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FACTORS INFLUENCING THE USE INTENTION OF SMART CONTRACTS BETWEEN PHARMACEUTICAL ENTERPRISES AND THEIR RAW MATERIAL SUPPLIERS

A dissertation submitted in partial fulfillment of

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By

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To: Dean William G. Hardin
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This dissertation, written by Alexandre Prati, and entitled Factors Influencing the Use Intention of Smart Contracts Between Pharmaceutical Enterprises and Their Raw Material Suppliers, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this dissertation and recommend that it be approved.

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DEDICATION

This is more than just a doctorate; it is a life journey. The path began in 2014, when I developed an interest in earning a DBA degree. Since then, my lovely wife Raquel and I have surmounted numerous obstacles. The decision to pursue this degree was a family decision that required us to relocate to the United States, changing our entire lives. Ultimately, it was never about me; the whole point was to provide opportunities for our boys to develop and flourish. I dedicate this dissertation to my four sons: Eduardo, Leonardo, Thiago, and Lucas. Never forget where you came from; with dedication, discipline, and effort, you can do great things in life.

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ABSTRACT OF THE DISSERTATION

FACTORS INFLUENCING THE USE INTENTION OF SMART CONTRACTS BETWEEN PHARMACEUTICAL ENTERPRISES AND THEIR RAW MATERIAL SUPPLIERS

by

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Active Pharmaceutical Ingredient (API) traceability is a major challenge for pharmaceutical businesses. Pharmaceutical companies must have stringent control methods in place to verify that API supplied by manufacturers meets product specifications and that producers follow all quality steps during the manufacturing process. Furthermore, it is necessary to guarantee that pharmaceutical suppliers do not mislead crucial data such as expiration dates, impurity levels, composition, etc. I propose that these organizations use smart contracts to improve all the controls and processes along their supply chain.

Smart contracts are digital protocols that are used to execute or enforce contracts automatically according to conditions previously agreed between parties. These contracts are enabled by blockchain technology which ensures the authenticity of the data, reducing transaction costs and increasing transparency in the process. Previous studies have analyzed some of the factors that influence smart contracts adoption or use intention between companies within different industries. However, understanding the use intention of smart contracts between a pharmaceutical company and its suppliers is something relatively novel. Using the Technology-Organization-Environment theory (TOE) as the framework for measuring some of factors that shape the smart contracts use intention, I developed a testable model consisting of three dimensions and eight hypotheses. Initial pilot included 200 respondents and the main study included 136 companies across several countries, such as Brazil, India, China, Italy, Germany, Spain. After collecting the data, several statistical tests were run using the software SmartPLS and SPSS.

The findings revealed that Top Management Support and Business Partner Pressure had a substantial impact on Smart Contract Use Intention (Dependent Variable). Furthermore, two independent factors were marginally supported: Perceived Non-Complexity and Organizational Readiness. This study's findings may benefit pharmaceutical companies, but also organizations from different industries with similar supply chain operations. Finally, this research has the potential to contribute to the literature by not only examining the employment of blockchain smart contracts in the supply chain and testing the potential benefits that this technology brings for the companies, but also by helping to advance the theories related to the application of new technologies in international markets.

Keywords

Smart Contract, Use Intention, Pharmaceutical Suppliers, International Business, Technology Adoption, Blockchain.

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CHAPTER 1 – INTRODUCTION

1.1 Background and Problem Statement

Supply chain management (SCM) is a critical component of performance within the pharmaceutical industry. In fact, “enterprises cannot be competitive without considering supply chain management (SCM) activities” (Singh et al., 2016). SCM is defined as the integration of important business operations across the supply chain with the goal of providing value for consumers and stakeholders (Jaberidoost et al., 2013). According to Moosivand, Ghatari & Rasekh (2019), “supply chain is usually described as a forward flow of materials and a backward flow of information and funds among multiple operating units both within and between chain members”. Supply chain management, in fact, connects supply and demand within and between businesses in an efficient business model (Jaberidoost et al., 2013). In the pharmaceutical industry, normally supply chains consist of the following steps: a) manufacturing of API (raw material); b) manufacturing of pharmaceuticals (final product); c) distributing centers; d) retail pharmacies and hospitals; and e) consumer (patient) (Moosivand et al., 2019) .

The “imperfect”, traditional, historical Supply Chain Management (SCM) architecture and systems have not been able to accurately keep track of materials as it passes from the supply of raw materials to manufacturer to wholesaler, to distributor, to pharmacist, and to customer. Numerous studies have focused on the supply chain from manufacturer to wholesaler, distributor, to pharmacist, to the customer but few, if any, have focused on the management of the supply chain from producer to manufacturer. For example, Mehralian, Zarenezhad & Ghatari (2015) proposed an agile supply chain pharmaceutical model to improve the entire chain. Although the authors considered the upstream part of the process, the model was not developed specifically for the producer - manufacturer relationship. Furthermore, their study was developed considering only one country as a reference (Iran). Liu, Barenji, Li, Montreuil & Huang (2021) proposed an interesting model using blockchain as a platform to track and trace the drug supply chain. However, the model did not consider the pharmaceutical active ingredient producer. Finally, Kumar, Dieveney & Dieveney (2009) proposed a model to mitigate the drug counterfeit within the pharmaceutical industry. The model focused on the reverse logistic process and used technology as the main component. However, similarly the previous two examples, Kumar et al., (2009) also did not include the pharmaceutical active ingredient producer in their model. As such my focus is the "upstream" supply chain, the raw material supplier to manufacturer side of the Supply Chain (SC).

I assert and contend that blockchain technology is not only important and useful in the management of the raw material stage to the manufacturing stage of the business cycle but should be considered crucial in the overall management of the SC as well. I believe that using blockchain technology will greatly improve and increase the supply chain's security, efficiencies, visibility, ensure product quality, increase security, overall management, performance measurements, quality management, corporate governance, data security, smart contracts, transparency, and traceability throughout these stages of the supply chain.

This study centers on managing all factors of the supply chain (mentioned above) from the raw material stage to the manufacturing stage using blockchain technology and to determine what factors contribute to Smart Contract use intention between Pharmaceutical Enterprises and their Raw Material Suppliers and how this technology can improve the SCM by applying and executing the advantages of this “novel broadly useful innovation” (Lingayat et al., 2021) of blockchain.

The main objective of this dissertation therefore is to identify some of the drivers of use intention to adopt Smart Contract. More specifically, I applied the dimensions of the Technology-Organization-Environment theory (TOE) as a framework for measuring some of the factors that shape the use intention of smart contract between Pharmaceutical Enterprises and their raw material suppliers.

1.2 Significance of the Problem

After many years of work experience within the pharmaceutical industry, I can argue that two of the main factors that have made generic pharmaceutical manufacturers successful are the a) quality of its products, and its b) cost-efficiency (low production cost). The nature of the pharmaceutical industry is to provide high-quality products, so the standards imposed by regulatory agencies, such as FDA, are very high to ensure the safety of pharmaceuticals. Any company in this industry must follow strict protocols to meet all quality requirements. This is why pharmaceutical raw material (API) producers are crucial to the industry at large. Both factors, quality, and low cost, are directly related to raw material suppliers – in the case of generic manufacturers, most suppliers are in China and India. To ensure the highest quality and cost-efficiency, a pharmaceutical company must ensure that its suppliers meet the highest quality standards and production capabilities. Therefore, it is fundamental to constantly improve the supply chain system to make it more efficient and reliable.

One ongoing concern among pharmaceutical companies is the *active pharmaceutical ingredient* (API) traceability. Pharmaceutical companies must have robust control processes to ensure that the API manufacturers are producing is as such, and that all quality steps of production are adhered to. Further that suppliers are not falsifying any documents such as expiration data, impurity level, etc. Therefore, I propose that the novel technology of smart contracts might directly improve these control processes and standards by 1) tracing and tracking raw materials (API); 2) reducing the probability of counterfeit; 3) reducing control costs; 4) increasing transparency; 5) increasing trust; and 6) reducing other costs such as transaction costs. I assert that Blockchain technology can and will "improve the supply chain's traceability and security" (Lingayat et al., 2021) and ensure that the supply chain is "a) Immutability, b) Transparency, c) Verification of information, d) Secured by cryptography" (Lingayat et al., 2021). Blockchain technology therefore is ideally suited to provide the solution for tracing the raw materials that go into the manufacture of drugs in the pharma supply chain.

1.3 Practical Research Relevance

Pharmaceutical enterprises must understand if the use intention of smart contracts will be practical. In other words, will the benefits outweigh the costs. Will improve its overall SCM, will it ensure a better process, will improve cost-efficiencies and finally, will the smart contract use intention be feasible. As such the main objective of this study is to determine what are the potential factors that will contribute to the use intention of smart contracts between pharmaceutical enterprises and their raw material suppliers. I undertake that this study's findings may benefit and improve both the pharmaceutical company subject of this study and its suppliers' processes. In addition, the study's findings will be of similar benefit to all analogous businesses and industries that have alike operations.

Smart Contract is part of Blockchain which "is a decentralized technology that enables stakeholders to share a common ledger with all the members of the network and the transactions taking place are recorded on it" (Thakker et al., 2021). According to Thakker et al., (2021), "in the recent years, the blockchain (BC) technology has been used in various applications ranging from financial sector to healthcare sector". Furthermore, applying *smart contract's* technology, a pharmaceutical company might benefit from "supply chain traceability, involvement of third party in the verification process, and reliability of transactions" (Thakker et al., 2021). In addition to these benefits, adopting smart contract technology has the potential to optimize financial transactions which will finally lead to a reduction in labor cost at the account department. There are also some subjective potential benefits such as an increase in trust between companies involved in the process.

The study's findings might also have some managerial implications. Blockchain technology may be particularly effective since clients place a high value on the legitimacy of pharmaceutical products. Moreover, "benefits accruing from blockchain will be comparably greater if transaction costs are relatively large as compared to transaction margins" (Nowiński & Kozma, 2017). It is important to highlight that blockchain will have an impact not just on the organizations who use it, but also on those that must restructure their business because blockchain undermines their offering. (Nowiński & Kozma, 2017). The latter case is demonstrated by “auditing companies for which the market may diminish or at least significantly change once the documentation of the processes alters or virtually becomes redundant” (Nowiński & Kozma, 2017).

Blockchain, smart contracts, and IoT (internet of things) can address the majority of supply chain issues now in place, saving businesses considerable costs, time, and effort (Bhandari, 2018). It can also help businesses reduce their contingent costs by improving product traceability (Bhandari, 2018). Finally, the smart contract guarantees data provenance, eliminates the need for intermediaries, and provides all participants with a secure, immutable transaction history (Konapure & Nawale, 2022).

1.4 Theoretical Research Relevance

Blockchain is a growing technology that has gained importance and admissibility over the past few decades. Yet the literature on this technology is in its infancy, and there is finite empirical research on blockchain, especially employing blockchain technology and smart contracts in the supply chain.

The minor existing studies on blockchain and its employment in the supply chain are focused on local markets and do not cover the employment of blockchain smart contracts in international markets (Dutta et al., 2020). There are several studies regarding blockchain / smart contract adoption published in the past years (Badi et al., 2021; Chang et al., 2019; Kamble et al., 2019; Sinha & Roy Chowdhury, 2021; Ullah & Al-Turjman, 2023). Kamble, Gunasekaran & Arha (2019) studied the adoption of blockchain within the supply chain. The authors collected data from 181 supply chain practitioners in India. More recently, Ullah & Al-Turjman (2023) proposed a blockchain-based smart contract model to be adopted by smart cities (real state). Badi, Ochieng, Nasaj & Papadaki (2021) identified the factors that influence the adoption of smart contract within the construction industry in UK. Unlike Kamble et al., (2019) and Ullah & Al-Turjman (2023) that focused their research on the Business to Consumer (B2C) relationship, my research will focus on the business to business (B2B) intention to adopt smart contract. Furthermore, although Badi et al., (2021) considered the B2B intention to adopt smart contracts, their research focused on the construction industry and considered only one country (UK). My research was performed in the pharmaceutical industry and in the international arena. Finally, I did not find a study that was performed considering the first part of the supply chain of the pharmaceutical industry (API manufacturer – Pharmaceutical manufacturer).

This research has the potential to contributes to the literature by not only examining the employment of blockchain smart contracts in the supply chain and testing the potential benefits that this technology brings for the companies but also by helping to advance the theories related to the application of new technologies in international markets. Therefore, this study aims to contribute to the literature by performing a study about the intention to use of a novel technology (blockchain - smart contract) within an area of the supply chain of the pharmaceutical industry that has been not well explored yet (raw material supplier – manufacturer). This research will apply the dimensions of the Technology – Organization – Environment theory (TOE), and it is expected that some drivers will have significant influence on the intention to adopt smart contracts. Managers might benefit from the findings of this study by creating a more accurate smart contract adoption strategy using the right drivers.

In addition, this study aims to leverage the Technology – Organization – Environment theory (TOE) by exploring some of the dimensions of this model on the research problem which might benefit both academic and business world. Although the TOE theory has been widely used to assess technology adoption among organizations since Tornatzky and Fleischer developed it in 1990, there are few (if any) studies adopting this theory to assess adoption intent of a new supply chain technology in the pharmaceutical industry. I expect this research will contribute to the theory by providing one more practical example of its application in an underexplored field.

1.5 Research Question

What are the factors that contribute to Smart Contract Use Intention between Pharmaceutical Enterprises and their Raw Material Suppliers?

CHAPTER 2 - BACKGROUND LITERATURE REVIEW AND THEORY

2.1 Blockchain and Smart Contracts

Blockchain is “one the most remarkable technological innovations of the 21st century” (Kimani et al., 2020). While most of the focus in recent years has been on the operation of cryptocurrencies, the prospects of blockchain cover numerous business purposes, including finance, corporate governance, international trade, and taxation.

Automating processes and saving time using smart contracts improves corporate efficiency and removes or reduces the need for middlemen, document processing, and contract enforcement, as well as the big budgets that go with them (Torres de Oliveira et al., 2020). Therefore, I believe that there are enormous opportunities for applying such technology in centralized industries. The usage of blockchain reduces risks associated with fraud and data security because data no longer needs to be given to or managed by centralized entities. (Hooper & Holtbrügge, 2020).

The “blockchain can be defined as a conveyed information base, which is shared among and concurred upon by a distributed organization, also known as a peer-to-peer network” (Lingayat et. al., 2021). When a component is captured by the blockchain, it cannot be changed, resulting in a blockchain that is an immutable record of past movements and linkages. This “timestamping” and capturing of each “transaction” “improves overall performance and security” (Lingayat et. al., 2021) and ensures immutability (fixity), transparency, and the verification (authentication) of information.

This is all secured by cryptography (coding) whereby each activity on this network is "appended to the network after verification by the Proof-of-Work consensus or any other custom consensus algorithm, which provides accountability and integrity to the blockchain network" (Lingayat et al., 2021).

Blockchain technology (BT) is well-known for its immutable distributed, decentralized, consensus-based information sharing, which allows for lower transaction costs, time, and fraud. Wust & Gervais (2018) "concluded that blockchain is suitable in a situation where there is a lack of trust between entities or the flow of information from trustless sources". Technology enables us to secure contracts and manage them in an organized manner. Decentralization, persistence, anonymity, and audibility are four features of BT (Zheng et al., 2017), make it appropriate in a global business where stakeholders' credibility may not be certain (Sinha, 2019; Sinha & Roy Chowdhury, 2021).

"Smart contracts are digital protocols used to execute, verify, or enforce contracts automatically when contract conditions are met" (Cong & He, 2019). The "blockchain program enforces the contract" (Hooper & Holtbrügge, 2020) through "contract enforcement that previously had to be triggered manually now becomes" automatic (Hooper & Holtbrügge, 2020) with the blockchain "ensuring the authenticity of data sources" (Shi et al., 2019) and the "blockchain-based smart contracts reduce the principal-agent costs that arise from conflicting interests in contracting" (Murray & Anisi, 2019).

According to an examination of existing research and professional papers, value creation using blockchain technology occurs in a variety of ways. Firstly, it builds value “via building transaction-related trust through authenticating assets which are subjects of the transaction” (Nowiński & Kozma, 2017). Secondly, it builds value “by decreasing costs via eliminating previously necessary intermediaries and operations” (Nowiński & Kozma, 2017). Thirdly, it builds value via “improving operational efficiency” (Nowiński & Kozma, 2017), shortening settlement times, for example, can increase product demand, lower processing costs, and generate savings that can be shared with customers (Capgemini, 2016).

