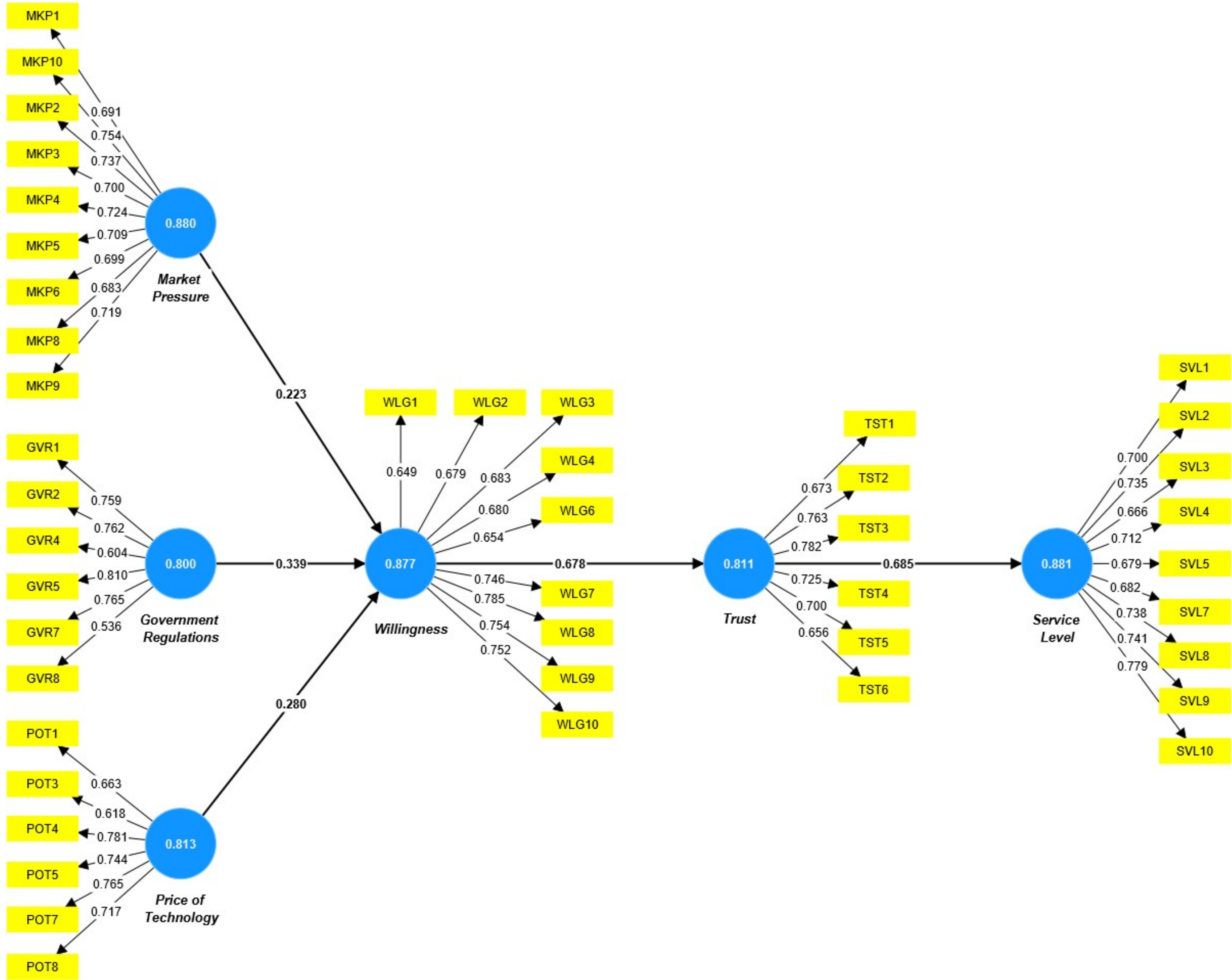

Figure 4.9: Calibrated Measurement Model

4.4.2 Reliability and Validity

4.4.2.1 Composite Reliability

Table 4.5: Composite Reliability Scores for the Constructs in the Research Model.

Variables	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Government Regulations	0.8	0.814	0.859	0.508
Market Pressure	0.88	0.883	0.903	0.509
Price of Technology	0.813	0.822	0.863	0.514
Service Level	0.881	0.885	0.904	0.512
Trust	0.811	0.813	0.864	0.516
Willingness	0.877	0.88	0.901	0.505

Table 4.5 provides crucial reliability and validity statistics for six components of the measurement model. Cronbach's alpha values, which assess internal consistency and reliability, consistently exceed the acceptable threshold of 0.7, ranging from 0.8 to 0.881. Composite reliability values (rho_a and rho_c) also surpass the recommended threshold of 0.7, consistently exceeding 0.8 for all constructs, indicating strong internal consistency. In terms of convergent validity, the Average Variance Extracted (AVE) values range from 0.505 to 0.516, surpassing the commonly accepted threshold of 0.5, signifying good convergent validity across all constructs. These findings highlight that the measurement instruments for the constructs in the research exceed established thresholds for both reliability and validity, affirming the robustness of the study's measurements.

4.4.2.2 Indicator Reliability

After establishing the internal consistency reliability for each construct, the assessment of indicator reliability follows. As depicted in the Table 4.6, all items demonstrate commendable indicator reliability, falling within the range of 0.536 to 0.810, surpassing the threshold value established by Byrne (2016). Additionally, all AVE scores exceed 0.5, indicating that no items needed to be eliminated from the analysis.

Table 4.6: Indicator Reliability Scores for each Variable in the Research Model

Construct	Indicator	Indicator Reliability (Outer Loadings)	Construct	Indicator	Indicator Reliability (Outer Loadings)
Government Regulations	GVR1	0.759	Willingness	WLG1	0.649
	GVR2	0.762		WLG2	0.679
	GVR4	0.604		WLG3	0.683
	GVR5	0.810		WLG4	0.680
	GVR7	0.765		WLG6	0.654
	GVR8	0.536		WLG7	0.746
Market Pressure	MKP1	0.691		WLG8	0.785
	MKP2	0.737		WLG9	0.754
	MKP3	0.700		WLG10	0.752
	MKP4	0.724	Trust	TST1	0.673
	MKP5	0.709		TST2	0.763
	MKP6	0.699		TST3	0.782
	MKP8	0.693		TST4	0.725
	MKP9	0.719		TST5	0.700
	MKP10	0.754		TST6	0.656
Price of Technology	POT1	0.663	Service Level	SVL1	0.700
	POT3	0.618		SVL2	0.735
	POT4	0.781		SVL3	0.666
	POT5	0.744		SVL4	0.712
	POT7	0.765		SVL5	0.679
	POT8	0.717		SVL7	0.682
				SVL8	0.738
				SVL9	0.741
				SVL10	0.779

4.4.2.3 Discriminant Validity

Table 4.7: Heterotrait-Monotrait (HTMT) Validity Analysis

Variables	Government Regulations	Market Pressure	Price of Technology	Service Level	Trust	Willingness
Government Regulations						
Market Pressure	0.725					
Price of Technology	0.601	0.751				
Service Level	0.668	0.761	0.716			
Trust	0.692	0.842	0.744	0.804		
Willingness	0.719	0.677	0.659	0.711	0.792	

Table 4.7 displays the results of Heterotrait-Monotrait (HTMT) ratios, assessing discriminant validity among six constructs in the research thesis: government regulations, market pressure, price of technology, service level, trust, and willingness. The HTMT ratios for all pairs of constructs are consistently below the widely accepted threshold of 0.85, indicating robust discriminant validity. This implies that each construct measures a distinct and unique concept within the study, reinforcing the credibility of the measurement model and affirming the validity of the research findings.

Table 4.8: Fornell-Larcker Criterion for Discriminant Validity Assessment.

Variables	Government Regulations	Market Pressure	Price of Technology	Service Level	Trust	Willingness
Government Regulations	0.713					
Market Pressure	0.610	0.713				
Price of Technology	0.487	0.634	0.717			
Service Level	0.554	0.675	0.616	0.715		
Trust	0.558	0.710	0.606	0.685	0.718	
Willingness	0.612	0.608	0.587	0.632	0.678	0.711

Table 4.8 presents the Fornell-Larcker criterion results, assessing discriminant validity among six constructs in the research thesis: government regulations, market pressure, price of technology, service level, trust, and willingness. The Fornell-Larcker criterion investigates whether the square root of the AVE for each construct exceeds its correlation with other constructs. In this analysis, all constructs satisfy the criterion because the square root of the AVE for each construct is consistently greater than the correlations with the other constructs. Specifically, for instance, the square root of the AVE for government regulations is greater than its correlations with market pressure (0.610), price of technology (0.487), service level (0.554), trust (0.558), and willingness (0.612). This pattern holds for all other constructs as well. These findings provide strong evidence of discriminant validity among the six constructs, confirming that they represent distinct and separate concepts within the research, further enhancing the credibility of the measurement model and the validity of the research outcomes.