There are several differences between traditional contracts and Smart Contracts. The main difference between them is the necessity of human interaction. Smart contracts do not require the authority of a third party to be verified. This allows the contract's parties to save time and money on a specific transaction. Furthermore, because smart contracts are stored on a blockchain, they are immutable. This prevents unwanted changes to the contract’s terms after they have been inputted to the network (blockchain). Traditional contracts, on the other hand, if they are not properly protected or verified by a competent professional, they can be counterfeited or tampered with. Finally, because smart contracts use digital key signature, it makes the signing process much more reliable because a contract cannot be signed without the other party knowing. Even though many traditional contracts have been using digital signature as well, there are many traditional contracts that still use regular signatures (manual) which increases the risk of fraud. Finally, once the contract conditions are met, the smart contract is automatically executed. The same does not occur with traditional contracts, which require someone to verify that the contract criteria were met before it is executed. The following figure from

Bennett, Miller, Pickering & Kara (2021) illustrates and summarizes the main differences between the contracts:

Figure 1 - Comparison Between Traditional Contracts vs Smart Contracts

Criteria	Conventional Contracts	Smart Contracts
Specification	Natural language and legal prose	Code
Identity and Consent	"wet" signatures	Digital Signatures
Dispute Resolution	Judges, adjudicators, arbitrators	Consensus via blockchain
Nullification	Parties via legal enforcement Process of breached terms	Parties via Agreed Upon Digital Nullification workflow and block consensus
Payment	Independent third-party Process	Automatic, based on executed terms (Built into Contract)
Escrow	Independent third-party Process	Automatic, based on executed terms (Built into Contract), or not even required

Cross-border trade including differing business environments between the sellers' and buyers' nations may result in conflicts due to disproportionateness in the information structure for businesses that order their supplies and raw materials from abroad (Sinha, 2019; Sinha & Roy Chowdhury, 2021). Frequently, "uncertainty looms once the goods cross his/her border" (Sinha, 2019; Sinha & Roy Chowdhury, 2021) as the importer does not completely know what they are receiving until it is received. By using a smart contract, all the issues of security, transparency, legitimacy, and trustworthiness are eliminated.

Lee (2019) predicts that blockchain will significantly alter, if not replace, many current accounting and finance applications, heralding a completely new industrial infrastructure. Pham, Tran & Nakashima (2018) claims that blockchain will result in significant automation of many commercial operations with little or no human interaction. Organizations "could utilize the blockchain technology to reduce operational, transaction and agency costs" (Sinha & Roy Chowdhury, 2021). Blockchain's distinct technical capabilities have the potential to transform organizational and national cultures while also improving transparency and trust in cyberspace (Sinha & Roy Chowdhury, 2021).

Blockchain technologies provide increased supply chain transparency, but more importantly, by nature of the protocol, create an immutable and distributed aspect of the custody record that lends itself well to traceability applications and aids firms in evaluating and mitigating supply chain risks by providing a reliable means to track and trace product origins and processes (Francisco & Swanson, 2018). This is even more important in the pharmaceutical industry where all the public are increasingly concerned about the industry’s production practices. Blockchain's capabilities impact traceability, security verification, secure transactions, and speedy processing via smart contracts (Francisco & Swanson, 2018). Each of these sectors has the potential to offer organizations a competitive advantage. Blockchain technology also allows new entrants to illustrate the benefits of their supply chain. This can be a major edge over competitors who are less agile, larger, and more established (Francisco & Swanson, 2018).

2.2 Industry Relevant Literature - Pharmaceutical

The global pharmaceutical industry can be divided into five sub-sectors in terms of manufacturing: large R&D-based multinationals, generic manufacturers operating in the international market, local companies based in only one country, contract manufacturers without their own portfolio, and biotechnological companies primarily concerned with drug discovery (Sousa et al., 2011). The company object of this study is classified in the second group: generic manufacturers operating in the international market.

Traditional pharmaceutical supply chain management entails raw material suppliers supplying raw material to manufacturers for drug generation, packaging, and distribution (Muzumdar et al., 2019). Furthermore, pharmaceutical supply chains, which are typical of items with a high added value per mass unit, include two manufacturing stages: primary manufacturing for active pharmaceutical ingredient (API) production and secondary manufacturing for formulation and packaging (Sousa et al., 2011). This is unerringly the objective of this study: to improve the transactions between pharmaceutical raw material producers (API) and secondary manufacturing (formulation and packing) which occurs in both national and international scenarios.

“The existing supply chain management processes (in pharmaceutical supply chain management) lack in offering transparency of information, user’s privacy, timely updates on demand peaks, improper tracing of information, quality management, deal repudiation and trust among users” (Muzumdar et al., 2019). In addition, Muzumdar et al., (2019) claim that blockchain can aid in the auditability and tracking of drug manufacturing and supply information in pharmaceutical supply chain management.

After more than 15 years of experience in the pharmaceutical industry (generic manufacturer), I can describe the dynamic that occurs between the pharma manufacturer and the raw material (API) supplier. First, these are some of the characteristics of a “good supplier”: a) follows all the quality requirements according to the regulatory agency (such as FDA); b) high production capacity; c) exportation expertise; d) reliable in terms of deadline (supply chain). Another important information is that most of the pharmaceutical raw material suppliers are in China and India. Therefore, to find a good supplier, a generic manufacturer must visit these companies in person in order to validate all the conditions described above. However, the problem is: after the commercial relationship is established, how can the generic manufacturer guarantee that fraud will not occur? For example, the supplier could outsource the production and falsify the documents (records). That is why smart contracts have the potential to be a powerful tool in this industry. In this case, after reaching a commercial agreement, these conditions will be imputed in an immutable contract using blockchain. Another possibility will be to add check points during the process. For example, several checkpoints could be added during the whole process (beginning of API production to delivery of goods). More specifically, a regular smart phone could read a QR Code during raw material production which would make the process much more transparent and reliable. In this case, the generic manufacturer could follow in real time the raw material production, including the geographic location.

As the World Health Organization (WHO) has estimated “that up to 10% of global pharmaceuticals are counterfeit, with rates as high as 50% in some countries” (Mattke et al., 2019; Nounou et al., 2018) there is a timely need to improve this supply chain dilemma. Especially as “each year, the inactive or harmful ingredients in counterfeit pharmaceuticals cause one million deaths globally and result in revenue losses of more than $200 billion for the pharmaceuticals industry” (Mattke et al., 2019) and that one result of such constraints within existing supply chains is counterfeit medications, which not only have a profound negative impact on human health but also cause significant economic loss to the healthcare business. (Musamih et al., 2021).

In order to combat the threat of counterfeit drugs, regulatory authorities (such as the FDA) have mandated the implementation of trace and track systems into the pharmaceutical supply chain (Archa et al., 2018) – there is no better tool to do so than “smart contracts”. Therein, “an end-to-end product tracking system across the pharmaceutical supply chain is paramount to ensuring product safety and eliminating counterfeits” (Musamih et al., 2021). After learning about the issues confronting the pharmaceutical business, regulatory agencies, the government, and, most importantly, the general population, it became clear that the key to combating counterfeiters and such products was a need to increase information exchange (K. et al., 2018). Consequently, according to Musamih et al., (2021), “monitoring, effective control and tracking of products in healthcare supply chain is fundamental to combating counterfeits”.

Smart contracts can be a powerful tool combating counterfeit drugs and helping pharmaceutical industry to improve and implement trace and track systems into its supply chain. “Each of the unit processes (manufacturing, registration, distribution etc.) fraudulent occurrences can lead to the development of substandard or counterfeit drugs” (Archa et al., 2018). As such, the main objective of this study is to focus on understanding how a pharmaceutical company can use smart contract technology across its national and international raw material suppliers. Therefore, this research will focus on solving only a piece of the supply chain, but the findings can be potentially expanded to the entire process (of manufacturing, registration, distribution etc.). In addition, pharmaceutical “companies can achieve significantly overhead cost reductions related administrating procure-to-pay activities by adopting blockchain for developing smart contracts” (Jochumsen, 2021).

2.3 The Technology, Organization, and Environment Theory (TOE)

As briefly mentioned in the introduction section, this study will adopt the *Technology, Organization, and Environment Theory (TOE)* as a framework for measuring the use intention of smart contracts between a pharmaceutical company and its raw material suppliers. TOE Framework was developed by Tornatzky & Fleischer (1990), and it "has been used to study the adoption of various types of IT innovations, especially at the organizational level" (Choi et al., 2020). The TOE framework has been frequently used to explain how multiple variables influence an organization's adoption or use intention of a new technology. Chittipaka, Kumar, Sivarajah, Bowden and Baral (2022) used the TOE theory dimensions to examined the factors influencing the blockchain technology adoption in supply chain. Aboelmaged and Hashem (2018), adopted this framework in order to understand how radio frequency identification (RFID) systems can improve health care services. Badi et al., (2021) applied the TOE framework to identify the drivers that influence the smart contracts adoption within the construction industry in UK.

It is also stated that the TOE theoretical framework provides superior quality insights based on firms' outer and interior dynamics. (Tornatzky et al., 1990). Another important aspect to highlight related to this framework is that it is a theory at the *organizational level* that recognizes the critical technical, organizational, and environmental impacts on organizational decisions (Thaha et al., 2022). Moreover, the decision to adopt the TOE framework in this research is because it has been chosen as the model that provides a more comprehensive assessment of the elements influencing adoption (Chittipaka et al., 2022) within organizations.

The TOE theory "identifies three aspects of an organization's context that influence the process of adopting and implementing a technological innovation, namely, *technological context, organizational context* and *external environmental context*" (Oliveira & Martins, 2010). Whitin each dimension, several factors can be applied to evaluate the drivers that influence the adoption of a new technology in any organization. Furthermore, because this framework covers a large amount of organizational operations, concentrating on the three pillars would aid in defining the types of obstacles and making it easier to treat them accordingly (Choi et al., 2020).

The first dimension of the TOE theory is *technological context*. The "technological context refers to the internal and external technologies that are applicable to the organization" (Gutierrez et al., 2015). Examples of drivers within this dimension can be: perceived usefulness, compatibility, complexity, and usage (Chittipaka et al., 2022). It is important to highlight that this dimension includes both market-available technology and technologies being used within the organization (Badi et al., 2021). The second dimension of the TOE theory is named *organizational context.* Oliveira & Martins (2010) argue that "organizational context refers to descriptive measures about the organization such as scope, size, and managerial structure". In addition, this context refers to organizations' internal characteristics including intangible and tangible resources (Chittipaka et al., 2022). These characteristics are crucial to determine if an organization is ready to adopt a new technology. *Environmental context* is the third and last dimension of the TOE framework. "Environmental context is the arena in which a firm conducts its business - its industry, competitors, and dealings with the government" (Oliveira & Martins, 2010). Environmental context contemplates relevant factors that have a significant impact on the adoption of new technologies (Chittipaka et al., 2022). For example, the number of organizations utilizing new technology in a specific sector was discovered to have a significant impact on innovation diffusion, as firms struggle to be the pioneers of the latest breakthroughs in order to secure their competitive edge (Badi et al., 2021).

The TOE framework provides the three dimensions described above, but it does not provide specific constructs. Therefore, adopting Badi et al., (2021) as reference, I developed a research model consisting of three dimensions and eight hypotheses.

CHAPTER 3 - RESEARCH DESIGN

3.1 Conceptual Framework

Even though the TOE framework does not offer specific constructs (Gutierrez et al., 2015), it has been used to evaluate the technology use or adoption between organizations. The presented research model was developed using as reference Badi et al., (2021) "Technological, organisational and environmental determinants of smart contracts adoption: UK construction sector viewpoint". It is possible to observe that the research model contemplates the three dimensions incorporated by the TOE theory: *technology*, *organizational, and environmental*. The dependent variable of my research model is named *Smart Contract Use Intention.* It is important to highlight that my focus is to measure the intention of using the smart contract technology and not the actual adoption of it. Moreover, a total of eight hypotheses are proposed, and they were classified according to the three different dimensions. Under *technology characteristics* there are four independent variables: perceived relative advantage, perceived compatibility, perceived non-complexity, and perceived trial-ability. In addition, there are two independent variables under the second dimension, the *organizational characteristics*: top management support, and organizational readiness. Finally, there are two independent variables under *environmental characteristics*: competitive pressure, and business partner pressure. The proposed model has only one, but very important, control variable: company size. I acknowledge that company size might have an important influence on the decision about the use intention of a new technology, so holding this variable constant is crucial to avoid distorted results. Construct and hypotheses justification will be further discussed in the next two sections. The conceptual research model can be observed in the following figure:

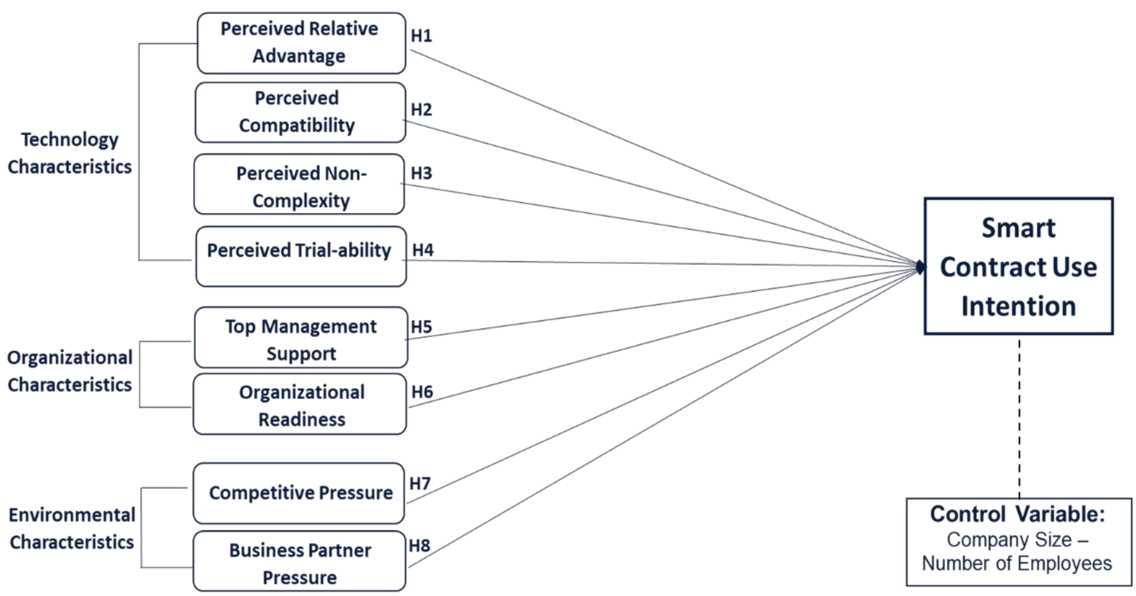


Figure 2 The Conceptual Research Model

3.2 Construct Definition

In Table 1, it is possible to observe that I applied the three TOE's dimensions (technology, organizational, and environmental). All the eight constructs are presented and defined as following:

Table 1 - Construct Definition

Construct Definition

Dimension	**Construct**	**Definition**	**Reference**
Technology Characteristics	**Perceived Relative Advantage**	It is "the degree to which a technological factor is perceived to provide a greater benefit for organisations" (Gutierrez et al., 2015). Another definition is "the degree to which an innovation is perceived as being better than the idea it supersedes". (Rogers, 2014)	Gutierrez et al., (2015), Rogers, (2014)
	Perceived Compatibility	"Compatibility is the degree to which an innovation is perceived to be consistent with the organisation values and needs which is also influenced by past experiences" (Gutierrez et al., 2015) In addition, "the degree to which an innovation is perceived as relatively difficult to understand and use" (Rogers, 2014)	Gutierrez et al., (2015) Rogers, (2014)
	Perceived Non-Complexity	Complexity refers to "the perceived difficulty of learning to use and understand a new system or technology" (Sonnenwald et al., 2001). In addition, perceived non-complexity refers to the degree of difficulty to understand a new	S.S. Kamble (2021), Sonnenwald et al., (2001)

		technology from both business and technical perspectives.	
	Perceived Trial-ability	It refers to "the degree to which an innovation may be experimented with on a limited basis" (Rogers, 2014). It is when individuals or organizations have the "opportunity to trial an innovation before its actually adoption" (Badi et al., 2021)	Badi et al., (2021) Rogers, (2014)
Organizational Characteristics	**Top Management Support**	"Top management support is seen to reduce the salience of the forces working against the change and help overcome internal resistance". "The support of top management can also influence the adoption process by stimulating change through communicating and reinforcing the values and vision of the firm" (Ramdani et al. 2013)	Badi et al., (2021), Ramdani et al. (2013)
	Organizational Readiness	According to Ramdani et al. (2013) organizational readiness is "the availability of the needed organisational resources for adoption". "The concept of readiness is concerned with the availability of the necessary skills, IT systems, and resources required to adopt the new technology" (Ramdani et al. 2013).	Badi et al., (2021), Ramdani et al. (2013)
Environment Characteristics	**Competitive Pressure**	"It refers to the pressure felt by the firm from industry competitors" (Oliveira & Martins, 2010). In addition, (Gutierrez et al., 2015) explain that "competitive pressure relates to the intensity and pressure levels experienced by organisations from their "same industry" competitors"	Oliveira & Martins, (2010), Gutierrez et al., (2015)

	Business Partner Pressure	“Business partners’ pressure (BPP) refers to the pressure faced by firms from its business partners” (Alharbi et al., 2016). “According to Sila (2013), the pressure from partners can be in the form of force, threats, persuasion, or invitations”. "Many studies have highlighted the important role of partners in the successful implementation of technological advances" (Badi et al., 2021).	Alharbi et al., (2016) Sila (2013), Badi et at. (2021)

3.3 Theoretical Development and Hypotheses

As described in section 3.1, the research hypotheses were developed according to the three dimensions of the TOE theory*: a) technological context; b) organizational context; and c) environmental context.* The total of eight hypotheses were classified according to each specific context and, after an extent literature review, the definitions can be observed in the next three sections.