4.4.3 Multicollinearity

The variance inflation factor (VIF) values are commonly used to assess multicollinearity in regression models. Multicollinearity arises when there is a high degree of correlation among the independent variables in a regression model, resulting in potential complications in interpreting the coefficients and standard errors. In general, lower VIF values indicate lower levels of multicollinearity. The table presents VIF values for each independent variable (or construct) in the measurement model. VIF values are a measure of multicollinearity, with higher values indicating a higher degree of collinearity between variables.

In this analysis, the VIF values in Table 4.9 for all constructs are well below the commonly recommended threshold of 3, suggesting that multicollinearity is not a concern in the study. These findings suggest that the independent variables in the research thesis are not highly correlated with each other, which is a positive indication for the reliability and stability of regression analyses or other statistical models used in the study. Researchers can have confidence in the results and interpretations without being concerned about multicollinearity-related issues in this context.

Table 4.9: Variance Inflation Factor (VIF) values for Individual Indicators

Indicator	VIF	Indicator	VIF	Indicator	VIF
GVR1	2.502	POT1	1.371	TST1	1.397
GVR2	2.286	POT3	1.554	TST2	1.817
GVR4	1.648	POT4	2.012	TST3	1.879
GVR5	2.282	POT5	1.585	TST4	1.571
GVR7	1.853	POT7	1.667	TST5	1.446
GVR8	1.38	POT8	1.473	TST6	1.387
MKP1	1.999	SVL1	1.791	WLG1	1.939
MKP2	1.919	SVL2	2.094	WLG2	2.083
MKP3	1.864	SVL3	1.647	WLG3	1.667
MKP4	1.852	SVL4	1.808	WLG4	1.813
MKP5	1.782	SVL5	1.761	WLG6	1.615
MKP6	1.654	SVL7	1.638	WLG7	2.016
MKP8	1.763	SVL8	1.872	WLG8	2.212
MKP9	2.16	SVL9	1.97	WLG9	2.207
MKP10	2.241	SVL10	2.207	WLG10	1.987

4.5 Structural Model Results

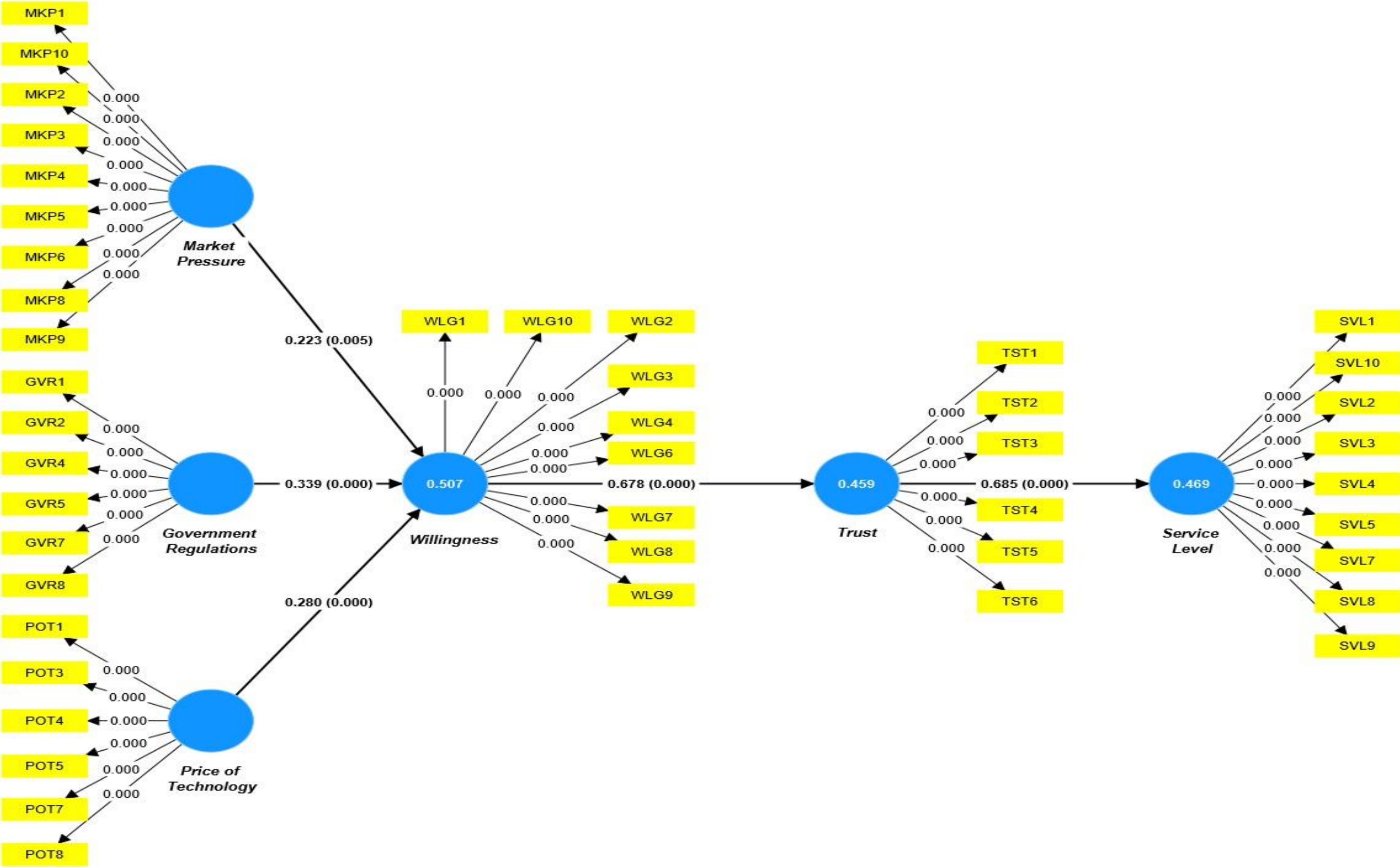

Figure 4.10: Structural Model Path Diagram

4.5.1 The coefficient of Determination (R^2)

The R-squared (R^2) and adjusted R-squared (R^2 adjusted) values for three key variables in the research: "service level," "trust," and "willingness" are reported as the coefficient of determination. These statistics measure the proportion of variance in each variable that is explained by the independent variable in their respective regression models. For "service level," ($R^2 = 0.469$), approximately 46.9% of the variance can be explained, with an adjusted R-squared of 0.466. "Trust" ($R^2 = 0.459$) is explained by around 45.9%, with an adjusted R-squared of 0.456. "Willingness" ($R^2 = 0.507$) exhibits the highest explanation, with 50.7% of the variance accounted for and an adjusted R-squared of 0.498. These values offer insights into the goodness of fit for each regression model, highlighting the degree to which the independent variables contribute to explaining the variability in these key research variables. However, it's important to note that no R-squared value will be 1.0 (100%) in real-world data because there is always some level of inherent variability.

4.5.2 Effect Size, F2

Table 4.10: Effect Size Analysis for Key Variables

Constructs	F-square	Effect
Government Regulations → Willingness	0.143	Medium
Market Pressure → Willingness	0.048	Small
Price of Technology → Willingness	0.092	Small
Trust → Service Level	0.884	Large
Willingness → Trust	0.850	Large

Effect size: Small ($\geq$ 0.02), Medium ($\geq$0.15), Large ($\geq$0.35)

The provided squared F-squared values in Table 4.10 offer insights into the explanatory power of specific independent variables on their respective dependent variables. Notably, the relationships between "trust" and "service level," as well as "willingness" and "trust," demonstrate strong explanatory capacity, with squared F-squared values of 0.884 and 0.850, respectively, suggesting that a substantial portion of the variability in these dependent variables can be accounted for by the independent variables. The relationship involving "government regulations," and "willingness exhibits moderate squared F-squared values, suggesting a medium explanatory relationship. In contrast, relationships involving "market pressure," and "price of technology" with "willingness" exhibit lower squared F-squared values, suggesting weaker explanatory relationships. Overall, these values quantify the extent to which specific independent variables contribute to explaining variability in their associated dependent variables.

4.5.3 Path Coefficient (Direct Effect)

The study's structural equation model revealed several significant relationships among key variables. Table 4.11 illustrates the path coefficients values for direct path analysis. Firstly, an increase in government regulations was associated with a greater willingness among rice exporting firms to adopt food traceability mechanism, with a path coefficient of 0.339. Market pressure also positively influenced willingness (path coefficient = 0.223), indicating that firms were more inclined to adopt traceability in response to market pressures. Similarly, an increase in the price of technology (path coefficient = 0.280) had a positive impact on willingness. Trust played a crucial role, as higher levels of trust were linked to better service level (path coefficient = 0.685). Additionally, willingness significantly influenced trust (path coefficient = 0.678), emphasizing the reciprocal relationship between these variables. All of these relationships were statistically significant, underscoring their practical significance for rice exporting firms' adoption of food traceability mechanism.

4.5.4 Hypothesis Testing

Table 4.11: Direct Effect Analysis in Research Model

Hypothesis	Path Coefficient (β)	Standard Deviation	T statistics	P values
H_1: Government Regulations → Willingness	0.339	0.072	4.710	0.000
H_2: Market Pressure → Willingness	0.223	0.079	2.839	0.005
H_3: Price of Technology → Willingness	0.280	0.066	4.224	0.000
H_4: Willingness → Trust	0.678	0.076	8.975	0.000
H_5: Trust → Service Level	0.685	0.081	8.459	0.000

Hypothesis 1: The analysis reveals a statistically significant and positive relationship between government regulations and willingness ($\beta = 0.339$, SD = 0.072, t = 4.71, $p < 0.001$). This suggests that as government regulations increase, willingness also tends to increase. The beta coefficient of 0.339 indicates the strength and direction of this relationship, with a standard deviation (SD) of 0.072 providing information about the variability in the data. The t-statistic of 4.71 demonstrates that this relationship is statistically significant, well beyond the threshold of significance ($p < 0.001$), supporting the acceptance of Hypothesis 1.

Hypothesis 2: The results show a statistically significant and positive association between market pressure and willingness ($\beta = 0.223$, SD = 0.079, t = 2.839, $p = 0.005$). This implies that as market pressure increases, willingness also tends to increase. The beta coefficient of 0.223 quantifies the strength and direction of this relationship, with a standard deviation (SD) of 0.079 indicating the variability in the data. The t-statistic of 2.839 demonstrates that this relationship is statistically significant at a conventional level of significance ($p = 0.005$), supporting Hypothesis 2.

Hypothesis 3: The analysis reveals a statistically significant and positive effect of the price of technology on willingness ($\beta = 0.28$, SD = 0.066, t = 4.224, $p < 0.001$). This indicates that as the price of technology increases, willingness tends to increase as well. The beta coefficient of 0.28 characterizes the strength and direction of this relationship, while the standard deviation (SD) of 0.066 represents data variability. The t-statistic of 4.224 demonstrates that this relationship is highly statistically significant ($p < 0.001$), providing robust support for Hypothesis 3.

Hypothesis 4: The analysis reveals a statistically significant and positive impact of willingness on trust ($\beta = 0.678$, SD = 0.076, t = 8.975, $p < 0.001$). This indicates that as willingness increases, trust also tends to increase. The beta coefficient of 0.678 quantifies the strength and direction of this relationship, while the standard deviation (SD) of 0.076 characterizes data variability. The t-statistic of 8.975 attests to the high level of statistical significance ($p < 0.001$), strongly supporting Hypothesis 4.

Hypothesis 5: The results establish a statistically significant and positive link between trust and service level ($\beta = 0.685$, SD = 0.081, t = 8.459, $p < 0.001$). This suggests that as trust increases, service level tend to increase as well. The beta coefficient of 0.685 signifies the strength and direction of this relationship, with a standard deviation (SD) of 0.081 reflecting data variability.

The t-statistic of 8.459 underscores the highly significant nature of this relationship ($p < 0.001$), providing strong empirical support for Hypothesis 5.

These comprehensive findings provide robust empirical evidence in favor of all hypotheses (H1 to H5), demonstrating statistically significant and meaningful relationships between the respective independent and dependent variables in the research model.

Table 4.12: Indirect Effect Analysis in Research Model

Hypothesis	Path Coefficient (β)	Standard Deviation	T Statistics	P values
H_6: Government Regulations → Willingness → Trust	0.230	0.052	4.420	0.000
H_7: Market Pressure → Willingness → Trust	0.151	0.061	2.472	0.013
H_8: Price of Technology → Willingness → Trust	0.190	0.053	3.611	0.000
H_9: Market Pressure → Willingness → Trust → Service Level	0.104	0.050	2.078	0.038
H_{10}: Willingness → Trust → Service Level	0.464	0.099	4.675	0.000
H_{11}: Price of Technology → Willingness → Trust → Service Level	0.130	0.045	2.902	0.004
H_{12}: Government Regulations → Willingness → Trust → Service Level	0.158	0.045	3.531	0.000

H_6: Government Regulations → Willingness → Trust

This hypothesis suggests that "Government Regulations" have an indirect effect on "Trust" through their impact on "Willingness." In other words, the influence of government regulations on trust is mediated by an individual's willingness to act or respond to those regulations. The path coefficient of 0.23 indicates a positive and statistically significant relationship between government regulations, willingness, and trust.

H_7: Market Pressure → Willingness → Trust

This hypothesis explores the indirect effect of "Market Pressure" on "Trust" through "Willingness." It suggests that market pressure affects trust through its influence on an individual's willingness to respond to that pressure. The path coefficient of 0.151 suggests a positive relationship, and the p-value of 0.013 indicates that this relationship is statistically significant, although less strongly than H6.

H_8: Price of Technology → Willingness → Trust

This hypothesis examines the indirect effect of the "Price of Technology" on "Trust" through "Willingness." It posits that the price of technology impacts trust through its influence on individuals' willingness. The path coefficient of 0.19 suggests a positive and statistically significant relationship.

H_9: Market Pressure → Willingness → Trust → Service Level

This hypothesis extends the analysis further by looking at a chain of relationships. It starts with "Market Pressure" affecting "Trust" through "Willingness" and then continues to explore how "Trust" impacts "Service Level." The path coefficient of 0.104 suggests a positive relationship between these variables, and the p-value of 0.038 indicates statistical significance.

H_{10}: Willingness → Trust → Service Level

This hypothesis focuses on a direct and indirect relationship between "Willingness" and "Service Level." It suggests that "Willingness" directly impacts "Trust," and "Trust" in turn influences "Service Level." The path coefficient of 0.464 is relatively high, indicating a strong relationship, and the p-value is very low, indicating statistical significance.

H_{11}: Price of Technology → Willingness → Trust → Service Level

Similar to H9, this hypothesis explores a chain of relationships. It starts with the "Price of Technology" influencing "Trust" through "Willingness" and then continues to examine how "Trust" affects "Service Level." The path coefficient of 0.13 indicates a positive relationship, and the p-value is 0.004, indicating statistical significance.

H_{12}: Government Regulations → Willingness → Trust → Service Level

This hypothesis extends H9 to consider government regulations and their impact on "Service Level" through the chain of "Willingness" and "Trust." The path coefficient of 0.158 suggests a positive relationship, and the p-value is very low (0.000), indicating strong statistical significance.

4.6 Summary

The study's structural equation model revealed several significant relationships among key variables. Firstly, an increase in government regulations was associated with a greater willingness among rice exporting firms to adopt food traceability mechanism, with a path coefficient of 0.339. Market pressure also positively influenced willingness (path coefficient = 0.223), indicating that firms were more inclined to adopt traceability in response to market pressures. Similarly, an increase in the price of technology (path coefficient = 0.280) had a positive impact on willingness. Trust played a crucial role, as higher levels of trust were linked to better service level (path coefficient = 0.685). Additionally, willingness significantly influenced trust (path coefficient = 0.678), emphasizing the reciprocal relationship between these variables. All of these relationships were statistically significant, underscoring their practical significance for rice exporting firms' adoption of food traceability mechanism.

Hypotheses ($H_6 \rightarrow H_{12}$) examine various indirect effects and mediation relationships within a model. They investigate how different factors, such as government regulations, market pressure, the price of technology, willingness, trust, and service level, are interconnected. The path coefficients reveal the intensity and direction of these associations, while the statistical significance, indicated by p-values and T statistics, indicates the reliability of the findings. These findings provide insights into how these variables are related and how they collectively impact trust and service level.

All hypotheses tested in the study were supported and accepted.

H_1: The hypothesis that government regulations positively influence the willingness of rice exporting firms to adopt food traceability mechanism was supported and accepted.