3.3.1 Technological Context

The technology context of the TOE theory is the first dimension of this study and “refers to the technological characteristics available in the organization for the adoption of technology. It includes both the structural aspects and the specialized human resources” (Oliveira & Martins, 2010). It is expected that the level of difficulty understanding a new technology will negatively affect the likelihood of using it (Choi et al., 2020). One of the important factors that influence the use intention of a technology is when a company observes the relative advantage of adopting it (Gutierrez et al., 2015).

The first independent variable under the technological context is *relative advantage.* According to Gutierrez et al., (2015), “relative advantage is the degree to which a technological factor is perceived to provide a greater benefit for organizations”. The degree to which an innovation is perceived to be superior to the idea it replaces is referred to as relative advantage (Oliveira & Martins, 2010). When companies perceive an innovation's relative advantage comparing with a practice already in place, the likelihood of adoption it increases (Gutierrez et al., 2015).

As mentioned in the introduction section, it is expected that the novel technology of smart contracts might directly improve some processes by 1) tracing and tracking raw materials (API); 2) reducing the probability of counterfeit; 3) reducing control costs; 4) increasing transparency; 5) increasing trust; and 6) reducing other costs such as transaction costs. A traditional contract only contemplates the terms of the transaction, but smart contracts have the potential to go far beyond. It could, for example, set up checkpoints during the manufacturing process so that raw material production could be tracked, reducing the probability of counterfeit, and increasing trust. Or it could be automatically processed, including automated payments if the conditions established were met. This process would reduce transaction costs and provide another significant advantage over traditional contracts. Because all rights are safeguarded by the incorporated automated payment methods, smart contracts may offer a sense of security and trust among project participants (Badi et al., 2021). If the benefits of the technology (in this example, smart contracts) outweigh the disadvantages of traditional methods and processes (in this case traditional contracts), it will influence its adoption (Oliveira & Martins, 2010). Respondents who perceive smart contracts to provide an advantage over existing practices and processes are more likely to show a higher intention to adopt it than those respondents who do not see the same benefits arising from the technology. Thus,

H1: Perceived Relative Advantage (PRA) will have a positive effect on a firm's Smart Contract Use Intention (UI).

The second independent variable in the technological context is *compatibility*. According to Oliveira & Martins (2010) "compatibility is the degree to which the innovation fits with the potential adopter's existing values, previous practices, and current needs." Gutierrez et al., (2015) defines compatibility as "the degree to which an innovation is perceived to be consistent with the organisation values and needs which is also influenced by past experiences". Finally, Choi et al., (2020) argue that compatibility is "the degree to which a technology corresponds with an organization's legacy system, practices, information technology infrastructure, and other networks with which it is expected to work".

Compatibility is considered by many authors a relevant factor for new technology use and adoption where firms are more inclinable to adopt smart contracts if the technology is recognized as being compatible with existing systems already in place (Oliveira & Martins, 2010, Gutierrez et al., 2015). Although smart contracts do not require complex and expensive adjustments, I am aware that many companies may be reluctant to implement them for different reasons. For example, companies are often averse to changing successful processes (in this case traditional contracts). Another reason is that adopting smart contracts would make the entire process much more transparent, which many firms would be unwilling to accept because it would expose their weaknesses.

Because adopting a new technology normally brings potential changes to company's routines and practices, this decision process frequently encounters resistance within the organization. Therefore, it is crucial that the new changes be "compatible with the current company's infrastructure" (Badi et al., 2021). "It is easier for an organization to apply a technology if it has a high compatibility level" (Choi et al., 2020). Furthermore, smart contracts must be compatible with the organization's existing contract management systems as well as its contract management requirements. Compatibility with the existing values and beliefs of the organization is also necessary (Badi et al., 2021). Respondents who perceive smart contracts to be compatible with existing technologies and processes are more likely to show a higher intention to adopt it than those respondents who do not see the same benefits arising from the technology. Therefore,

H2: Perceived Compatibility (PC) will positively influence the Smart Contract Use Intention (UI).

The third independent variable in the technological context is *perceived non-complexity.* Use and adoption of a new technology is less likely to happen when it adds complexity to the current process. It is crucial to the decision process of adopting new technology that will add value to the organization. Therefore, the use intention of smart contracts might encounter resistance if it is perceived more complex and challenging to use than the systems already in place (Gutierrez et al., 2015).

According to Choi et al., (2020), “the more complex a technology is, the less likely it is to be quickly implemented. When a technology is difficult to apply, its adoption is frequently either abandoned or postponed”. In addition, Gutierrez et al., (2015) argue that “that new technologies need to be easy to use and manageable in order to increase the adoption rate”. Smart contract is a novel technology, so few professionals have experience using it. Furthermore, the process object of this study (pharmaceutical manufacturer – API producer), has been using traditional contracts for many years adding more resistance for change. Another key issue in terms of complexity is that this research considers international relationships, which makes it much more challenging due to cultural differences.

Currently, the raw material purchase within the pharmaceutical industry follows a standard process: 1) Company A negotiates an API order with Company B; 2) Company A send a purchase order (PO) to Company B; 3) Company B produces the order; 4) Company B ships the order to Company A; 5) Company A receives and analyses it; and finally, 6) Company A pays it to Company B. It is possible to observe that this process involves different departments (supply chain, production, quality control, finance, etc.). As a result, adopting smart contracts would require a change in all those departments, adding even more complexity to the change.

In terms of technological complexity, smart contracts require a low level of investment and difficulty. Companies can use and rely on the smart contract technology without being concerned with intricate technical details (Badi et al., 2021). Moreover, smart contract users do not need to comprehend the coding structure or the algorithms underlying the system (Badi et al., 2021). Therefore, in my point of view, the complexity of adopting smart contracts is based more on a process change involving multiple departments than on technological complexity. As a result, respondents who perceive smart contract to be non-complex to use are more likely to show a higher intention to use it than those respondents who perceive high complexity in using such technology. Therefore,

H3: Perceived Non-Complexity (PNC) will have a positive impact on the Smart Contract Use Intention (UI)

The fourth and last independent variable in the technological context is *perceived trial-ability*. Every time an organization has the possibility to test or trial a new technology before making the decision, the likelihood of positive decision towards adopting it increases (Mason & Escott, 2018). I have experienced that several companies have a common practice called “pilot test”: a) small pilot test; b) evaluate results; c) invest heavily in the full-size operation. The same concepts can be applied to the decision about use adoption of smart contract.

According to Badi et al., (2021), trialability “is defined as the degree to which an innovation may be experimented with on a limited basis”. In addition, when individuals or organizations have the opportunity to test a new technology prior to its official adoption, the probability of successful adoption rises (Badi et al., 2021). Finally, Mason & Escott (2018) highlighted “the need for a trial period of testing before the actual implementation of smart contracts”. Because smart contracts are a novel technology, there are few opportunities for benchmarking which adds more resistance in the intention to use it. In terms of trialability, I feel that implementing smart contracts with two or three long-term business partners would be a viable strategy. In this instance, these companies rely on one another, which makes the process go much more smoothly. It will be much easier to persuade other suppliers to adopt the new technology after this test and successful trial. Another possibility would be implementing smart contracts in one purchase order (PO) and keeping other purchase orders (PO) with traditional contracts. The implementation of smart contract could increase gradually according to its success. Using this approach, companies could compare the results of both processes (Traditional vs Smart Contracts).

Respondents who perceive smart contract to be tested/trialed before a full implementation are more likely to show a higher intention to adopt it than those respondents who do not perceive the possibility of testing the new technology before implementing it. Thus,

H4: Perceived Trial-Ability (PTA) will have a positive effect on a firm's Smart Contract Use Intention (UI).

3.3.2 Organizational Context

Organizational context refers to all the elements within a company necessary to make the decision about the use or adoption of a new technology. These elements and the organization culture can function both as a facilitator or a constrain about innovation adoption. According to Oliveira & Martins (2010), "the organization context is defined in terms of the resources available to support the adoption of an innovation; it refers to the characteristics of the firm that facilitate or constrain the adoption and implementation of the innovation”. In addition, different factors, such as the level of centralization, the distribution of power, resources availability, information sharing, communication, firm size, and top management support, influence the adoption intention of an innovation (Oliveira & Martins, 2010). Finally, Gutierrez et al., (2015) argue that organizational context refers to a variety of factors relating to the organization itself, such as firm size, scope, trust, centralization, technology readiness, formalization, quality of human resources, *organizational readiness*, innovativeness, and the level of *top management support.*

As described in section 3.1, there are two independent variables within the organizational characteristics dimension. The first independent variable is *top management support.* When a new type of technology is introduced into an industry, managers have a critical role in determining whether or not it will be adopted (Choi et al., 2020). Top management support is among the most important factors when an organization is assessing the use intention of smart contracts (Oliveira & Martins, 2010).

Top management support is crucial in fostering a positive attitude toward innovation adoption and in providing the necessary resources and monitoring assistance (Badi et al., 2021). In addition, this support assists organizations in overcoming internal barriers and opposition to change (Gutierrez et al., 2015). Top management support is critical for smart contract use intention because it guides resource allocation, service integration, and process re-engineering (Oliveira & Martins, 2010). Top management that sees the benefits of smart contracts would most likely allocate the resources required for their adoption and persuade the organization's members to execute the change. When top management fails to grasp the benefits of smart contracts to the firm, they will be opposed to their implementation. (Oliveira & Martins, 2010).

Another important aspect is the managers' level of familiarity with the technology is correlated with their response. Decision makers tend to exercise caution when encountering uncertainty. Blockchain is not only simply a novel technology, but it is also a complex network technology (Choi et al., 2020). Therefore, "top management support is seen to reduce the salience of the forces working against the change and help overcome internal resistance" (Badi et al., 2021). Finally, top management assistance may be required to assure resource commitment and organizational climate cultivation (Ilin et al., 2017). A firm's top management should be aware of the benefits that smart contracts may bring to the firm's future success and should influence employees to raise their understanding of the benefits that smart contracts can bring to the firm's future success (Ilin et al., 2017). Respondents who perceive that the top management will support the adoption of smart contracts are more likely to show a higher intention to use it than those respondents who do not perceive to have support from the top management. Therefore,

H5: Top Management Support (TMS) will positively influence the Smart Contract Use Intention (UI).

The second independent variable in the organization context is *organization readiness*. According to Badi et al., (2021) it is defined "as the availability of the needed organizational resources for adoption". More specifically, the main idea of this variable is to measure if the organization has both IT infrastructure and IT personnel skills available to adopt the smart contract technology. "When an organization has both the needed infrastructure and IT skills, new technologies can be more effectively integrated and adopted" (Badi et al., 2021). In addition, a "high level of organizational readiness positively influences the perceived use of technology" (S. S. Kamble et al., 2021).

Organization readiness is a complex factor to be analyzed because there are different dimensions that can influence the perception of readiness. From an institutional standpoint, cultural resistance by industry needs to be overcome; knowledge and understanding of the potential use and implications of blockchain must be developed among businesses, customers, and government; and how technology might be incorporated into current processes. The changing role of intermediaries and the threat of disruption; the obligation to embed smart contracts in existing software; and the impact on business processes are all market variables (Bennett et al., 2021). Therefore, I decided to narrow it down and focused on both IT infrastructure and IT personnel skill as Badi et al., (2021) suggested.

Respondents who perceive that their organizations have the required resources to adopt the smart contract are more likely to show a higher intention to use it than those respondents who do not perceive to have the needed resources. Thus,

H6: Organization Readiness (OR) will have a positive impact on the Smart Contract Use Intention (UI).

3.3.3 Environmental Context

The environmental context aims to measure broader or macro variables that could influence the decision about adoption of a new technology. According to Oliveira &

Martins (2010), “the environment context is the setting in which a firm conducts its business and is influenced by the nature of the industry, the firm’s competitors, access to resources supplied by others, and interactions with the government”. The environmental context encompasses the macroenvironment in which an organization operates, including industry market components and the presence of technological service providers (Gutierrez et al., 2015). Finally, the number of organizations utilizing new technology in a specific sector was discovered to have a significant impact on innovation diffusion, as firms seek to be the pioneers of the latest breakthroughs in order to achieve a competitive edge (Badi et al., 2021). Within this construct, two variables will be measured: a) competitive pressure; and b) business partner pressure.

The first independent variable in this dimension is *competitive pressure*. Competitive pressure has long been regarded as an essential driver of technological dissemination in the literature on innovation diffusion. It relates to the firm's perception of pressure from industry competitors (Oliveira & Martins, 2010). In addition, competitive pressure refers to the degree and level of pressure felt by organizations from their "same industry" competitors, emphasizing its significance as a significant incentive and adoption motivator (Gutierrez et al., 2015). According to Badi et al., (2021), “competitive pressure as one of the most important drivers of ebusiness adoption”. Low et al., (2011) suggested that prior exposure to strong competition is a significant driver of IT adoption.

Companies are constantly trying to differentiate themselves from competitors to create a competitive advantage. Oliveira & Martins (2010) argue that “adopting new technology is often a strategic necessity to compete in the market place”. Modern technologies provide leverage to supply chains to achieve a competitive advantage over competitors (S. S. Kamble et al., 2021). Supply chains can use blockchain technology to develop numerous sharing applications such as peer-to-peer automatic payment methods, foreign exchange platforms, digital rights management, etc (Huckle et al., 2016).

Because the pharmaceutical industry is normally not technological driven (in terms of software), I expect that competitive pressure will not have a significant influence on the use intention of smart contracts. However, the object of this study is a pharmaceutical company that produce generic drugs (commodities), so every opportunity to be more efficient needs to be taken in consideration while competing in this arena. "It is assumed that the organizations adopting blockchain technology will gain competitive advantages over their competitors" (S. S. Kamble et al., 2021). Respondents who perceive a highly competitive pressure to adopt the smart contract are more likely to show a higher intention to adopt it than those respondents who do not perceive such pressure. Thus,

H7: Competitive Pressure (CP) will positively influence the Smart Contract Use Intention (UI).

The second and last independent variable in the environmental dimension is *business partner pressure (BPP).* It refers to the pressure that a company may suffer from its business partners regarding the adoption of a new technology. In the context of this study, the objective of this variable is to measure how important the BBP is when a pharmaceutical company and its suppliers are evaluating the use intention of smart contracts.

According to Badi et al., (2021), business partner pressure (BPP) is identified as a factor that influences the decision of adoption. BPP has been a critical factor in Blockchain / smart contract intention to use (Chittipaka et al., 2022). An organization may feel compelled to adopt new technology if its business partners advocate or demand it, or if it believes the competition will gain a significant competitive advantage. (Ilin et al., 2017). Several studies have shown that business partners play a crucial role in the successful adoption and use of technical or IT developments (Badi et al., 2021; Pan & Jang, 2008; Yee-Loong Chong & Ooi, 2008).

Business Partner Pressure (BPP) in this study is related to the bargaining power that the pharmaceutical company has over suppliers. The “power structure between business partners is highly correlated with the degree of interdependence and its key balance which is determined by who has the control of key resources” (Shang et al., 2005). If an organization's sales are dependent on its customers or suppliers and there are few substitutes available, it has less bargaining power (Yee-Loong Chong & Ooi, 2008). Therefore, “pressure from these partners will push an organization to adopt an innovation in order to maintain their working relationship” (Senyo et al., 2016).

The willingness and cooperation of the partners to be a part of the blockchain effort is a vital component of implementation and is not achievable with defective connections between them (S. S. Kamble et al., 2021). Respondents who perceive a high business partner pressure to adopt the smart contract are more likely to show a higher intention to use it than those respondents who do not perceive such pressure. Therefore,

H8: Business Partner Pressure (BPP) will positively impact the Smart Contract Use Intention (UI).