H_2: The hypothesis stating that market pressure is a driving factor for the willingness to adopt food traceability mechanism among rice exporting firms was supported and accepted.

H_3: The hypothesis proposing that the price of technology significantly affects the willingness to adopt food traceability systems was supported and accepted.

H_4: The hypothesis suggesting that willingness to adopt food traceability mechanism plays a significant role in building trust was supported and accepted.

H_5: The hypothesis indicating that trust has a significant effect on service level was supported and accepted.

H_6: The hypothesis posits that government regulations have an indirect effect on trust through their influence on willingness.

H_7: The hypothesis suggests that market pressure indirectly affects trust through its impact on willingness.

H_8: The hypothesis proposes that the price of technology indirectly affects trust by influencing willingness.

H_9: The hypothesis proposes that market pressure may lead to greater willingness, which, through the mediation of trust, can influence the service level.

H_{10}: The hypothesis suggests that willingness directly influences trust and trust, in turn, impacts service level.

H_{11}: The hypothesis starts with the price of technology influencing trust through willingness, and then it examines how trust, in turn, impacts service level.

H_{12}: The hypothesis suggests that government regulations influence service level through a chain of intermediaries: willingness and trust.

In summary, the study's findings provided robust empirical support for all of these hypotheses, confirming the significance of these factors in influencing the adoption of food traceability mechanism by rice exporting firms.

CHAPTER 5. DISCUSSION AND CONCLUSION

5.1 Introduction

This chapter provides a concise overview of the study's findings with respect to the research topics. The first section will present the overall conclusion based on the results. This is followed by an in-depth discussion of the study's implications and its contributions. Finally, the study's shortcomings and prospective recommendations are discussed.

5.2 Recapitulation of study

The purpose of this study was to look at the antecedents and outcomes of rice exporters' willingness to adopt product traceability mechanism within the context of the rice export industry. The research aimed to shed light on the factors that influence this willingness and explore its implications for service level within the industry. Our study was driven by four primary research objectives:

RO1: To identify the factors affecting rice exporters' willingness to adopt traceability mechanism.

RO2: To examine the impact of the willingness of rice exporters to adopt product traceability mechanism on service level.

RO3: To test the role of government regulations, market pressure, price of technology, and trust in the relationship between willingness to adopt a traceability mechanism and service level.

RO4: To suggest policy measures to improve the adoption of product traceability in the rice supply chain.

To achieve these objectives, a comprehensive framework was developed, incorporating key independent variables, a dependent variable, and three research questions. In the research methodology chapter, we established the philosophical approach guiding our study, which is positivism. This approach aligns with the belief that objective observation and experimentation are essential for scientific research (Saunders, Lewis, & Thornhill, 2007). It was chosen to ensure the rigorous examination and validation of food traceability systems.

Our research adopted a deductive-quantitative approach. This approach involved developing hypotheses based on existing theories and conducting empirical research to test these hypotheses. The use of structured questionnaires and statistical analysis was key to this approach (Blackstone, 2012). We utilized a simple random sampling technique based on the availability of a reliable sampling frame, the Rice Exporters Association of Pakistan (REAP). This method allowed us to ensure that each rice exporting company had an equal probability of being selected for inclusion in our study (X. Liu, Yan, & Song, 2020).

The primary data collection method employed was a survey. A questionnaire designed specifically for this study was distributed to rice exporting companies, and 157 responses were collected over a two-month period. This phase involved careful data validation and cleaning processes to maintain data quality (Saunders et al., 2012). To ensure the quality of our data, we addressed issues related to reliability and validity. Internal-consistency was measured using Cronbach's alpha, and various indices were employed to evaluate the reliability and validity of our measurement instruments (Tavakol & Dennick, 2011; Hair et al., 2017). The core of our data analysis was structural equation modeling (SEM), which is a robust statistical tool for investigating complex relations between variables. (Mueller & Hancock, 2019).

We employed SmartPLS 4.0 for PLS-SEM, a method capable of handling non-normal data and small sample sizes, which was well-suited to our research objectives (Hair et al., 2017). After establishing the validity and reliability of the measurement model, the subsequent step was testing the structural model to see if the hypothesised relationship held true, and the results of the investigation were summarized in the previous chapter. The next section discusses the study's findings.

5.3 Discussion of the Findings

Due to the lack of studies on the willingness of rice exporters to adopt traceability mechanism, the primary goal of this study was to explore the antecedents of rice exporters' willingness to adopt traceability mechanism. In this study, twelve (12) hypotheses have been developed on the relationship between independent variables (IV's) and dependent variables (DV's). The following section discusses the study's conclusions and answers the research question. One significant finding of this study is that the majority of the rice exporting firms were willing to adopt traceability mechanism.

RQ1: What are the factors affecting the willingness to adopt product traceability in the rice supply chain?

In response to RQ1, we identified a range of factors affecting the willingness to adopt product traceability, including cost considerations, government regulations, market demands, and the perceived benefits of traceability systems.

Our investigation into the factors influencing the willingness of rice exporters to adopt product traceability mechanism revealed several noteworthy findings. Government regulations emerged as a significant driver of traceability adoption. Respondents indicated that regulatory pressures and compliance requirements exerted substantial influence over their willingness to adopt traceability mechanism. This underscores the crucial role of regulatory frameworks in shaping industry practices. Market pressures were another influential factor. As global markets demand greater transparency and traceability in food supply chains, rice exporters are increasingly compelled to meet these expectations. Market-oriented firms recognized the importance of traceability in gaining a competitive edge and satisfying customer demands. This finding underscores the interconnectedness of market dynamics and traceability adoption.

The cost of technology, while recognized as a potential barrier to adoption, exhibited nuances. Large exporting firms with greater financial resources expressed a greater willingness to invest in traceability technologies. In contrast, smaller companies faced greater financial constraints and were less inclined to embrace costly traceability systems. This finding emphasizes the need for tailored solutions and support mechanism to accommodate the diverse financial capacities of industry players. Trust emerged as a pivotal factor. Trust in the efficacy of traceability systems, trust in supply chain partners, and trust in regulatory authorities played a central role in shaping willingness to adopt. The findings highlight the intricate relationship between trust and traceability adoption, suggesting that fostering trust may facilitate greater adoption rates.

RQ2: What is the level of willingness of rice exporters to adopt product traceability mechanism?

RQ2 revealed that a substantial portion of rice exporters expressed a willingness to adopt traceability mechanism, citing improved supply chain visibility and market. Our study quantified the level of willingness among rice exporters to adopt product traceability mechanism. The results indicated a moderate to high level of willingness across the industry. This signifies a positive outlook for traceability adoption within the rice export sector. The industry's recognition of the importance of traceability is a promising indicator for enhancing supply chain transparency and food safety.

RQ3: Does the willingness of rice exporters to adopt a product traceability mechanism affect trust and service level?

RQ3 demonstrated that a higher willingness to adopt traceability mechanism indeed led to enhanced trust among trading partners and an improved service level. Our research explored the relationship between willingness to adopt traceability mechanism and its impact on service levels. The research discovered a substantial positive correlation between willingness to adopt and service level. Rice exporters with a higher willingness to embrace traceability mechanism tended to exhibit higher service quality, including timely deliveries, better communication, and improved customer satisfaction.

5.4 Contribution of the study

This research makes several notable theoretical contributions. This work addresses a notable gap in the existing literature by providing a comprehensive description of the antecedents of the willingness of rice exporters to adopt traceability mechanism and discussing their impact on the service level of the firm. This research adds to the existing body of knowledge in various ways. Firstly, it empirically examines the factors influencing the willingness of rice export firms to adopt food traceability mechanism, shedding light on the unique dynamics of this industry. Secondly, our findings offer valuable insights for policymakers and industry stakeholders seeking to promote traceability adoption and enhance food safety in the rice export sector. Finally, this study adds to the body of the knowledge on technology adoption and supply chain management through investigating the importance of trust and service quality in adoption decisions.

5.5 Practical Implications

The study's findings have various practical implications for rice export sector stakeholders and policymakers concerned with food safety and supply chain transparency.

5.5.1 Regulatory Frameworks

Government agencies should continue to develop and enforce traceability regulations that encourage firms to adopt this mechanism. These regulations should strike a balance between ensuring food safety and minimizing the burden on firms, especially smaller ones. Policymakers can consider providing incentives, such as tax breaks or subsidies, to alleviate the perceived cost barrier of adopting traceability technology. Policymakers hold the reins in shaping the regulatory landscape. Our research suggests that well-crafted regulations can be instrumental in encouraging traceability adoption. However, this regulatory framework should not only prioritize food safety but also align with broader sustainability goals. Governments can incentivize environmentally friendly practices, creating a win-win situation for both industry players and the planet. Traceability systems can help ensure compliance with environmental regulations and standards in agriculture and food processing. Enforcing regulations related to burning crop residues, controlling emissions from machinery, and other environmentally sensitive practices can contribute to smog reduction.

5.5.2 Industry Collaboration

Stakeholders in the rice export industry, including farmers, processors, exporters, and technology providers, should collaborate to enhance trust and information sharing within the supply chain. The industry must unite to establish best practices that not only enhance traceability but also promote sustainability. Establishing industry-wide best practices and standards for traceability can foster greater trust among participants and facilitate the adoption of traceability systems.

5.5.3 Technology Providers

Traceability technology providers should prioritize customer service and support. Offering comprehensive training, troubleshooting assistance, and ongoing support can make the adoption process smoother for firms. Additionally, technology providers can explore innovative pricing models that make traceability solutions more accessible to a wider range of firms. Many stakeholders in the rice supply chain may already have existing systems in place. Technology providers can offer solutions that seamlessly integrate with these systems, ensuring a smooth transition to traceability without disrupting established workflows. Traceability involves the collection and management of sensitive data. Technology providers need to prioritize robust cybersecurity measures to protect the integrity and confidentiality of the data, ensuring that stakeholders can trust the traceability system.

5.5.4 Sustainability Considerations

Acknowledging the environmental and social dimensions, integrating sustainable practices within traceability mechanisms is crucial. This includes adopting eco-friendly packaging, reducing the carbon footprint in the supply chain, and ensuring ethical sourcing practices. Stakeholders should consider how traceability mechanisms align with broader sustainability goals for a responsible and resilient rice export industry. Traceability enables farmers to monitor and manage their agricultural practices more effectively. This includes optimizing the use of water, fertilizers, and pesticides, thereby promoting sustainable farming methods and minimizing environmental impact.

5.6 Limitations and Future Recommendations

Several constraints were encountered while performing this research, which should be addressed in order to provide a balanced view of the study's conclusions. To collect data at a precise point in time, this study used a cross-sectional approach. This design could offer deeper insights into the dynamic nature of rice exporters' willingness to adopt traceability mechanisms and their impact on service levels. The study utilized a sample of rice exporting companies within a specific geographical region (Punjab). This may limit the findings' applicability in a broader context. Future studies could aim for larger and more broader samples to improve the external validity of the results.

The primary data collection method employed in this study was self-report surveys, which are subject to potential response bias and social desirability bias. By integrating several data-gathering techniques, such as conducting interviews or making observations, a more comprehensive comprehension of the investigated phenomena can be attained. The study focused on specific antecedents of willingness to adopt traceability mechanism. Future research should consider incorporating additional contextual factors that might influence this willingness, such as industry-specific regulations or cultural factors.

To address the limitations outlined above and advance the understanding of the antecedents and outcomes of rice exporters' willingness to adopt product traceability mechanism, several avenues for future research are suggested. Extend research to other sectors beyond rice export to assess the generalizability of findings and identify industry-specific factors influencing traceability adoption. Collaborate with researchers from different regions to gain global perspectives on traceability adoption, considering variations in regulations, cultures, and economic conditions. Investigate the implications of research findings for policymakers, industry associations, and regulatory bodies. Assess how policy changes could facilitate the adoption of traceability mechanism and improve service levels. Combine quantitative surveys with qualitative methods such as interviews and observations to triangulate findings and provide a richer understanding of the research phenomenon.

Explore differences in willingness to adopt traceability mechanism across different regions, countries, or industries. Comparative studies can uncover contextual factors that influence adoption decisions. Design experiments to establish causal relationships and mediating effects between variables. Experimental approaches can help validate findings from observational studies. Investigate the impact of emerging advancements, such as blockchain or the Internet of Things (IoT), on the willingness to adopt traceability mechanism in the rice export industry. Future research has the potential to enhance our comprehension of the intricate connection between precursors, results, and service levels within the framework of traceability mechanisms in the rice export industry.

5.7 Conclusion

In closing, this study has provided valuable insights into the complex relationships between antecedents, outcomes, and service levels concerning traceability mechanism in the rice export industry. Our findings emphasize the importance of government regulations, market pressures, cost considerations, and trust in shaping willingness to adopt, ultimately enhancing service levels and fostering greater transparency and food safety. As the rice export industry continues to evolve in an increasingly globalized marketplace, our research serves as a foundation for making informed decisions, policy development, and future exploration. The pursuit of efficient, secure, and transparent supply chains remains paramount, ensuring the well-being of consumers and the sustainability of the rice export industry. One pivotal aspect that requires prolonged consideration is the environmental sustainability of the rice export sector. While our research focuses on the technological and operational aspects of traceability mechanisms, it is imperative to acknowledge the broader environmental footprint of the industry. The rice export sector can play a crucial role in mitigating environmental impacts. Sustainable practices, including eco-friendly packaging, reduced carbon emissions in transportation, and ethical sourcing of raw materials, should be integral to the industry's vision.

As the pursuit of efficient, secure, and transparent supply chains remains at the forefront of industry goals, it becomes a shared responsibility. Stakeholders, from governments and regulatory bodies to industry players and consumers, must collaborate to navigate these complexities. The findings of our research provide a roadmap, but the journey requires collective efforts and a commitment to sustainable practices. The pandemic (COVID-19) underscored the fragility of global supply chains. As the rice export industry looks to the future, building resilience becomes imperative. This resilience encompasses not only operational contingencies but also a robust response to environmental challenges. Sustainable practices contribute not only to environmental well-being but also to the long-term viability of supply chains.

As we reflect on the overall findings of this research, let it serve as a clarion call for a responsible and resilient future. Where the rice export industry thrives in harmony with the environment, technology fosters innovation without compromising sustainability, and collective efforts pave the way for a transparent, secure, and ethical global trade ecosystem. Adopting product traceability in the rice supply chain in Pakistan can indirectly contribute to the reduction of smog through improved agricultural and supply chain practices. Smog is an alarming issue in Pakistan from last few years that must be catered for healthy and cleaner environment. Enforcing regulations related to burning crop residues, controlling emissions from machinery, and other environmentally sensitive practices can contribute to smog reduction.

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APPENDICES

APPENDIX A: SURVEY QUESTIONNAIRE

Survey for "Antecedents and Outcomes of Rice Exporters' Willingness to Adopt Product Traceability Mechanism"

Project Brief

Traceability of food products is a major requirement from overseas customers. Rice exporters' willingness to adopt a product traceability mechanism boosts the trust and service level in the eyes of overseas customers. Market pressure, government regulations, and the price of technology being adopted are the factors that affect their willingness. This research evaluates the interplay between all the factors affecting the rice exporters' willingness to adopt a product traceability mechanism and its impact on the trust and service level. This survey is in line with NUST code of research ethics. Your opinion is very important in this academic research, and we regard your free will to share the information you are comfortable with and discontinue the survey at any stage.

Informed consent.

I have read the project brief and I consent by my free will to participate in this survey.

	Yes	No
Is your company exporting rice?	(If "YES" then please proceed with the survey)	(If "NO" then please abandon the survey)

	Willingness of rice exporters to adopt a product traceability mechanism.	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
1.	Product traceability is important for a rice exporting company.					
2.	Our company is aware of potential benefits of implementing a product traceability mechanism.					
3.	The adoption of product traceability mechanism requires substantial investment in technology and infrastructure.					

4.	Our customers are willing to pay a slightly higher price for products if we have a robust traceability mechanism in place.					
5.	Our company believes that the adoption of a product traceability mechanism can improve food safety and quality.					
6.	Our company believes that adopting a product traceability mechanism is a responsible and ethical practice for companies.					
7.	Our company is willing to invest resources (time, budget, technology, etc.) in adopting a product traceability mechanism					
8.	Our company is willing to collaborate with our supply chain partners to establish a comprehensive product traceability mechanism.					
9.	Our company is willing to spend additional time or effort to adopt product traceability mechanism.					
10.	Our company is willing to allocate resources for staff training and education on implementing and managing a product traceability mechanism.					
11.	Our company is willing to adapt and modify existing processes and systems to integrate product traceability mechanism.					

	Trust	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
1.	Our company believes that adopting a product traceability mechanism would improve the integrity of our company.					
2.	Our company trusts that implementing a product traceability mechanism would improve accountability in the supply chain.					