3.4 Research Design Summary

In chapter 3, I presented the research model and the research hypotheses. The model was developed according to the TOE theory and using Badi et al., (2021) as the main reference. Three different dimensions from the TOE theory were considered: technological, organizational, and environmental. In addition, eight independent variables were presented and defined according to each dimension. The independent variable is "smart contract use intention". Finally, "company size – number of employees" was defined as a control variable. The research hypotheses are summarized in the following table:

Table 2 - Research Hypotheses

RESEARCH HYPOTHESES
H1: Perceived Relative Advantage (PRA) will have a positive effect on a firm's Smart Contract Use Intention (UI).
H2: Perceived Compatibility (PC) will positively influence the Smart Contract Use Intention (UI).
H3: Perceived Non-Complexity (PNC) will have a positive impact on the Smart Contract Use Intention (UI)
H4: Perceived Trial-Ability (PTA) will have a positive effect on a firm's Smart Contract Use Intention (UI).
H5: Top Management Support (TMS) will positively influence the Smart Contract Use Intention (UI).

H6: Organizational Readiness (OR) will have a positive impact on the Smart Contract Use Intention (UI)
H7: Competitive Pressure (CP) will positively influence the Smart Contract Use Intention (UI)
H8: Business Partner Pressure (BPP) will positively impact the Smart Contract Use Intention (UI)

CHAPTER 4 - RESEARCH METHODOLOGY

4.1 Introduction to Research Methodology

This study will use a quantitative research survey design. More specifically, it will be a quantitative, internet-based survey that will examine the use intentions of blockchain-enabled smart contracts. In order to evaluate the research model and the hypotheses proposed in section 3, the complete study will be divided into two main phases: Pilot Study and Main Study.

To determine and establish face validity, content validity, construct validity, reliability, instrument validity, internal validity, and ultimately statistical conclusion validity this research will follow the processes as described and demonstrated in Straub (1989). Those phases are Phase 1: Pretest, Phase 2: Technical Validation, Phase 3: Pilot Test, Phase 4: Full-Scale Survey (D. W. Straub, 1989). On Phase 1, I will run an *Informed Pilot* where a total of six people will participate in a qualitative analysis. The main idea of phase 1 is to assess the instrument in order to verify if the questionnaire is clear, easy to understand and unambiguous. In this phase I will also evaluate the survey operation: review writing issues, Qualtrics features such as “force response”, time required to participate, etc. Further details regarding phase 1 are described in section 4.6. Phases 2 and 3 will be embedded in the same moment which I named *Pilot Study*. In this phase, a total of 200 participants will answer the survey where the main objective is to verify construct validity and reliability. In addition, several statistical tests will be run, such as Cronbach Alpha and Factor Analysis. Finally, the last phase of this study I named as *Main Study* where the full-size sample will be contacted, and the survey will be answered in full scale. At this point, the instrument should not have validity or reliability issues. Moreover, all the statistical tests and analysis should work accordingly. More details about these phases will be given in the next sections of this chapter.

It is crucial that all these phases are respected and followed to have a validated instrument (D. W. Straub, 1989). As it relates to research design, “if measures do not have a high degree of content validity they cannot have a high degree of construct validity even if they meet empirical standards” (Peter, 1981). Additionally, Peter concludes “that, considerably more attention should be given to the conceptual aspects of construct validity and theory development before rigorous construct validation studies are performed” (Peter, 1981).

4.2 Unit of Analysis and Observation

There are different types of unit of analysis in social science research, such as groups, individual, organization, countries (Babbie, 2021). Since the objective of this research is to understand what are the factors that contribute to smart contract use intention between a pharmaceutical company, and its pharmaceutical raw material suppliers, the main unit of analysis are *organizations.* For this research, organizations are both the unit of analysis and unit of observation.

4.3 Population of Interest and Sample Size

A population for a study is that group about whom we want to draw conclusions (Babbie, 2021). The population of interest for this study are a family-owned pharmaceutical company and a sample of its raw material suppliers, specifically companies from India, China, Europe, and Brazil. Sampling is a crucial step in this process because poorly representation might lead to equivocally conclusions (Agresti, 2018). Therefore, it is important to be insightful in the sample selection process to collect robust and trustful data.

This research will have access to a total of 240 *direct suppliers* from this Brazilian family-owned pharmaceutical company. In addition, I will ask some of the pharmaceutical brokers (distributors), with whom I have contact, to send the survey link to other pharmaceutical raw material producers who are not included in my current sample size but are part of my population of interest. This extra sample size I will identify as *indirect suppliers.* The 240 direct suppliers are geographically distributed according to the following list:

- Europe: 20
- India: 68
- China: 55
- Brazil: 97

Finally, I will create two different Qualtrics versions: one for direct suppliers and another for indirect. The goal is to see whether there is a significant difference between the responses from the companies that are currently doing business with the pharmaceutical company compared with those that are not. The questionnaire will be exactly the same for both samples. Respondents will be from the companies' sales department.

4.4. Validation of Instruments

In the process of instrument validation, five important concepts in social research will be taken in consideration: *reliability, validity, internal validity, construct validity, and content validity.*

According to Babbie (2021), "*reliability* is a matter of whether a particular technique, applied repeatedly to the same object, yields the same result each time". In addition, D. Straub (1989) asks the following questions in order to build reliability: "do measures show stability across the units of observation? That is, could measurement error be so high as to discredit the findings?"

"Validity is a term describing a measure that accurately reflects the concept it is intended to measure" (Babbie, 2021), in other words, it is measuring what is supposed to be measuring. In addition, there is "*face validity* which is the quality of an indicator that makes it seem to be reasonable measure of some variable" (Babbie, 2021). "*Internal validity* raises the question of whether the observed effects could have been caused by an unhypothesized variable" (D. Straub, 1989).

"Construct validity is the degree to which a measure relates to other variables as expected within a system of theoretical relationships" (Babbie, 2021). Therefore, in the research model presented in this proposal, there were three constructs which every variable should be related to other variables within each construct. In order to verify if the constructs have validity, D. Straub (1989) makes the following question: do measures show stability across methodology? Finally, "*content validity* is the degree to which a measure covers the range of meanings included within a concept" (Babbie, 2021). "Are instruments drawn from all possible measures of the properties under investigation?" (D. Straub, 1989).

There is empirical evidence that the variance introduced by measurement methods, as opposed to the true relationships between the constructs, introduces biases to the relationships between two constructs. This can lead to Type I and Type II errors when the true relationships between the constructs are confounded (Doty & Glick, 1998; Podsakoff et al., 2003). Determining and establishing face validity, content validity, construct validity, reliability, instrument validity, internal validity, and ultimately statistical conclusion validity will be done by myself by following the procedures outlined in and illustrated in D. Straub (1989).

4.5 Instrumentation

This will be an explanatory study that will use survey to collect data throughout a questionnaire. Developing a concise, well-written and objective questionnaire is crucial to the success of the research. Confusing questions, very complex or poorly words, might lead to bias responses (Agresti, 2018). Moreover, even the order that questions are asked can potentially influence and change considerably the results (Agresti, 2018). Finally, when questions are written in ambiguously way, inaccuracies in the statistical analysis can also be reflected (D. Straub, 1989).

This study will use the quantitative approach. According to Agresti (2018), “a variable is called quantitative when the measurement scale has numerical values that represents different magnitudes of the variables”. Furthermore, except the demographic questions, all the other questions will be stated in the five Likert scale method which is part of *interval measure* approach which is a level of measurement that rank-ordered the question and have equal distances between options (Babbie, 2021).

An extend literature review was conducted to identify the best scales available. As described in the literature review section, this study will adopt the Technology-Organization-Environment theory (TOE) as its foundation framework. The instrument was developed using scales already tested and proved to be successful in similar problems. This study will use as reference of measurement instrument (scale) the following article: “Technological, organisational and environmental determinants of smart contracts adoption: UK construction sector viewpoint” Sulafa Badi, Edward Ochieng, Mohamed Nasaj & Maria Papadaki. The measurement items from this study were successfully used, proving their validity.

All the variables will be measuring using 5 Likert scale method. The survey was built following the TOE dimensions order: a) technological; b) organizational; and c) environmental. Bellow, it is possible to observe one example of item for each variable:

- *Perceived Relative Advantage*: is “the degree to which an innovation is perceived as being better than the idea it supersedes”. (Rogers, 2014)

- “A smart contract reduces payout time.”

- *Perceived Compatibility:* "Compatibility is the degree to which an innovation is perceived to be consistent with the organisation values and needs which is also influenced by past experiences". (Gutierrez et al., 2015)
  - “A smart contract is compatible with the existing contract management systems in my organization”.
- *Perceived Non-Complexity:* perceived non-complexity refers to the degree of difficulty to understand a new technology from both business and technical perspectives (S. Kamble et al., 2019).
  - **“**A smart contract is easy to understand.”
- *Perceived Trialability:* It is when individuals or organizations have the "opportunity to trial an innovation before its actual adoption". (Badi et al., 2021)
  - **“**I intend to try out a smart contract in a limited scope in my works, before deciding whether to adopt it in practice”.
- *Top Management Support:* "Top management support is seen to reduce the salience of the forces working against the change and help overcome internal resistance" (Badi et al., 2021)
  - **“**Top management in my organization is aware of the benefits that smart contracts can provide”.
- *Organizational Readiness:* “The concept of organizational readiness is concerned with the availability of the necessary skills, IT systems, and resources required to adopt the new technology” (Ramdani et al. 2013).

- "My organization has the needed resources to support smart contract adoption".

- *Competitive Pressure:* "It refers to the pressure felt by the firm from industry competitors" (Oliveira & Martins, 2010).
    - "The use of smart contracts would increase the ability of my organization to outperform the competition".
- *Business Partner Pressure:* "Business partners' pressure (BPP) refers to the pressure faced by firms from their business partners" (Alharbi et al., 2016).
    - "My organization's business partners recommend the adoption of smart contracts".
- *Smart Contract Use Intention:* The degree to which a person has made conscious arrangements to perform or not perform some defined future activity is referred to as intention to adopt (Warshaw & Davis, 1985).
    - "My organization intends to use smart contracts actively".

In addition to the validated instrument from Badi et al., (2021), I created extra items for all the constructs that had originally only three items. In the "Appendix B" it is possible to access the complete survey instrument.

4.6 Data Collection and Analysis Procedures

Before collecting the data, I will test the survey instrument to ensure that it is reliable. In addition, these tests are crucial to verify if the operation at Qualtrics is working accordingly. Lack of validated measures in research study affects the trustful aspect of it (it can't be trusted) (D. W. Straub, 1989). Therefore, the survey instrument test will follow three steps: Informed Pilot, Pilot Study, and Main Study.

1) Informed Pilot: where the main objective of this stage is to use the knowledge of peers to evaluate the survey instrument. So, three volunteer DBA peers will evaluate the survey instrument. In addition to peer's evaluation, the study will receive feedback from a pharmaceutical industry professional with significant experience gained through employment at a large, well-established, and well-respected pharmaceutical company, directly responsible for supply chain, who has volunteered to assist. Finally, two academics will also evaluate the instrument. The first one is a PhD in Aerospace, Aeronautical and Astronautical Engineering graduated from the Penn State University. He has vast academic experience which will bring value to my instrument. Finally, the other academic expert has a master's in biotechnology from the Duquesne University – Pittsburgh, and large experience within the pharmaceutical industry. Because she has both academic and professional expertise, her input will also be very valuable.

2) Pilot Study: data will be collected as soon as IRB approval has been granted and the dissertation proposal defense is completed. More specifically, a quantitative, internet-based survey will be constructed within Qualtrics and, upon IRB approval and proposal defense, administered via CloudResearch. In order to access a more committed and engaged population of interest, compensation equivalent to $15 per hour

of productive work will be considered. The survey should remain below 8 minutes length. Therefore, compensation of $ 2.00 will be offered to survey participants. Sample questions can be found within Appendix B. Before proceeding to the first question, each participant will be required to consent to the study. All surveys will be subjected to randomized attention checks, and completed surveys will be assigned a unique survey completion ID. I opted not to use the main sample (raw material suppliers) for the pilot test because of its high-quality and scarcity level. I would not be able to contact these companies twice – for the pilot test and main study.

3) Main Study: the data collection procedure for this phase will follow the same pattern as the pilot study. The only difference is that the main sample will be contacted via email and there will not be financial compensation. Participants will have two weeks to complete the survey. Within these two weeks, they will receive two reminder emails. As explained in section 4.3, I will create two different Qualtrics versions: one for direct suppliers and another for indirect.

The following table illustrates the summary of procedures for the entire study:

Table 3 - Summary of Study Procedures

Study Procedures		
Step	Title	Description

1	Qualtrics Survey	Create Qualtrics survey with required pre-survey consent embedded as question 1.
2	Email Solicitation	Create email solicitation for distribution to 6 informed pilot participants. Send email to participants once final.
3	Feedback Focus Group	Identify 3 participants within the internal pilot group to conduct in-depth review of instrument and study. Focus on opportunity for increasing face validity and internal reliability.
4	Make Instrument Modifications I	Based on feedback from the focus group, make necessary changes to the survey instrument.
5	Pilot Group Solicitation	Create CloudResearch task with embedded survey link. Target 200 survey participants based on statistical parameters.
6	Data Analysis I	Collect and clean the data from Pilot Group. Run several statistical tests using SmartPLS and SPSS: Descriptives; EFA; Regression, Reliabilities and Hypothesis Testing.
7	Make Instrument Modifications II	Based on the results from Pilot Group, make necessary changes to the survey instrument.
8	Main Group Solicitation	Contact by email the main group. The total sample size contact will be 240 direct raw material suppliers.
9	Data Analysis II	Collect and clean the data from Main Group. Run several statistical tests using SmartPLS and SPSS: Descriptives; EFA; Regression, Reliabilities and Hypothesis Testing.
10	Reporting	Analyze and report the findings of the study.

After collecting the data, it is important to properly process it. Then, I will run several statistical tests, using both SmartPLS, and SPSS, such as:

- Descriptives
- Exploratory Factor Analysis (EFA)
- Linear Regression

- Kaiser-Meyer-Olkin Test (KMO)
- Collinearity Assessment
- Structural Model Path Coefficients and Hypothesis Testing
- Cronbach Alpha Test

The last phase will be reporting the findings.

CHAPTER 5 – DATA ANALYSIS

5.1 Informed Pilot

As described in section 4.6 and illustrated on table 3, the first step of the pilot study procedures is the informed pilot. The main objective of this stage is to use the knowledge of peers and industry experts to evaluate the survey instrument. Therefore, the informed pilot was divided into three main phases: 1) selection / invitation of strategic participants; 2) participants feedback; 3) survey instrument modification according to feedback received. These three steps are described as following:

1) Invitation: first, I created a word file containing detailed background information such as study abstract, research model and list of hypotheses. After that, participants were invited via text, email or phone call. After receiving a positive reply, I sent an email to each participant with an official invitation with the Qualtrics link and the word file attached. As described before, a total of six participants were part of my informed pilot: 3 DBA students, 2 academic experts and 1 industry expert. The general idea was to invite participants with different

backgrounds but strong capabilities of analyzing the survey instrument and provide constructive feedback.

2) Participants Feedback: an "Informed Qualtrics Version" was created containing boxes of comments after each block of questions. Therefore, participants were able to write their comments right after reading the questions. Two participants preferred to write an email containing their feedback. I set up a zoom meeting with three participants to receive more detailed feedback: one DBA, one academic expert, and one industry feedback. The idea was to have a broader perspective, but the most valuable ideas came from the DBA peer.

3) Survey Instrument Feedback: Because previously published well-developed scales were used, I received a few minor suggestions of modifications. In general, the questions were clear and addressed the population of interest. There were no double barreled, confusing nor ambiguous questions. Finally, apparently the questions seem to load well according to their purpose. However, few important comments were helpful in order to improve my survey:

    - Include an explanation of what a smart contract is.
    - Fix writing issues on the consent text.
    - Missing attention questions.
    - Missing "force response"
    - Reorganize the order of role level (demographics)
    - Add company location (country level)

After examining the main feedback and conducting in-depth evaluation of instrument, I decided to modify all the items provided in the list above. First, several inaccuracies in my consent form were corrected and was added a paragraph introducing smart contracts after the demographics' section. After that, under demographics, two changes were made: 1) Reordered the role level of the hierarchical question and 2) Added a new question regarding the company country of origin. Finally, I inserted two attention questions and included the feature "force response" throughout the survey.

5.2 Pilot Study

After performing the informed pilot phase and making the necessary adjustment to the instrument, the next phase was to conduct a pilot study. The main objective of this phase was to evaluate the quality of the instrument to verify its validity and reliability before performing the last and most important phase – the main study. The data was collected using the Cloud Research platform as described during the methodology section. A total of 175 survey responses were collected. After the data collection, several processes and tests were conducted, and the results will be presented in the following sections.

5.2.1 Data Cleaning

This is an important step that needs to be taken carefully before running statistical tests. Two attention questions were added in the survey instrument – questions "AQ1" and "AQ2" (Appendix B.1). Attention questions were the main factor in excluding participants. A total of three participants who failed to answer an attention question were removed. In addition, three extra steps were taken into consideration: 1) Speeding: it was observed during the informed pilot and with personal tests that less than 3 minutes would not be possible to answer the survey. Therefore, one participant was removed for answering the survey in less than three minutes. 2) Missing data: There were no missing questions as can be observed in table 4. 3) Outliers' detection: SPSS outliers detection test was run, and a total of nine responses presented outlier behavior more than three times. I performed the required statistical tests for this phase (pilot) considering both scenarios: a) with outliers; b) without outliers. The conclusion was that there were no significant differences between either scenario, so it was decided to maintain those nine outliers' responses.

After taking into consideration these four steps, a total of 4 participants / responses were removed. A total of 175 participants answered the survey which ended up with 171 responses after the cleaning data stage. Finally, also during the data cleaning phase, the question "UI4" had a code reversed as predicted in the survey instrument.

Table 4 – Missing Data

Case Processing Summary						
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
BPP_M	171	100.0%	0	0.0%	171	100.0%
CP_M	171	100.0%	0	0.0%	171	100.0%
OR_M	171	100.0%	0	0.0%	171	100.0%
TMS_M	171	100.0%	0	0.0%	171	100.0%
PT_M	171	100.0%	0	0.0%	171	100.0%
PNC_M	171	100.0%	0	0.0%	171	100.0%
PC_M	171	100.0%	0	0.0%	171	100.0%
PRA_M	171	100.0%	0	0.0%	171	100.0%

5.2.2 Descriptive Analysis

The Demographics section summarizes the participants' profile. In the first question, it is possible to observe that 70 people or 40.5% work for organizations with more than 499 employees. In addition, the work experience was well balanced in the provided range, where 51 participants or 29.5% have between 7 to 12 years of work experience. Most people hold a college degree (59.5%) and 26.6% hold a master's or higher degree which is an illustration of the quality of this data. In terms of hierarchical level, 68 respondents or 39.3% are currently managers. Finally, the last two questions on the demographics section aim to have a better understanding of the participants' knowledge regarding blockchain, and companies' actual usage of smart contracts. A total of 61 or 35.3% of the participants are moderately familiar with blockchain technology, and 135 or 78% of the companies have never used smart contract technology. These descriptive statistics provide a comprehensive overview of the study participants, which may be very helpful to have a broad understanding of the respondents' characteristics and how it may influence the results of this phase of the study.

Table 5 – Demographics Analysis

Item	Frequency	Percentage (%)
How Many Employees		
1-49 employees	45	26.0%
50-499 employees	58	33.5%
>499 employees	70	40.5%
Work Experience		
1-6 years	36	20.8%
7-12 years	51	29.5%
13-19 years	43	24.9%
>20 years	43	24.9%
Highest Education Level Completed		
High School or Lower	0	0.0%
Some College	23	13.3%
College Degree	103	59.5%
Master's Degree or Higher	46	26.6%
Other	1	0.6%
Current Hierarchical Level		
Representative	37	21.4%
Executive	10	5.8%
Senior Executive	16	9.2%
Manager	68	39.3%
Director	5	2.9%
Other	37	21.4%
Company Used Smart Contract		
Yes	38	22.0%
No	135	78.0%
Familiarity with Blockchain Technology		
Not at all	13	7.5%
Slightly	37	21.4%
Somewhat	41	23.7%
Moderately	61	35.3%
Extremely	21	12.1%

An examination of table 6 indicates the test of normality of the data. The Kolmogorov-Smirnov tests indicate a significant departure from normality (p = <.001), and the Shapiro-Wilk indicates the same (p= <.001). Even though Business Partner Pressure (BPP) and Top Management Support (TMS) differ from the other variables, they are still below the 5% level (0.05) which indicates that the data is normally distributed.

Table 6 – Normality Test

Tests of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
BPP_M	0.072	171	0.038	0.969	171	0.001
CP_M	0.084	171	0.007	0.970	171	0.001
OR_M	0.105	171	0.000	0.941	171	0.000
TMS_M	0.079	171	0.013	0.956	171	0.000
PT_M	0.148	171	0.000	0.925	171	0.000
PNC_M	0.096	171	0.001	0.960	171	0.000
PC_M	0.121	171	0.000	0.953	171	0.000
PRA_M	0.090	171	0.002	0.959	171	0.000

a. Lilliefors Significance Correction

5.2.3 KMO and Confirmatory Factor Analysis

The Kaiser-Meyer-Olkin measure verified the sampling adequacy for the analysis, KMO = .948 (‘marvelous’ according to Kaiser and Rice, 1974), and well above the acceptable limit of .50 which means that the data is suited for factor analysis. The KMO results can be observed in the following table:

Table 7 – KMO Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**0.948**
Bartlett's Test of Sphericity	Approx. Chi-Square	6512.528
	df	903
	Sig.	0.000

After running the KMO test and proving that the data is suited for factor analysis, I performed a confirmatory factor analysis test. Results indicate that all the eight independent variables loaded well. The following table summarizes the factors loadings:

Table 8 – Confirmatory Factor Analysis

Outer Loadings - Matrix									
	BPP	CP	OR	PC	PNC	PRA	PT	TMS	UI
BPP1	0.925								
BPP2	0.916								
BPP3	0.890								
BPP4	0.922								
BPP5	0.839								
CP1		0.872							
CP2		0.891							
CP3		0.863							
CP4		0.818							
CP5		0.808							
OR1			0.891						
OR2			0.908						
OR3			0.834						
OR4			0.896						
OR5			0.898						
PC1				0.886					
PC2				0.883					
PC3				0.792					
PC4				0.918					
PC5				0.909					
PC6				0.768					
PNC1					0.827				
PNC2					0.870				
PNC3					0.800				
PNC4					0.716				
PNC5					0.826				
PRA1						0.568			
PRA2						0.614			
PRA3						0.735			
PRA4						0.715			
PRA5						0.808			
PRA6						0.808			
PT1							0.873		
PT2							0.666		
PT3							0.706		
PT4							0.898		
PT5							0.889		
PT6							0.877		
TMS1								0.879	
TMS2								0.908	
TMS3								0.915	
TMS4								0.944	
TMS5								0.936	
UI1									0.960
UI2									0.958
UI3									0.977
UI5									0.948
UI6									0.957

5.2.4 Construct Reliability and HTMT

The next test observed was construct reliability and validity. In the table 9, it is possible to observe that the nine factors had high reliability, with the following Cronbach's alphas: 1) BPP = 0.940; 2) CP = 0.904; 3) OR= 0.931; 4) PC= 0.929; 5) PNC= 0.872; 6) PRA=0.811, 7) PT= 0.905, 8) TMS= 0.952, and 9) UI= 0.979. All the scales had high levels (well above the acceptable level of 0.70) which suggests that these scales are reliable. However, the Average Variance Extracted (AVE) of Perceived Relative Advantage (PRA) was 0.509 which is just above the >.50 limit. Therefore, I analyzed that two items were negatively influencing the results: PRA1 and PRA2. A new test was performed using SmartPLS removing these two items, and results didn't improve significantly. Considering that this is not a major issue because the AVE is still above the minimum threshold of 0.50 limit, it demonstrates that the construct explains at least 50% of the variance in its collection of indicators on average. Furthermore, because the data used for this phase was not the same that will be used in the main study, I decided to maintain items PRA1 and PRA2 for the main study.

Table 9 – Construct Reliability and Validity

Construct Reliability and Validity				
	Cronbach's alpha	**Composite reliability (rho_a)**	**Composite reliability (rho_c)**	**Average variance extracted (AVE)**
Business Partner Pressure	0.940	0.943	0.955	0.808
Competitive Pressure	0.904	0.904	0.929	0.724
Organizational Readiness	0.931	0.937	0.948	0.785
Perceived Compatibility	0.929	0.935	0.945	0.742
Perceived Non-Complexity	0.872	0.905	0.904	0.655
Perceived Relative Advantage	0.811	0.864	0.86	**0.509**
Perceived Trial Ability	0.905	0.939	0.926	0.678
Top Management Support	0.952	0.955	0.963	0.840
Use Intention	0.979	0.979	0.983	0.921

After running the HTMT, it was possible to observe in table 10 that two constructs were strongly correlated – above the >.90 limit: Perceived Compatibility and Organizational Readiness. Therefore, I ran a correlation test using SPSS and concluded that four items were highly correlated (PC4, PC5, OR4 and OR5). I then returned to my instrument and examined these four things to see if there were any wording errors. After that, the HTMT test with different variations was run (adding or removing some of the four problematic items). My conclusion was that the outcome was fine, except for the item OR5, so after removing it, the output reached the acceptable level. Results are illustrated in the following two tables:

Table 10 – Discriminant Validity - HTMT

Discriminant Validity - HTMT

	BPP	CP	OR	PC	PNC	PRA	PT	TMS	UI
Business Partner Pressure									
Competitive Pressure	0.866								
Organizational Readiness	0.748	0.881							
Perceived Compatibility	0.767	0.826	**0.902**						
Perceived Non-Complexity	0.648	0.702	0.799	0.826					
Perceived Relative Advantage	0.529	0.604	0.496	0.591	0.571				
Perceived Trial Ability	0.662	0.771	0.863	0.824	0.753	0.613			
Top Management Support	0.798	0.764	0.809	0.77	0.652	0.478	0.661		
Use Intention	0.871	0.847	0.859	0.838	0.705	0.434	0.722	0.854	

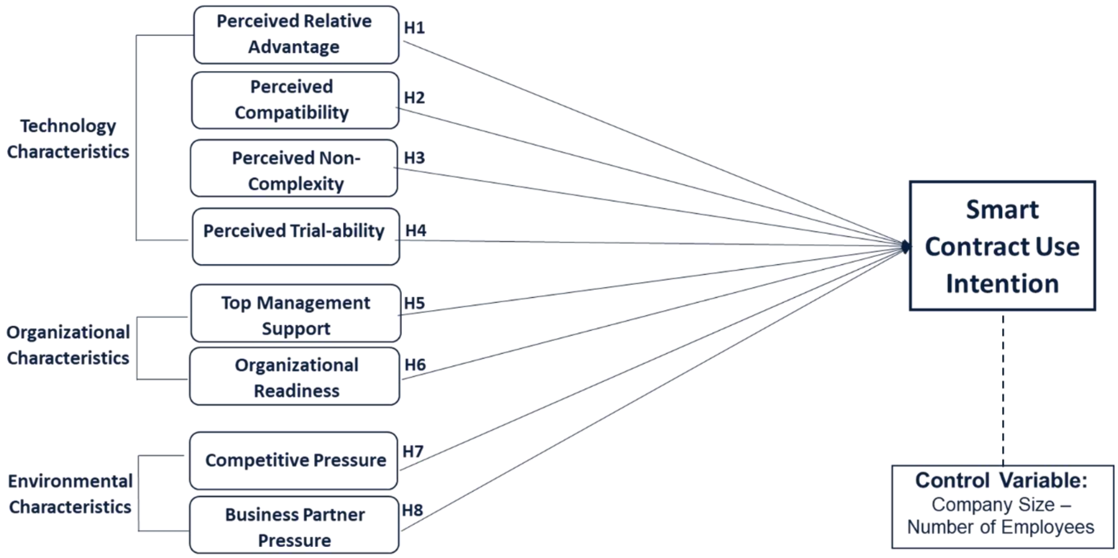
Discriminant Validity - HTMT

	BPP	CP	OR	PC	PNC	PRA	PT	TMS	UI
Business Partner Pressure									
Competitive Pressure	0.866								
Organizational Readiness	0.731	0.872							
Perceived Compatibility	0.767	0.826	0.885						
Perceived Non-Complexity	0.648	0.702	0.794	0.826					
Perceived Relative Advantage	0.529	0.604	0.487	0.591	0.571				
Perceived Trial Ability	0.662	0.771	0.847	0.824	0.753	0.613			
Top Management Support	0.798	0.764	0.785	0.77	0.652	0.478	0.661		
Use Intention	0.871	0.847	0.834	0.838	0.705	0.434	0.722	0.854	

5.2.5 Instrument Adjustments

After performing the Informed Pilot phase and the Pilot Study, I concluded that there was no necessity to make major modifications. The research model for the main study will remain the same as proposed in chapter two:

Figure 3 - The Conceptual Research Model



Regarding the instrument, minor adjustments were made for the next phase of the study. The modifications were made considering three different approaches: 1) feedback received during the informed pilot; 2) my own review of the instrument; and 3) the statistical tests performed during the pilot study. are listed below:

- PC4: in this item, I changed the work “easy” to “compatible” because it was measuring the construct Perceived Non-Complexity instead of the Perceived Compatibility.
    - Before: “Smart contracts would be **easy** to integrate with our current processes”.

    - After: “Smart contracts would be **compatible** to integrate with our current processes”.
- OR5: “My organization would allocate the necessary resources and budget for the implementation of smart contracts”.
    - As described in the previous section, this item was causing a strong correlation between two constructs (OR and PC), so I decided to remove it from the instrument.
- UI5: “My organization is actively considering the use of smart contracts”.
    - This item was very similar to item UI1: “My organization intends to use smart contracts actively”. Therefore, I also decided to remove it.

The final version of the instrument is composed of a) Seven demographics questions; b) Two attention questions; and c) Forty-eight regular questions. It can be observed in Appendix B.1.

5.3 The Main Study

After completing the pilot phase and making the necessary modifications to the survey instrument, this dissertation reaches the final phase – the *main study*. Before starting the data collection process, it was necessary to translate the questionnaire to Portuguese because data would be collected in both languages: English and Portuguese. The translation process followed these steps:

1) Because I am fluent in both languages, I first translated the questionnaire to Portuguese.
2) A friend who is Brazilian and have PhD in Aerospace, Aeronautical and Astronautical Engineering graduated from the Penn State University – USA, translated it back from Portuguese to English. He has extensive academic and professional experience that brought a high level of validity to this translation process.
3) Finally, both documents were compared: original vs translated, and using a translation tool (Google translate), I made final small adjustments. The questionnaire was ready to be used in both languages.

Following the methodology described in chapter IV, the next step of this dissertation was to collect the data. Appendix C was used to organize and keep track of the process. The data was mainly collected from pharmaceutical suppliers that are currently doing business with our company (direct). In addition, as a tentative of increasing the sample size, other suppliers were also contacted (indirect). All companies were contacted by email, with three consecutive weekly reminders. Using Qualtrics, a total of 136 were collected from Brazil, India, China, and Europe. Before starting to analyze the data, it was necessary to clean it.

First, a total of 29 responses that did not complete the survey were removed. Most of these respondents dropped after the “demographics” section (beginning). After that, 1 response was removed because of the speeding issue – answering the survey in less than three minutes. Finally, 4 participants were excluded because they did not respond adequately to the attention questions. After taking into consideration all the steps just described, I ended up with a total of 102 responses.

The raw data was transferred from Excel to both SPSS and SmartPLS in order to perform all the statistical tests proposed in the methodology section.