3.	Our company believes that adopting a product traceability mechanism would enhance the credibility/trustworthiness between our company and customers.					
4.	Our company believes that trust is strengthened when companies actively engage with their customers, seek feedback, and involve them in decision-making processes.					
5.	Our company believes that adopting a product traceability mechanism would enhances data privacy and security.					
6.	Our company acknowledges that transparency in the supply chain is necessary in building your trust with international customers.					

	Service level	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
1.	Our company understands that adopting product traceability mechanism improves responsiveness.					
2.	Our company believes that adopting product traceability mechanism will improves communication and collaboration among stakeholders.					
3.	Our company believes that adopting product traceability mechanism leads to continuous improvement.					
4.	Our company understands that adopting product traceability mechanism assures product quality.					
5.	Our company understands that adopting product traceability mechanism improves reliability and consistency.					
6.	Our company understands that adopting product traceability mechanism improves operational efficiency.					

7.	Our company understands that adopting product traceability mechanism improves supply chain transparency.					
8.	Our company believes that adopting a product traceability mechanism will help our company to meet regulatory compliance requirements.					
9.	Adopting product traceability mechanism can provide reliable and timely information along the entire supply chain.					
10.	Our organization strives to meet customer expectations regarding traceable products to remain competitive.					

	Market Pressure	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
1.	Consumer demand for traceable food products has increased significantly over time.					
2.	There has been increasing pressure in the food industry to track and trace food products through various stages of supply chain such as procurement, production, and distribution.					
3.	Our company understand that the market demand to adopt product traceability mechanism is necessary to remain competitive.					
4.	Customer demand for high-quality food along with safety concerns has risen because of several food crises that have occurred in recent years.					
5.	Consumers are paying particular attention to the transparency of the food supply chain for a variety of reasons, including dietary concerns over food ingredients as well as social and environmental issues involved in the production of products					

6.	Our company is facing pressure from key stakeholders (e.g., suppliers, partners, and customers) to implement product traceability mechanism.					
7.	Our company believes that the pressure to adopt a traceability mechanism is stronger in export markets compared to domestic markets.					
8.	Our company believes that the demand for product traceability in the market is primarily driven by the actions of competitors.					
9.	Our company believes that product traceability initiatives are essential for building and maintaining long-term relationships with customers in the rice export industry.					
10.	Our company considers the adoption of a product traceability mechanism as a strategic move to cater the customer preferences and demands.					

	Government Regulations	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
1.	The government actively seeks input/feedback from rice exporters when formulating or revising regulations.					
2.	Government provides guidance/consultancy in implementing traceability mechanism.					
3.	Our company considers international standards and certifications important for ensuring product traceability in the rice export industry.					
4.	Our company supports the government's efforts to align domestic regulations with international standards and certifications for product traceability.					
5.	The government initiatives have positively influenced the competitiveness of our company in global market.					

6.	Our company believes that the government should provide incentives/support to encourage rice exporters to adopt product traceability mechanism.					
7.	Our company believes that current regulations are sufficient to meet the demands of international customers regarding product traceability.					
8.	Our company believes that government regulations of both exporting and importing countries are equally important in adopting product traceability mechanism.					

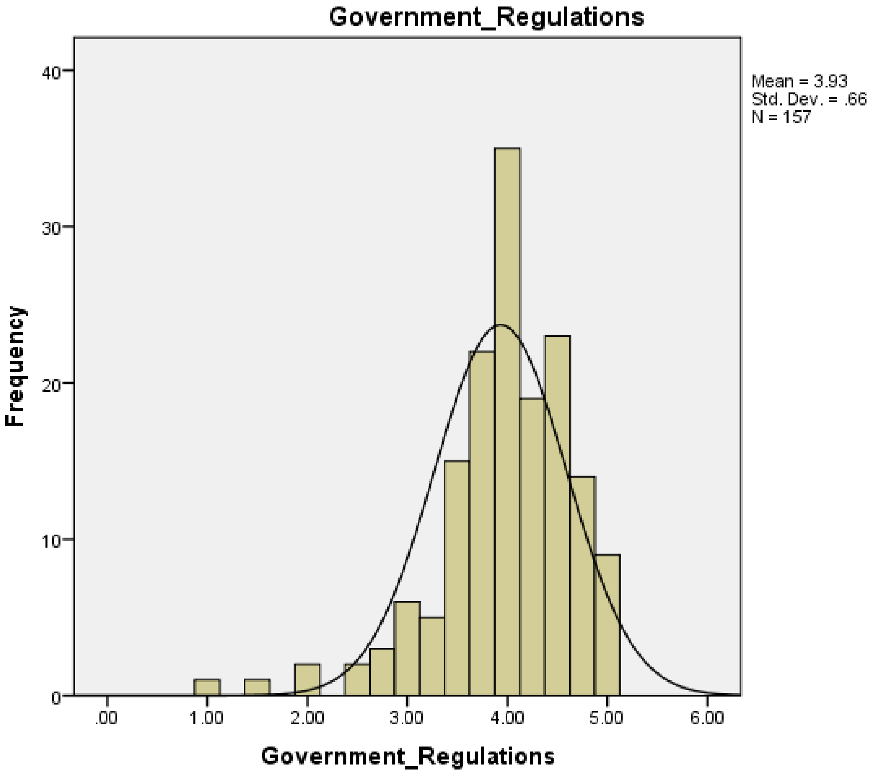
	Price of technology	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
1.	The cost of implementing a traceability mechanism is important to our company.					
2.	The potential improvement in supply chain efficiency and customer trust outweighs the price of technology.					
3.	Our company believes that technological limitations and infrastructure gaps may hinder the adoption of product traceability mechanism.					
4.	Our company believes that investing in product traceability technology is a worthwhile long-term investment for rice exporters					
5.	The perceived benefits of traceability, such as improved product quality and safety, outweigh the cost of technology.					
6.	Cost of implementation is a barrier to adopting a product traceability mechanism in your company.					
7.	Our company is willing to explore cost-effective alternatives for implementing traceability technology.					
8.	Our company believes that the price of technology for product traceability should be based on the size and capacity of rice exporters.					

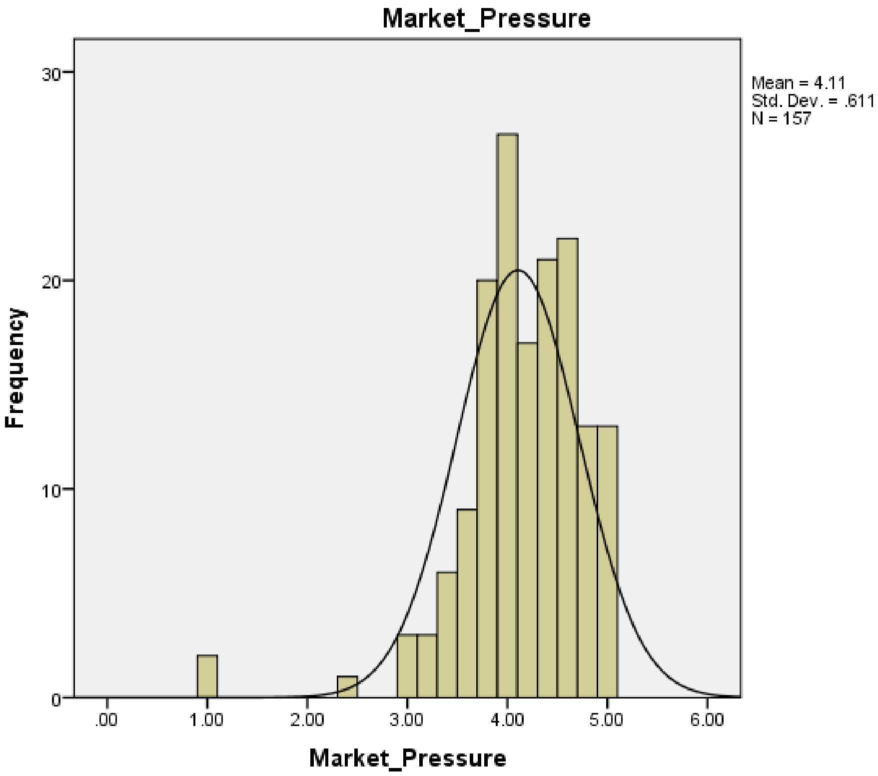
Demographics of Respondents

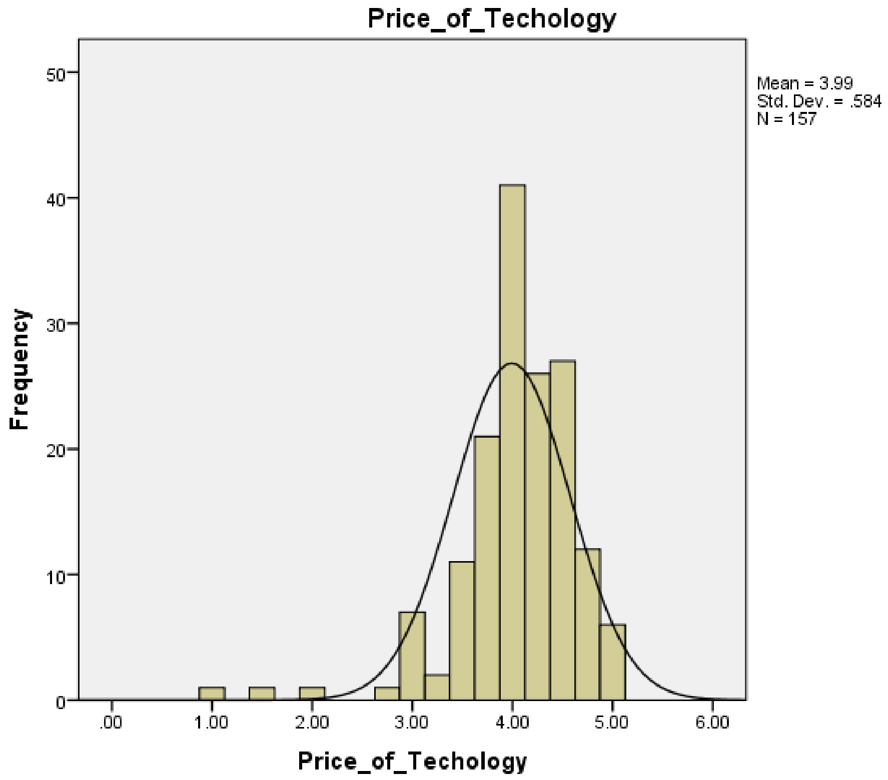
1.	Firm Size What is the number of employees in your company? 0-20 Employees 21-40 Employees 41-80 Employees (3) 81-100 Employees More than 100 Employees	6.	Education (Years of schooling) No formal education Primary school certificate Secondary school certificate Higher secondary school certificate Bachelor's degree Master's degree Ph.D.
2.	Firm Age Less than 5 years 6-10 years 11-15 years More than 20 years	7.	Overall professional experience Less than 5 years 6-10 years 11-15 years More than 15 years
3.	Ownership Structure Sole Proprietorship Partnership Private Limited Company Public Limited Company Corporation	8.	My job title/designation ___________________________________
4.	Rice Exporters Association of Pakistan (REAP) membership? Yes No	9.	Experience in this firm ________years_________months
5.	Which country or region are you exporting rice?	10.	Gender Male Female

Thanks for your time and feedback.

APPENDIX B: NORMALITY CURVES



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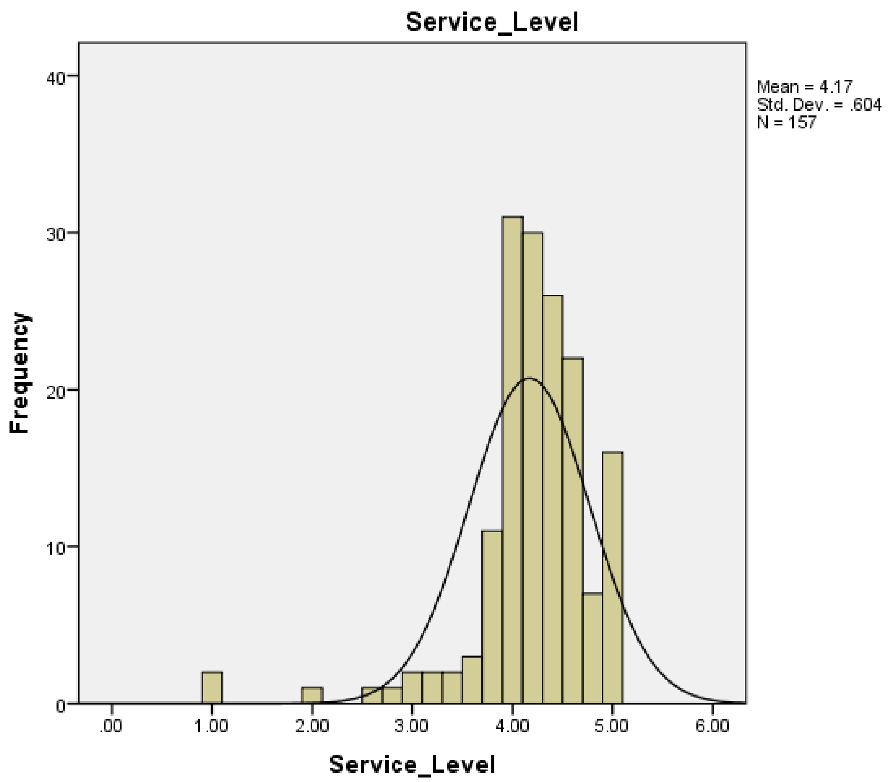
Price_of_Techology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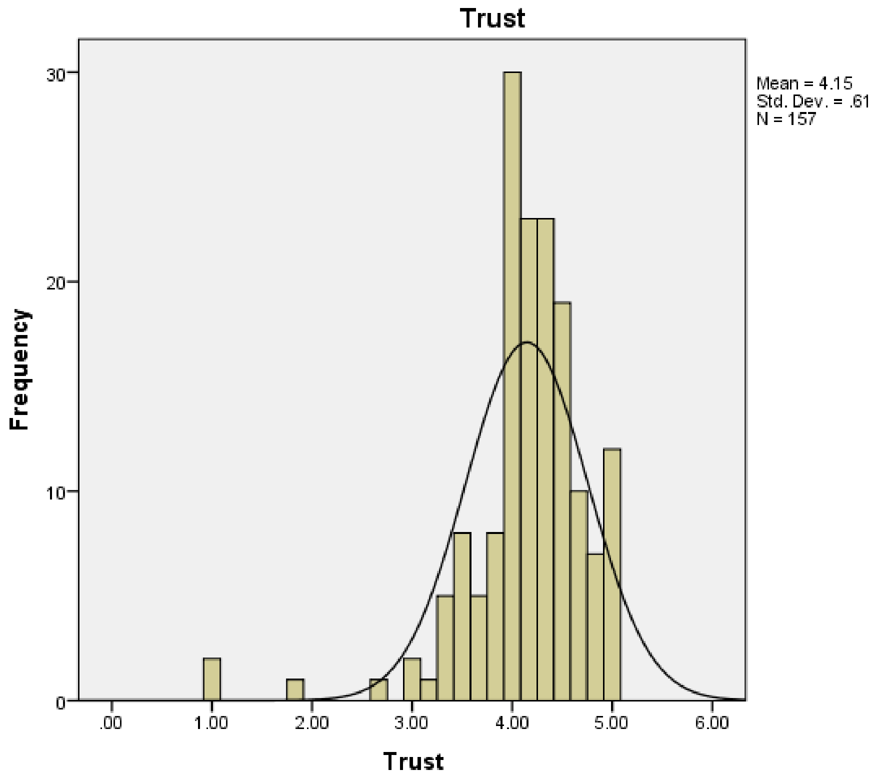
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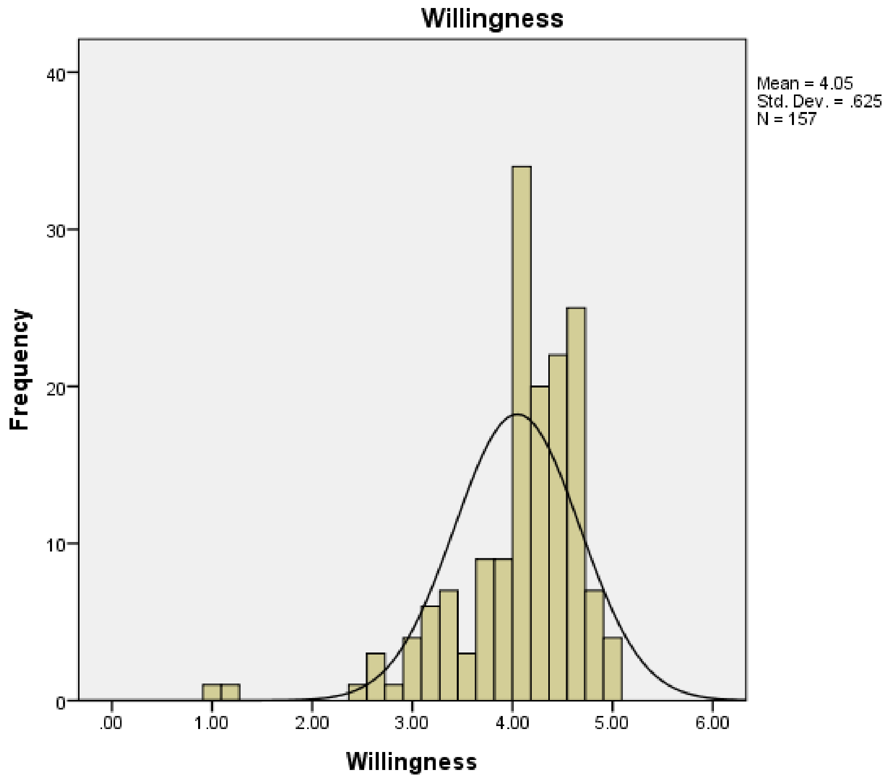
Trust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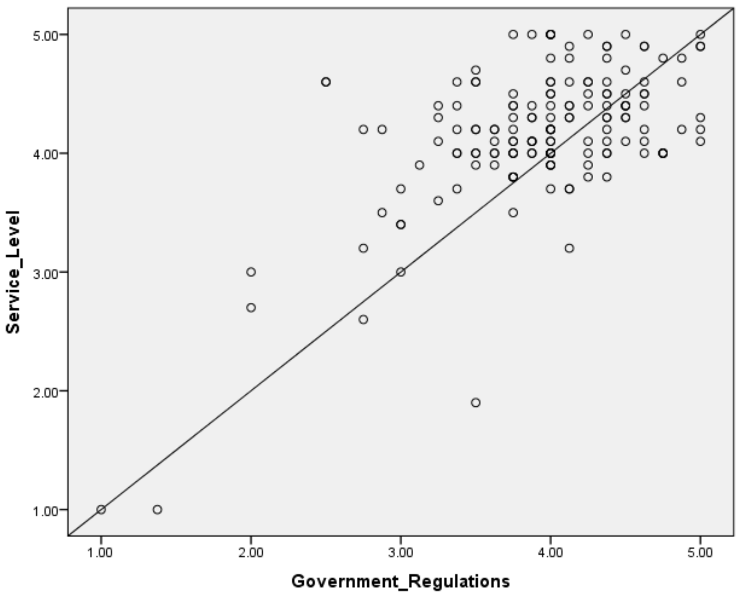
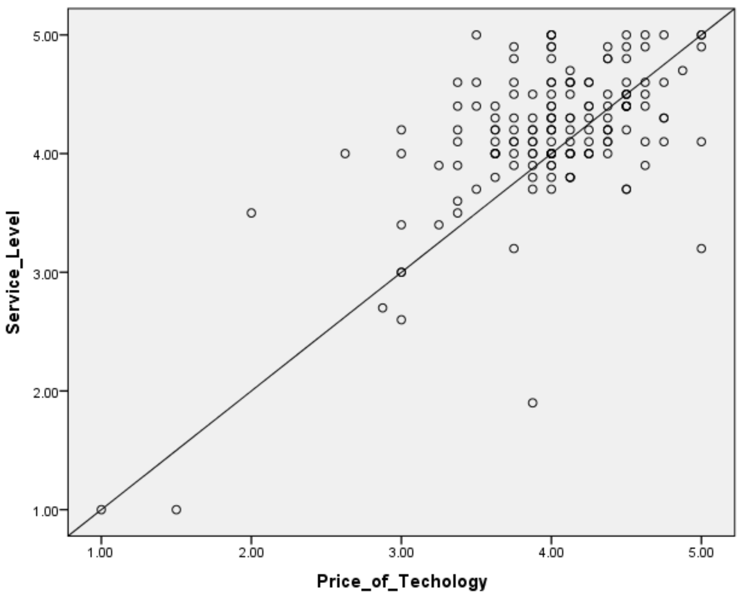
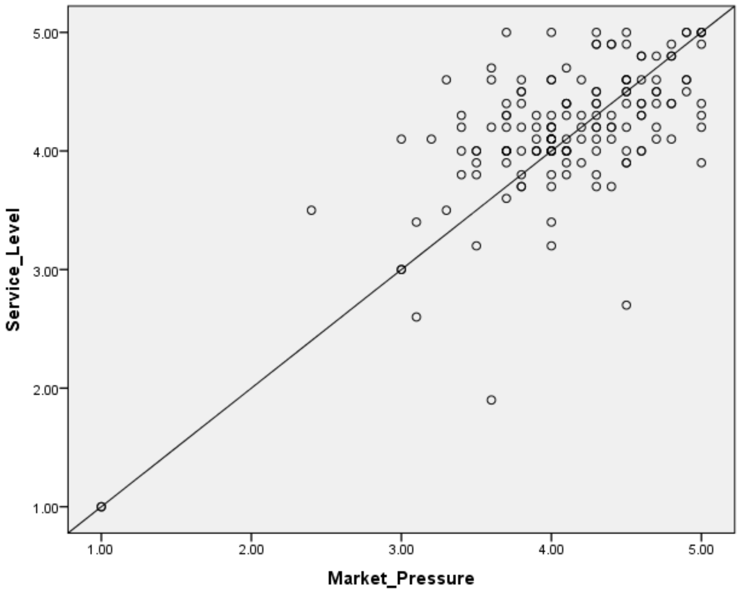
Willingness