5.3.1 Descriptive Analysis

The Descriptive Analysis section summarizes the participants' profile. In the first question, it is possible to observe that 50 people or 49.0% work for organizations with more than 499 employees. In terms of work experience, 71 respondents or 69.6% have more than 13 years of work experience. Most people hold a college degree (49.0%) and 44.1% hold a master's or higher degree which is an illustration of the quality of this data. Furthermore, when asked about their current hierarchical level, 36.3% of participants responded that they are currently managers and 28.4% are directors. In terms of the company's location, the sample was well balanced between Brazil, India, and China, where 29.5% were from Brazil, 38.2% from China, and 21.6% from India. Finally, the last two questions on the demographics section aim to have a better understanding of the participants' knowledge regarding blockchain, and companies' actual usage of smart contracts. A total of 35 or 34.3% of the participants are slightly familiar with blockchain technology, and 60 or 58.8% of the companies have never used smart contract technology. These descriptive statistics provide a comprehensive overview of the study participants, which may be very helpful to have a broad understanding of the respondents' characteristics and how it may influence the results of this phase of the study. The following table illustrates the sample profile:

Table 11 – Descriptive Statistics

Item	**Frequency**	**(%)**
How Many Employees		
1-49 employees	21	20.6%
50-499 employees	31	30.4%
>499 employees	50	49.0%
Work Experience		
1-6 years	13	12.7%
7-12 years	18	17.6%
13-19 years	31	30.4%
>20 years	40	39.2%
Highest Education Level Completed		
High School or Lower	2	2.0%
Some College	5	4.9%
College Degree	50	49.0%
Master's Degree or Higher	45	44.1%
Current Hierarchical Level		
Representative	7	6.9%
Executive	8	7.8%
Senior Executive	10	9.8%
Manager	37	36.3%
Director	29	28.4%
Other	11	10.8%
Company Location		
Brazil	30	29.5%
China	39	38.2%
India	22	21.6%
Europe	8	7.8%
Other	3	2.9%
Company Used Smart Contract		
Yes	16	15.7%
No	60	58.8%
I don't know	26	25.5%
Familiarity with Blockchain Technology		
Not at all	25	24.5%
Slightly	35	34.3%

Somewhat	28	27.5%
Moderately	12	11.8%
Extremely	2	2.0%

5.3.2 KMO and CFA

The Kaiser-Meyer-Olkin measure verified the sampling adequacy for the analysis, KMO = .884 ('meritorious' according to Kaiser and Rice, 1974), and well above the acceptable limit of .50 which means that the data is suited for factor analysis. The KMO results can be observed in the following table:

Table 12 – KMO Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**0.884**
Bartlett's Test of Sphericity	Approx. Chi-Square	4535.194
	df	1081
	Sig.	0.000

After running the KMO test and proving that the data is suited for factor analysis, I performed a confirmatory factor analysis test. Results indicate that all the eight independent variables and the dependent variable loaded well. The following table summarizes the factors loadings:

Table 13 – Confirmatory Factor Analysis

Outer Loadings - Matrix									
	BPP	**CP**	**OR**	**PC**	**PNC**	**PRA**	**PT**	**TMS**	**UI**
BPP1	0.925								
BPP2	0.919								
BPP3	0.856								
BPP4	0.801								
CP1		0.901							
CP2		0.892							
CP3		0.892							
CP4		0.725							
CP5		0.672							
OR1			0.725						
OR2			0.875						
OR3			0.865						
OR4			0.839						
PC1				0.850					
PC2				0.894					
PC3				0.889					
PC4				0.846					
PC5				0.771					
PC6				0.667					
PNC1					0.814				
PNC2					0.847				
PNC3					0.779				
PNC4					0.644				
PNC5					0.741				
PRA1						0.639			
PRA2						0.755			
PRA3						0.819			
PRA4						0.733			
PRA5						0.839			
PRA6						0.852			
PT1							0.769		
PT2							0.837		
PT3							0.822		
PT4							0.871		
PT5							0.755		
PT6							0.820		
TMS1								0.850	
TMS2								0.777	
TMS3								0.885	
TMS4								0.897	
TMS5								0.839	
UI1									0.930
UI2									0.926
UI3									0.907
UI6									0.889
UI7									0.863

5.3.3 HTMT and Construct Reliability

The next test analyzed was the discriminant validity (HTMT). In the table 14, it was possible to observe that two relationships were strongly correlated – not above the >.90 limit, but close to the threshold: BPP and UI; TMS and UI. Therefore, I ran a correlation test using SPSS and concluded that two items were mainly causing it: UI4 and BPP5. So, after removing them, the output reached an acceptable level. Results are illustrated in the following two tables:

Table 14 – Discriminant Validity - HTMT

Discriminant Validity - HTMT									
	BPP	CP	OR	PC	PNC	PRA	PT	TMS	UI
Business Partner Pressure									
Competitive Pressure	0.836								
Organizational Readiness	0.725	0.675							
Perceived Compatibility	0.645	0.707	0.766						
Perceived Non-Complexity	0.664	0.783	0.676	0.811					
Perceived Relative Advantage	0.493	0.697	0.406	0.673	0.789				
Perceived Trial Ability	0.597	0.682	0.547	0.627	0.833	0.775			
Top Management Support	0.775	0.732	0.698	0.753	0.836	0.644	0.600		
Use Intention	0.880	0.819	0.794	0.722	0.824	0.605	0.650	0.861	

Discriminant Validity - HTMT									
	BPP	CP	OR	PC	PNC	PRA	PT	TMS	UI
Business Partner Pressure									
Competitive Pressure	0.817								
Organizational Readiness	0.730	0.675							
Perceived Compatibility	0.615	0.707	0.766						
Perceived Non-Complexity	0.618	0.783	0.676	0.811					
Perceived Relative Advantage	0.440	0.697	0.406	0.673	0.789				
Perceived Trial Ability	0.550	0.682	0.547	0.627	0.833	0.775			
Top Management Support	0.743	0.732	0.698	0.753	0.836	0.644	0.600		
Use Intention	0.848	0.806	0.760	0.703	0.799	0.582	0.634	0.828	

Following the analysis, I observed the construct reliability and validity output taking into consideration all the items, except UI4 and BPP5. In the table 15, it is possible to observe that the nine factors had high reliability, with the following Cronbach's alphas: 1) BPP = 0.899; 2) CP = 0.876; 3) OR= 0.846; 4) PC= 0.903; 5) PNC= 0.826; 6)

PRA=0.867, 7) PT= 0.897, 8) TMS= 0.904, and 9) UI= 0.944. All the scales had high levels (well above the acceptable level of 0.70) which suggests that these scales are reliable. In terms of the Average Variance Extracted (AVE), results were all above the threshold 0.50 limit, with the following AVE: 1) BPP = 0.769; 2) CP = 0.676; 3) OR= 0.686; 4) PC= 0.678; 5) PNC= 0.590; 6) PRA=0.602, 7) PT= 0.661, 8) TMS= 0.724, and 9) UI= 0.816. The AVE's results are a demonstration that the constructs explained at least 59% of the variance in its collection of indicators on average.

Table 15 – Construct Reliability and Validity

Construct Reliability and Validity				
	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Business Partner Pressure	0.899	0.910	0.93	0.769
Competitive Pressure	0.876	0.894	0.911	0.676
Organizational Readiness	0.846	0.863	0.897	0.686
Perceived Compatibility	0.903	0.919	0.926	0.678
Perceived Non-Complexity	0.826	0.841	0.877	0.590
Perceived Relative Advantage	0.867	0.884	0.900	0.602
Perceived Trial Ability	0.897	0.901	0.921	0.661
Top Management Support	0.904	0.906	0.929	0.724
Use Intention	0.944	0.944	0.957	0.816

5.3.4 Path Coefficients and Hypotheses Testing

Figure 4 – Structural Model

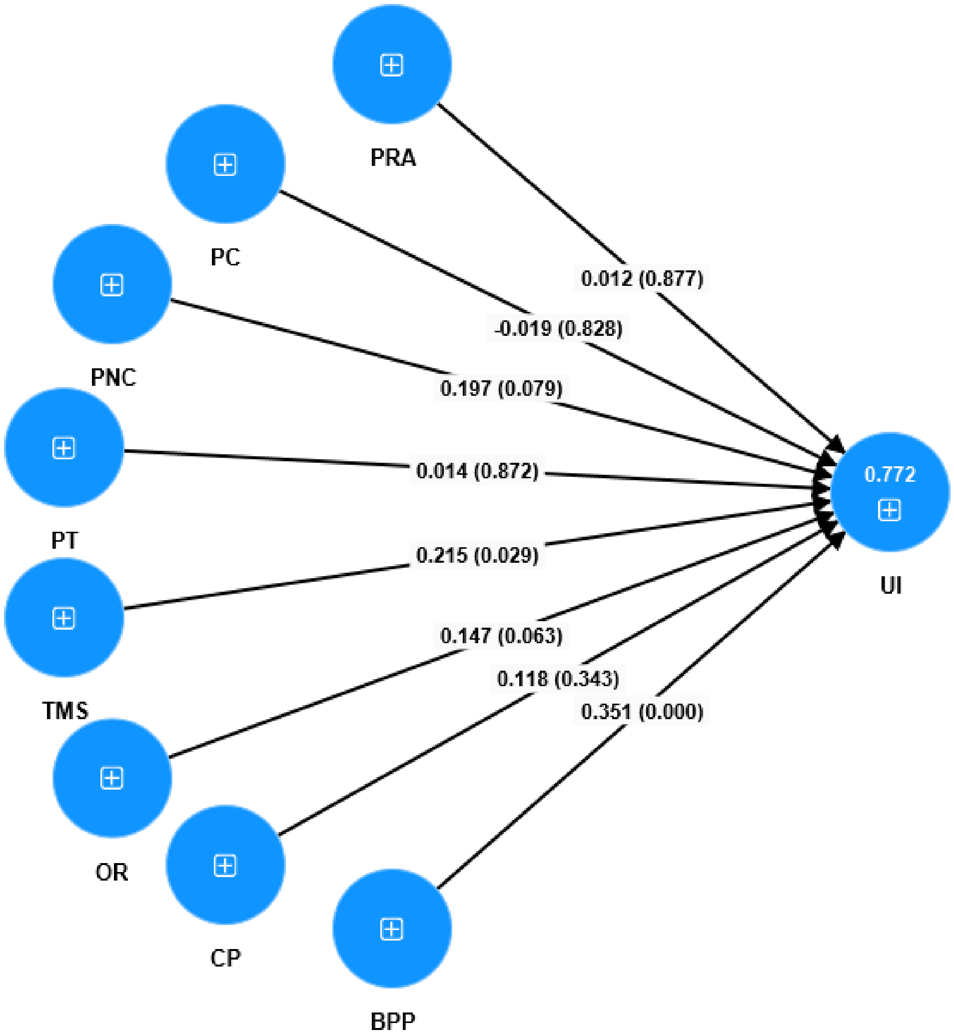


Figure 5 summarizes the results of the structural research model. It is possible to observe that the values presented indicate the results of the R-squared (R^2), the Path Coefficient, and the p-values of this study.

The R-squared (R^2) value found was 0.772 which means that the predictors explain 77.2% of the variance in Smart Contract Use Intention (UI). This indicates that the regression model's independent variables are effective at explaining the variance in

Smart Contract Use Intention (UI), suggesting a strong relationship between the independent variables and UI (dependent variable).

Regarding the Path Coefficient, the results are standardized paths between the different constructs in the research model, with the values inside parentheses representing the p-values, acquired from a bootstrapping run with 5,000 replications. According to Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M., (2019), Path coefficient must be at least 0.100 to be significant, so it can be observed on figure 5 that Business Partner Pressure (BPP) and Top Management Team (TMS) have an important effect on Smart Contract Use Intention (UI). On the other hand, Perceived Compatibility (PC), Perceived Relative Advantage (PRA) and Perceived Trialability (PT) have low effect on the dependent variable (UI).

This study's bootstrapping methodology used a p-value of less than 0.05 to indicate statistical significance. The p-value is a statistical indicator that evaluates the significance of a hypothesis test. It represents the probability of obtaining the observed results or more extreme results, assuming that the null hypothesis is true (Dahiru, 2011). Therefore, if the p-value of a path coefficient is less than 0.05, it is considered statistically significant.

Table 16 reports the beta coefficient (original estimate) for each relationship, as well as the standard deviation, the T-statistics, and the correspondent p-values for each relationship. All these results were taken into consideration to test and discuss each of the eight hypotheses proposed in the research model.

Following the assessment of the measurement model, the next step is the evaluation of structural path coefficients (relationship amongst study constructs) and their statistical significance.

Table 16 – Path Coefficient

Hypothesis	Relationship	Beta Coefficient	Standard deviation	T statistics	P values
H1	PRA -> UI	0.012	0.079	0.155	0.877
H2	PC -> UI	-0.019	0.086	0.217	0.828
H3	PNC -> UI	0.197	0.112	1.755	0.079
H4	PT -> UI	0.014	0.089	0.161	0.872
H5	TMS -> UI	0.215	0.098	2.186	0.029
H6	OR -> UI	0.147	0.079	1.858	0.063
H7	CP -> UI	0.118	0.124	0.948	0.343
H8	BPP -> UI	0.351	0.091	3.852	0.000

	Beta Coefficient	Standard deviation	T statistics
BPP -> UI	0.351	0.091	3.852
CP -> UI	0.118	0.124	0.948
OR -> UI	0.147	0.079	1.858
PC -> UI	-0.019	0.086	0.217
PNC -> UI	0.197	0.112	1.755
PRA -> UI	0.012	0.079	0.155
PT -> UI	0.014	0.089	0.161
TMS -> UI	0.215	0.098	2.186

*Relationship is significant at P < 0.001

According to H1, Perceived Relative Advantage (PRA) was expected to have a positive effect on a firm's Smart Contract Use Intention (UI). The results presented on figure 5 and table 16 revealed that PRA has positive but not significant impact on UI (B= 0.012, t= 0.155, p= 0.877), which means that the results do not provide support for the predicted relationship between Perceived Relative Advantage (PRA) and Smart Contract Use Intention (UI). Therefore, H1 was not supported.

Hypothesis 2 examined the relationship between PC and UI. More specifically, H2 predicted that Perceived Compatibility (PC) will have a positive effect on a firm's Smart Contract Use Intention (UI). The results revealed that PC has a negative impact on UI (B= -0.019, t= 0.086, p= 0.828), which means that the results do not provide support for the predicted relationship between Perceived Compatibility (PC) and Smart Contract Use Intention (UI). Therefore, H2 was not supported.

Hypothesis 3 examined the relationship between PNC and UI. More specifically, H3 predicted that Perceived Non-Complexity (PNC) will have a positive effect on a firm's Smart Contract Use Intention (UI). The results revealed that PNC has a positive impact on UI (B= 0.197, t= 1.755, p= 0.079). Although the p-value was slightly higher than the threshold (0.05), it is close to significance, meaning the results point in the right direction to provide support for the predicted relationship between Perceived Non-Complexity (PNC) and Smart Contract Use Intention (UI). Therefore, it can be concluded that H3 was marginally supported.

Hypothesis 4 examined the relationship between PT and UI. More specifically, H4 predicted that Perceived Trial-Ability (PT) will have a positive effect on a firm's Smart Contract Use Intention (UI). The results revealed that PT has a positive but not significant impact on UI (B= 0.014, t= 0.161, p= 0.872), which means that the results do not provide support for the predicted relationship between Perceived Trial-Ability (PT) and Smart Contract Use Intention (UI). Therefore, H4 was not supported.

Hypothesis 5 examined the relationship between TMS and UI. More specifically, H5 predicted that Top Management Support (TMS) will have a positive effect on a firm's Smart Contract Use Intention (UI). The results revealed that TMS has a positive and significant impact on UI (B= 0.215, t= 2.186, p= 0.029), which means that the results provide support for the predicted relationship between Top Management Support (TMS) and Smart Contract Use Intention (UI). Therefore, H5 was supported.

Hypothesis 6 examined the relationship between OR and UI. More specifically, H6 predicted that Organizational Readiness (OR) will have a positive effect on a firm's Smart Contract Use Intention (UI). The results revealed that OR has a positive impact on UI (B= 0.147, t= 1.858, p= 0.063). Although the p-value was slightly higher than the threshold (0.05), it is close to significance, meaning the results point in the right direction to provide support for the predicted relationship between Organizational Readiness (OR) and Smart Contract Use Intention (UI). Therefore, it can be concluded that H6 was marginally supported.

Hypothesis 7 examined the relationship between CP and UI. More specifically, H7 predicted that Competitive Pressure (CP) will have a positive effect on a firm's Smart Contract Use Intention (UI). The results revealed that CP has a positive but not significant impact on UI (B= 0.118, t= 0.948, p= 0.343), which means that the results do not provide support for the predicted relationship between Perceived Competitive Pressure (CP) and Smart Contract Use Intention (UI). Therefore, H7 was not supported.

Hypothesis 8 examined the relationship between BPP and UI. More specifically, H5 predicted that Business Partner Pressure (BPP) will have a positive effect on a firm's Smart Contract Use Intention (UI). The results revealed that BPP has a positive and significant impact on UI (B= 0.351, t= 3.852, p= 0.001), which means that the results provide support for the predicted relationship between Business Partner Pressure (BPP) and Smart Contract Use Intention (UI). Therefore, H5 was supported.

The results presented provided support to examine the proposed research model and the research question. Moreover, all the hypotheses were evaluated using the statistical tests performed. The following table summarizes the hypotheses results:

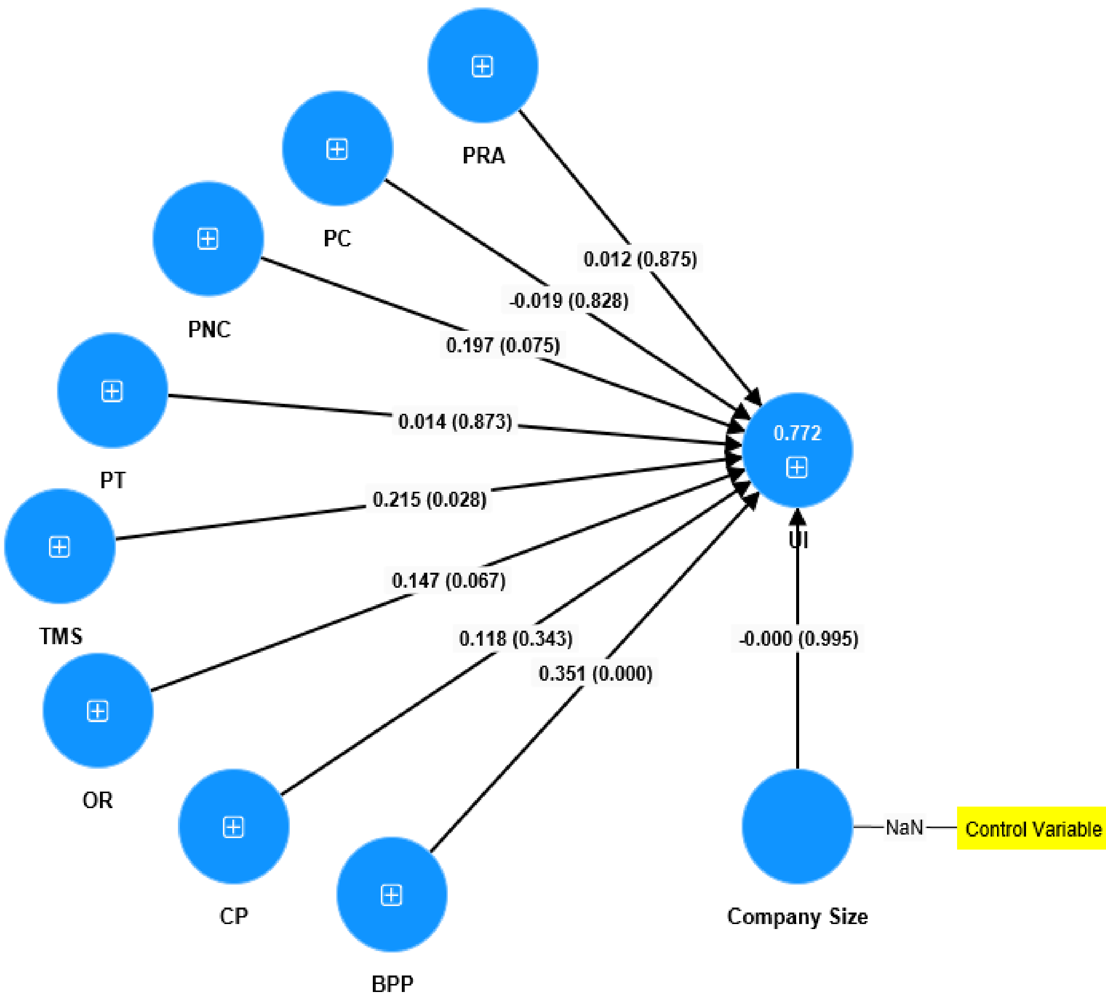
Table 17 – Hypotheses Summary

RESEARCH HYPOTHESES	**RESULT**
H1: Perceived Relative Advantage (PRA) will have a positive effect on a firm's Smart Contract Use Intention (UI).	Not Supported
H2: Perceived Compatibility (PC) will positively influence the Smart Contract Use Intention (UI).	Not Supported
H3: Perceived Non-Complexity (PNC) will have a positive impact on the Smart Contract Use Intention (UI)	Marginally Supported
H4: Perceived Trial-Ability (PT) will have a positive effect on a firm's Smart Contract Use Intention (UI).	Not Supported
H5: Top Management Support (TMS) will positively influence the Smart Contract Use Intention (UI).	Supported
H6: Organizational Readiness (OR) will have a positive impact on the Smart Contract Use Intention (UI)	Marginally Supported
H7: Competitive Pressure (CP) will positively influence the Smart Contract Use Intention (UI)	Not Supported

H8: Business Partner Pressure (BPP) will positively impact the Smart Contract Use Intention (UI)	Supported

5.4 Control Variable

Figure 6 – Structural Model with Control Variable



The proposed research model of this dissertation contemplates one control variable: company size. According to the survey instrument, company size was divided into three groups: small, medium, and large companies. Small-sized companies have between 1 and 49 employees; medium-sized companies have between 50 and 499 employees; and large-sized companies have more than 500 employees. The objective of this analysis is to examine if the control variable has an effect on the dependent variable (Smart Contract Use Intention). Figure 6 illustrates the structural model with the control variable, which was analyzed using the bootstrap method while taking into consideration both the path coefficient and the p values. The results indicate that company size is not statistically significant in this study (B= -0.000, p= 0.995), which means that the control variable does not have significant impact on the dependent variable (UI).

5.5 Additional Analyses

5.5.1 Company Size

In addition to all the analyses performed according to the proposed research model, I wanted to have a better understanding of possible differences between countries and company sizes. Therefore, additional tests were conducted to verify if any intriguing information could be found.

Table 18 summarizes the path coefficient results according to company's size. The column "total" represents the results of the total sample and the three next columns (large, medium, and small) represent the results of each company size respectively. The results with higher discrepancies from the "total" column were highlighted in red. It is possible to observe that H1 (Perceived Relative Advantage) has a strong effect on the dependent variable (UI) for small companies, but negative effect for both large and medium-sized companies. In terms of business implication, this means that for small companies perceived relative advantage is important when considering adopting smart contract, but that is not the case for large and medium companies.

The second relationship highlighted is H2 – Perceived Compatibility. For medium-sized companies, PC has a strong effect on the UI. However, for large companies the effect is weaker, and it is negative for small companies. It is an indication that, for medium-sized organizations, smart contracts must be compatible with the technology already in place when considering adopting it. However, for small and large organizations, PC does not appear to be relevant when considering adopting it.

The third relationship highlighted is TMS – Top Management Support where results showed that this factor has a strong effect on the UI for large companies. For medium companies, the relationship has a positive, but not significant effect, and for small companies, results showed that the relationship is weak. The findings make sense because, in small-sized companies, owners typically make decisions, whereas in large-sized companies, the top management team is responsible for such decisions.

The fourth relationship is H6 – Organization Readiness, where the findings revealed that it has a negative effect on the UI for Medium organizations, but a positive/moderate effect for large and small organizations. Observing the results, it can be interpreted that Organization Readiness is more relevant for large companies than for medium or small companies when deciding about using smart contracts.

The last relationship highlighted is H7 – Competitive Pressure. The findings revealed that it has a strong effect on the dependent variable for medium companies, a small but positive effect for small companies, and a negative effect on UI for large companies. It can be interpreted that large companies have a more robust strategic plan and generally adhere to it. As a result, large companies do not make decisions based on what their competitors are doing. Apparently, for small and medium companies, competitor pressure appears to be an important factor when deciding whether to use or not smart contracts.

Table 18 – Path Coefficient – Company Size

Hypothesis	Relationship	Beta Coefficient			
		Total	Large	Medium	Small
H1	**PRA -> UI**	0.012	-0.163	-0.038	**0.346**
H2	**PC -> UI**	-0.019	0.022	**0.235**	-0.211
H3	**PNC -> UI**	0.197	0.179	0.160	0.187
H4	**PT -> UI**	0.014	0.032	-0.079	-0.085
H5	**TMS -> UI**	0.215	0.358	0.120	**0.003**
H6	**OR -> UI**	0.147	0.262	**-0.051**	0.150
H7	**CP -> UI**	0.118	**-0.030**	0.360	0.109
H8	**BPP -> UI**	0.351	0.336	0.272	0.631

In addition to the path coefficient values, another analysis taken into consideration was the p-values. Table 19 summarizes the p-values results according to company's size. Following the same logic of the previous table, the "total" column represents the results of the total sample and the three next columns (large, medium, and small) represent the results of each company size respectively. As presented during the hypothesis test results, H5 and H8 were supported, and H3 and H6 were marginally supported. However, analyzing the different p-values according to company size, it can be concluded that large companies differ considerably compared to medium and small companies. The findings highlighted in table 19 are aligned with the findings from table 18. It is possible to observe that H5 (TMS) and H6 (OR) are statistically significant for large companies, but it is not for medium and small-sized companies. In terms of the business world, these findings indicate that, having the top management support and having the organization ready (in terms of IT personnel and IT infrastructure), is crucial when large organizations decide whether to use smart contracts. Finally, Business Partner Pressure (H8) was supported for large companies, but it was not for medium and small ones. This is an interesting finding, where further research could be performed to have a better understanding of why BPP appears to be more important for large companies than for small or medium companies when deciding about the use intention of smart contracts.

Table 19 – P Values – Company Size

Hypothesis	**Relationship**	**P values**			
		Total	**Large**	**Medium**	**Small**
H1	**PRA -> UI**	0.877	0.106	0.867	0.310
H2	**PC -> UI**	0.828	0.845	0.519	0.669
H3	**PNC -> UI**	**0.079**	0.200	0.546	0.933
H4	**PT -> UI**	0.872	0.783	0.730	0.978
H5	**TMS -> UI**	**0.029**	**0.018**	0.647	0.999
H6	**OR -> UI**	**0.063**	**0.012**	0.856	0.673
H7	**CP -> UI**	0.343	0.809	0.291	0.886
H8	**BPP -> UI**	**0.000**	**0.034**	0.227	0.638

5.5.2 Country

Following the same logic of the analyses of company size, I wanted to have a better understanding of possible differences between countries. Tables 20 and 21, summarize the findings, where the column “total” represents the results of the total sample and the three next columns (Brazil, China, and India) represent the results of each country respectively. The Results with the greatest discrepancy in relation to the original values (“total”) were highlighted in red. The difference between countries responses were very interesting.

The first relationship highlighted is PRA >UI (H1 - Perceived Relative Advantage) which has a strong effect on the dependent variable (UI) for India, but a weak effect on UI for China and a small negative effect on UI for Brazil. In terms of business implication, this means that for Indian companies perceived relative advantage is important when considering adopting smart contract, but that is not the case for Brazilian and Chinese companies.

The second relationship highlighted is H3 – Perceived Non-Complexity. For Chinese companies, PNC has a strong effect on the smart contract use intention. However, for Brazilian companies the effect is weaker, and it is negative for Indian companies. It is an indication that, for Chinese organizations, the perception of complexity has a strong effect when suppliers in this country make the decision about adopting this novel technology. However, for Brazilian organizations, PNC does not appear to be relevant when considering adopting it. Moreover, for Indian companies, this relationship has negative effect, implying that they are unconcerned about the complexity involved in the use of smart contracts.

The third relationship is H4 – Perceived Trialability (PT), where the findings revealed that it has a positive effect on the UI for Indian organizations, but a negative effect for Brazilian and Chinese organizations. Based on the findings, it is possible to conclude that the ability to conduct a trial before making a final choice to implement smart contract technology is critical for Indian enterprises, but not for Brazilian or Chinese companies.

The fourth relationship highlighted is TMS>UI (Top Management Support) where results showed that this factor has a strong effect on the UI for Brazilian and Indian companies. For Chinese companies, the relationship has a positive but a weak effect on the dependent variable (UI). The findings indicate that TMS is relevant for both Brazilian and Indian companies when they must make the decision about the use intention of smart contracts. On the other hand, for Chinese organizations TMS does not appear to have the same level of importance.

The fifth relationship highlighted is H7 – CP>UI (Competitive Pressure). The findings revealed that it has a strong effect on the dependent variable for Brazilian companies, a weak and negative effect for both Chinese and Indian companies. These findings suggest that because Brazilian enterprises are more focused on the domestic market than on the external (exportation), the pressure they face from their competitors is significantly greater. On the other hand, because both China and India are established in an export-driven industry, they perceive less pressure from their local competitors.

Finally, Business Partner Pressure (H8) had a strong effect on the UI for Chinese and Indian companies, but it had weaker/negative effect on UI for Brazilian organizations. These results revealed that both Indian and Chinese enterprises are more inclined to use smart contracts if their business partners require it, but this is not the case for Brazilian companies.

Table 20 – Path Coefficient - Country

Hypothesis	Relationship	Beta Coefficient			
		Total	Brazil	China	India
H1	**PRA -> UI**	0.012	-0.189	0.052	**0.299**
H2	**PC -> UI**	-0.019	-0.044	-0.164	-0.188
H3	**PNC -> UI**	0.197	0.163	**0.505**	-0.340
H4	**PT -> UI**	0.014	-0.069	-0.241	**0.222**
H5	**TMS -> UI**	0.215	0.247	**0.019**	0.446
H6	**OR -> UI**	0.147	0.271	0.108	0.229
H7	**CP -> UI**	0.118	**0.595**	-0.015	-0.082
H8	**BPP -> UI**	0.351	**-0.02**	0.739	0.479

In addition to the path coefficient values, another analysis taken into consideration was the p-values. Table 21 summarizes the p-values results according to each country. Following the same logic of the previous table, the “total” column represents the results of the total sample and the three next columns (Brazil, China, and India) represent the results of each country respectively. As presented during the hypothesis test results, H5 and H8 were supported, and H3 and H6 were marginally supported. However, after analyzing the different p-values according to the three countries, different results were found.

First, H3 – Perceived Non-Complexity was supported for China, and I was not statistically significant for Brazil and India. This result was comparable to that shown in table 20 (path coefficient). It suggests that, for Chinese firms, the perception of complexity is an important consideration when deciding whether to adopt this unique technology. However, for Brazilian and Indian organizations, PNC does not appear to be significant when contemplating adoption. The second relationship highlighted was H7 – CP>UI (Competitive Pressure). The findings revealed that it statistically significant for

Brazilian companies, but it was not significant for both Chinese and Indian companies. Again, these findings are aligned with the results presented on the previous table (20), suggesting that for Brazilian enterprises, competitive pressure is a relevant factor when they make the decision whether to use smart contract. On the contrary, for Chinese and Indian enterprises, this pressure does not appear to be relevant. Finally, Business Partner Pressure (H8) was statistically supported for Chinese companies, but it was not for both Brazilian and Indian organizations. These results revealed that Chinese enterprises are more inclined to use smart contracts if their business partners require it, but this is not the case for Brazilian companies.

Table 21 – P Values - Country

Hypothesis	Relationship	P values			
		Total	Brazil	China	India
H1	**PRA -> UI**	0.877	0.260	0.773	0.346
H2	**PC -> UI**	0.828	0.842	0.283	0.683
H3	**PNC -> UI**	0.079	0.397	**0.010**	0.483
H4	**PT -> UI**	0.872	0.615	0.067	0.543
H5	**TMS -> UI**	**0.029**	0.100	0.927	0.289
H6	**OR -> UI**	0.063	0.112	0.414	0.691
H7	**CP -> UI**	0.343	**0.031**	0.945	0.842
H8	**BPP -> UI**	**0.000**	0.923	**0.000**	0.185

CHAPTER 6 – DISCUSSION AND CONCLUSION

6.1 Discussion

We are living in an era of constant technological innovation change, so information technology is part of strategic planning of most companies. To survive and continue being competitive, companies must be aware of new technologies available. The pharmaceutical industry is well-known for being highly technological advanced in terms of R&D. However, when considering other dimensions within the business operation, there are many opportunities for adoption of new technologies. Therefore, understanding what are the factors that influence the use intention of new technology, is crucial in order to a successful and more accurate decision.

As mentioned in the introduction, a constant concern among pharmaceutical companies is the *active pharmaceutical ingredient* (API) traceability. Moreover, there are several other issues such as falsifying documentation and product counterfeit. Therefore, I proposed that the novel technology of smart contracts might directly improve these control processes and standards by 1) tracing and tracking raw materials (API); 2) reducing the probability of counterfeit; 3) reducing control costs; 4) increasing transparency; 5) increasing trust; and 6) reducing other costs such as transaction costs. The main objective of this study was to identify some of the drivers that lead to use intention of using Smart Contract between a pharmaceutical enterprise and its suppliers. I aimed to answer the following research question: *What are the factors that contribute to Smart Contract Use Intention between Pharmaceutical Enterprises and their Raw Material Suppliers?* In order to answer this research question, I reviewed a vast amount of literature available trying to understand what studies had been performed and what theories had been applied.

As described in the introduction and literature review sections, this study adopted the *Technology, Organization, and Environment Theory (TOE)* as a framework. TOE was developed by Tornatzky & Fleischer (1990), and it "has been used to study the adoption of various types of IT innovations, especially at the organizational level" (Choi et al., 2020). The TOE framework has been frequently used to explain how multiple variables influence an organization's adoption or use intention of a new technology (Aboelmaged & Hashem, 2018; Badi et al., 2021; Chittipaka et al., 2022).