APPENDIX C: LINEARITY GRAPHS



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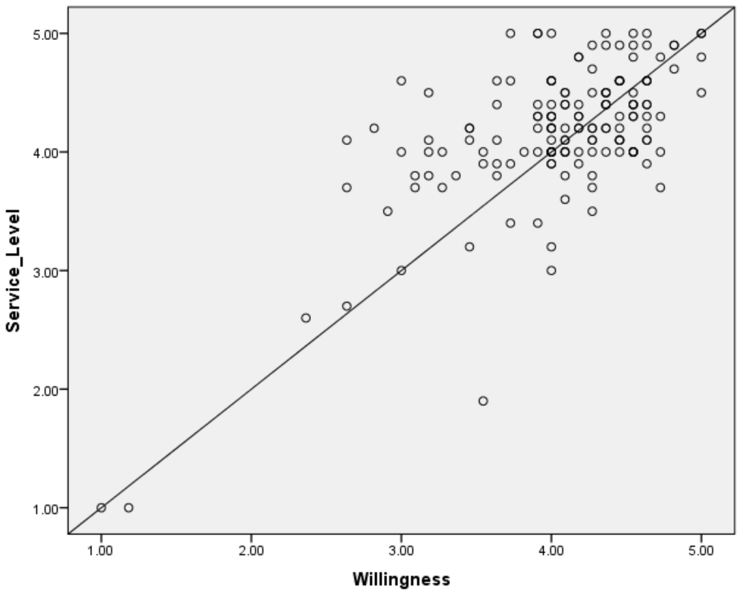
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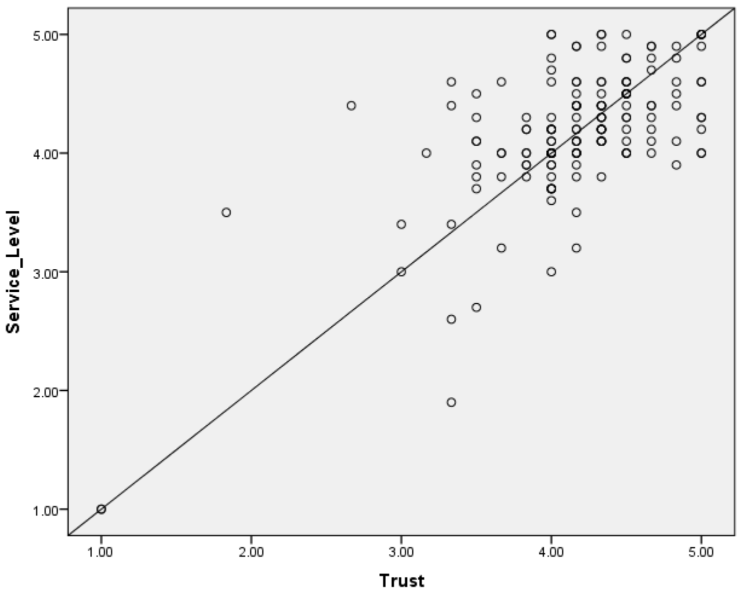
Willingness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PUBLICATION

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