Several studies exploring the adoption of smart contract enabled by blockchain have been in the past years (Badi et al., 2021; Chang et al., 2019; Kamble et al., 2019; Sinha & Roy Chowdhury, 2021; Ullah & Al-Turjman, 2023). However, I could not identify a study performed within the pharmaceutical enterprises and their raw material suppliers aiming to understand the drivers that motivate the adoption of this innovation. Due to the novelty of the new smart contract technology and the use of TOE theory in the pharmaceutical industry, answering the research question has the potential to shed light on both the academic and managerial worlds.

The proposed research model presented in chapter three was developed using as reference the TOE theory, and it contemplates eight independent variables, one dependent variable and one control variable. To perform this study, data was collected from 136 pharmaceutical raw material suppliers across different countries, such as Brazil, India, China, Spain, Germany, and Italy. These companies were contacted by email and a questionnaire containing 55 questions was answered throughout the Qualtrics platform.

6.2. Results and Implications

Results presented in the chapter V, proved that two variables were supported (Top Management Support and Business Partner Pressure); two variables were marginally supported (Perceived Non-Complexity and Organization Readiness), and four variables were not supported (Perceived Relative Advantage, Perceived Compatibility, Perceived Trialability, and Competitive Pressure). This section provides a brief overview of the hypothesis tested.

According to H1, Perceived Relative Advantage (PRA) was expected to have a positive effect on Smart Contract Use Intention (UI). The results show that PRA has a positive, but not significant impact on UI (B= 0.012, t= 0.155, p= 0.877), which do not provide support for the relationship expected in H1. In terms of business implication, these results mean that PRA is not a significant factor when companies are considering using smart contracts. In other words, Perceived Relative Advantage is the degree to which an innovation is perceived to be superior to the idea it replaces is referred to as relative advantage (Oliveira & Martins, 2010). When companies perceive an innovation's relative advantage comparing with a practice already in place, the likelihood of adoption it increases (Gutierrez et al., 2015). In this scenario, companies did not perceive smart contracts were preferable to existing practices.

Hypothesis 2 examined the relationship between PC and UI. More specifically, H2 predicted that Perceived Compatibility (PC) would have a positive effect on a Smart Contract Use Intention (UI). The results revealed that PC has a negative impact (but not significant) on UI (B= -0.019, t= 0.086, p= 0.828). Therefore, H2 was not supported. According to Oliveira & Martins (2010) “compatibility is the degree to which the innovation fits with the potential adopter's existing values, previous practices, and current needs." I assumed that compatibility would be a major criterion when firms consider using smart contracts, but the data show that this is not the case. The findings revealed that companies are unconcerned about how the novel technology presented would be integrated with their existing procedures and systems. Therefore, managers should not take compatibility into account when selecting whether or not to employ smart contracts.

Hypothesis 3 examined the relationship between PNC and UI. More specifically, H3 predicted that Perceived Non-Complexity (PNC) would have a positive, and marginally significant, effect on a firm's Smart Contract Use Intention (UI). The results revealed that PNC has a positive impact on UI (B= 0.197, t= 1.755, p= 0.079). Although the p-value was slightly higher than the threshold (0.05), it is close to significance, meaning the results point in the right direction to provide support for the predicted relationship between Perceived Non-Complexity (PNC) and Smart Contract Use Intention (UI). Therefore, it can be concluded that H3 was marginally supported. According to Choi et al., (2020), "the more complex a technology is, the less likely it is to be quickly implemented. When a technology is difficult to apply, its adoption is frequently either abandoned or postponed". Even though this hypothesis was partly supported, these findings demonstrated that complexity is an essential factor when organizations decide whether to adopt smart contracts. As a result, managers should learn about this technology before presenting it to decision makers. Smart contracts are generally simple to understand and implement, so it is critical to communicate the concept correctly in order to avoid a negative decision.

Hypothesis 4 examined the relationship between PT and UI. H4 predicted that Perceived Trialability (PT) would have a positive effect on Smart Contract Use Intention (UI). The results revealed that PT has a positive, but not significant, impact on UI (B= 0.014, t= 0.161, p= 0.872), which means that the results do not provide support for the predicted relationship between Perceived Trial-Ability (PT) and Smart Contract Use Intention (UI). Therefore, H4 was not supported. According to my experience, I believed that this hypothesis would be supported because every time an organization has the possibility to test or trial a new technology before making the decision, the likelihood of positive decision towards adopting it increases. The research revealed that Perceived Trialability is unimportant when organizations decide whether to use smart contracts. In terms of business implications, managers should not be concerned with testing this new technology on a small/pilot scale before considering broad implementation.

Hypothesis 5 examined the relationship between TMS and UI. More specifically, H5 predicted that Top Management Support (TMS) would have a positive effect on Smart Contract Use Intention (UI). The results show that TMS has a positive and significant impact on UI (B= 0.215, t= 2.186, p= 0.029), which means that the results provide support for the predicted relationship between Top Management Support (TMS) and Smart Contract Use Intention (UI). Therefore, H5 was supported. Top management support is among the most important factors when an organization is assessing the use intention of smart contracts (Oliveira & Martins, 2010). These findings suggest that managers must be aligned with a company's top management team when they are deciding whether to use or not smart contracts. Without TMS support, the adoption of this new technology may be delayed or abandoned entirely.

Hypothesis 6 examined the relationship between OR and UI. More specifically, H6 predicted that Organizational Readiness (OR) would have a positive effect on Smart Contract Use Intention (UI). The results revealed that OR has a positive and marginally significant impact on UI (B= 0.147, t= 1.858, p= 0.063). Although the p-value was slightly higher than the threshold (0.05), it is close to significance, meaning the results point in the right direction to provide support for the predicted relationship between Organizational Readiness (OR) and Smart Contract Use Intention (UI). Therefore, it can be concluded that H6 was marginally supported. The main idea of this hypothesis was to measure if the organization has both IT infrastructure and IT personnel skills available to adopt the smart contract technology. The results showed that this relationship was marginally supported, indicating that the majority of respondents believe these pharmaceutical suppliers are prepared, in terms of IT infrastructure and IT personnel skills, to implement smart contracts. These findings are essential for this study since organizational readiness is one of the most critical criteria to evaluate during the decision-making process.

Hypothesis 7 examined the relationship between CP and UI. H7 predicted that Competitive Pressure (CP) would have a positive effect on Smart Contract Use Intention (UI). The results show a positive but not significant impact on UI (B= 0.118, t= 0.948, p= 0.343), which means that the results do not provide support for the predicted relationship between Perceived Competitive Pressure (CP) and Smart Contract Use Intention (UI). CP relates to the firm's perception of pressure from industry competitors (Oliveira & Martins, 2010). In addition, competitive pressure refers to the degree and level of pressure felt by organizations from their "same industry" competitors, emphasizing its significance as a significant incentive and adoption motivator (Gutierrez et al., 2015). The findings revealed that these companies do not consider the pressure from their competitors when deciding on new technology. As a result, these pharmaceutical suppliers do not make decisions based on what their competitors do (in this context).

Hypothesis 8 examined the relationship between BPP and UI. More specifically, H5 predicted that Business Partner Pressure (BPP) would have a positive effect on Smart Contract Use Intention (UI). The results revealed that BPP has a positive and significant impact on UI ($B= 0.351$, $t= 3.852$, $p= 0.001$), which means that the results provide support for the predicted relationship between Business Partner Pressure (BPP) and Smart Contract Use Intention (UI). Therefore, H8 was supported. It refers to the pressure that a company may suffer from its business partners regarding the adoption of a new technology. In the context of this study, the objective of this variable was to measure how important BBP is when a pharmaceutical company and its suppliers are evaluating the use intention of smart contracts. The findings revealed that BPP is crucial to the decision-making process, suggesting that managers may make judgments influenced by the pressures of their business partners. Of course, there are other factors that influence this pressure, such as total economic transactions between these organizations; the greater their economic dependency, the greater would be the pressure felt.

6.2.1 Theoretical Implications

In terms of academic contribution, this study contributes to advance the theories related to the application of new technologies in international markets. This research added value to the literature by performing a study about the intention to use of a novel technology (blockchain - smart contract) within an area of the supply chain of the pharmaceutical industry that has been not well explored yet (raw material supplier – manufacturer). Moreover, this research aimed to leverage the Technology – Organization – Environment theory (TOE) by exploring some of its dimensions. Although the TOE theory has been widely used to assess technology adoption among organizations since Tornatzky and Fleischer developed it in 1990, there are few (if any) studies adopting this theory to assess adoption intent of a new supply chain technology in the pharmaceutical industry. Results proved that the TOE theory is suitable for examining the use intention of a novel technology in the pharmaceutical industry.

As described in chapter 3, the research model was divided into three different dimensions: 1) Technology Characteristics (H1, H2, H3, and H4); 2) Organizational Characteristics (H5, and H6); and 3) Environmental Characteristics (H7, and H8). The summary of the findings was:

- Marginally Supported:
    - H3: Perceived Non-Complexity
    - H6: Organization Readiness
- Supported:
    - H5: Top Management Support
    - H8: Business Partner Pressure

The findings proved that the most relevant TOE dimension for this study was Organizational Characteristics where the two hypotheses were significant (H5 – TMS: Supported; and H6 – Organization Readiness: Marginally Supported). These results are relevant to both academic and management fields.

In comparison to Badi et al., (2021), their study sought to uncover the factors influencing the adoption of smart contracts in the UK construction sector. According to their data, three hypotheses were supported: Supply Chain Pressure (which I renamed as Business Partner Pressure), Competitive Pressure, and Top Management Support. It's interesting to note that this two research, conducted in completely different industries, produced comparable results.

- Similarities: Both studies had BPP and TMS Supported.
- Differences:
    - In contrast to this dissertation, Badi et al., (2021) found that Competitive Pressure was supported.

It is possible to conclude that because my research was conducted in an international setting with enterprises focused on exportation (particularly Chinese and Indian), competitive pressure was irrelevant in this scenario. Badi et al., (2021) conducted a study in a local area (UK), hence CP was shown to be relevant.

Finally, in sections 5.5.1 and 5.5.2, I detailed the findings from a comparison of different company sizes and countries. Under these circumstances, the findings were different from the overall sample, which may lead to further assumptions.

- Company Size: Table 19 shows that the results (p-value: 0.018) from "Large" companies had a significant impact on making the hypothesis H5 being supported. Furthermore, H8 followed the same pattern, with a p-value of 0.034, "Large" companies time influenced the BPP>UI relationship.

- Country: Table 21 shows that Brazil influenced negatively H8-BPP. Even though H8 was supported across the full sample, the p-value for Brazil was 0.923, indicating that Brazilian companies do not make decisions about using smart contracts based on pressure from their business partners, but Chinese and Indian companies do.

All the findings described in this section have the potential to contribute to academic research, but they can also have a significant impact on the business world when pharmaceutical enterprises (and even companies from other industries) decide whether or not to use smart contracts in their supply chain operations. Furthermore, certain results are inconclusive, particularly those based on firm size and country, which provide an ideal opportunity for further research.

6.2.2 Managerial Implications

The results have the potential to benefit the pharmaceutical industry and other industries with similar supply chain operations. In terms of managerial implications, I can stress that having Top Management Support is vital when considering adopting a new technology. In addition, two other factors were marginally supported and should be considered during the decision process of adopting smart contract: perceived non-complexity and organization readiness. Regarding external factors, this study revealed that Business Partner Pressure has a substantial influence when organizations decide to adopt a new technology. However, when I broke the data into different classifications (company size and country), it was possible to draw new conclusions. H3 (perceived non-complexity) was important for company from China but were not for companies from

Brazil and India. Another important difference was on H4 (perceived triability) where the results proved to an impact for India, but not from Brazil and China. In addition, H7 (competitive pressure) had a relevant result for Brazilian companies, but not for Indian and Chinese companies. Finally, H8 (business partner pressure) was important for China, but it was not for Brazil and India. Summarizing it in terms of relevance:

- Brazil: Competitive Pressure
- India: Perceived Relative Advantage; Top Management Support, and Business Partner Pressure.
- China: Perceived Non-Complexity; and Business Partner Pressure.

A possible explanation for such difference is the fact that the Brazilian economy is much more closed in terms of international business than the Chinese and Indian. Therefore, Brazilian companies are more focused oriented on the internal market (Competitive Pressure), while Chinese and Indian companies are more focused on external factors, such as Business Partner Pressure or customer driven. After all the analyses performed during this study, I concluded that there is not a single approach to address the research question. The strategy should be developed considering the size of the organization and its location. The following table is an attempt to create a hypothetical decision matrix to support pharmaceutical enterprises in deciding whether to implement a new technology (smart contract) considering the characteristics of their raw material suppliers.

Table 22 – Decision Matrix

	Brazil	India	China
Small	Competitive Pressure	Perceived Relative Advantage Business Partner Pressure	Business Partner Pressure
Medium	Competitive Pressure	Business Partner Pressure	Business Partner Pressure
Large	Competitive Pressure	Top Management Support Business Partner Pressure	Business Partner Pressure

It can be observed on table 22 that a pharmaceutical enterprise should take different approaches according to its supplier size and location. Therefore, for Brazilian suppliers, the enterprise should address the problem arguing that smart contract would be a competitive advantage over their competitors. For the Chinese suppliers, the enterprise should pressure them showing that this new technology would be important for their commercial relationship. Finally, for the Indian suppliers, the approach should differ according to company size, where business partner pressure is crucial for all sizes. To summarize, a pharmaceutical business interested in implementing smart contracts should take different approaches depending on its supplier. It should initially categorize its suppliers based on country and firm size. Following that, develop different strategies according to table 22 to increase the likelihood of success in encouraging its supplier to use this new technology.

Even though the research model did not account for country and company size, I found it intriguing to see the difference in findings when doing extra statistical analyses. Table 22 might serve as a reference for pharmaceutical organizations considering implementing smart contracts in their supply chain operations. Furthermore, these insights have the potential to be used across multiple industries with similar operations, and other technologies that might arise. However, it is important to note that those extra tests have significant limitations, particularly in terms of sample size, necessitating further research to make more conclusive assumptions.

6.3 Limitations and Future Research

Despite the fact that the data used to conduct this study is of high quality, it is important to acknowledge that it has limitations. Some countries or regions, such as Europe, were underrepresented, making it impossible to draw any further conclusions. Moreover, another limitation in terms of data is the amount collected. Some of the conclusions drawn in this study might be affected by the small sample size. The decision matrix presented in section 6.2.2 contains potential flaws due to the fact of there is not enough data to compare company size versus countries.

Another limitation is the fact that the respondent selection is outside of my control where each company was represented by a single survey response, which does not necessarily imply that it was a consensus position across the organization. The data was collected at a single point of time by a single representative per company, so it may not represent the oscillations that occur over time. Results could be different if the study was performed using other approaches, such as a longitudinal study.

In terms of research design, I acknowledge that there are also several limitations. The research model was developed using the TOE theory, and even though the TOE theory is suitable for addressing the research question, there are many other theories available that could have been used. In addition, this study analyzed eight different factors which are appropriate for a dissertation, but there are many other variables that could have been analyzed.

These limitations were not addressed to undermine the credibility of this study. The purpose is to highlight the complexity of performing a study where the unit of analyses were organizations. In addition, these limitations provide opportunities for future research.

More research is needed to overcome the limitations mentioned in this section. I was unable to collect enough data from Europe. As a result, another study might be conducted, including more data from Europe, and potentially expanding to other countries such as the United States. Although the analyses performed evaluating the differences between countries and company sizes were highly insightful, further research, adding more data, would be required to make more trustworthy conclusions.

In terms of data collection, more research is needed using different approaches to validate this dissertation's findings. A longitudinal study could be conducted to compare the responses from different points of time. In addition, another strategy could be to collect additional responses from each company and compare them to verify if there are any major differences.

Future research could expand on the research model by including new variables, such as Perceived Observability, Government Regulatory Support, and Cultural Characteristics. Moreover, other theories could be used to compare if would be any differences in the findings. There are several theories available, including the Technology Acceptance Model (TAM), the Diffusion of Innovations Theory (DOI), the Unified

Theory of Acceptance and Use of Technology (UTAUT), and the Theory of Reasoned Action (TRA).

Finally, future research could use the same research model to explore the other end of the pharmaceutical supply chain: from medicine producers to the final consumer. Another possibility is to use the same research model and context while expanding to include new countries. Future research could also compare different countries versus different company sizes which would expand the understanding of the decision matrix proposed in this dissertation.

6.4 Conclusions

One persistent concern among pharmaceutical companies is API traceability. Pharmaceutical enterprises must have rigorous control mechanisms to ensure API produced by manufacturers complies with product specifications, and that producers adhere to all quality steps of production. Furthermore, there is a need to ensure that suppliers are not falsifying key data such as expiration dates, impurity levels, etc. Therefore, I proposed that the novel technology of smart contracts, enabled by blockchain technologies, might directly improve these control processes and standards by 1) tracing and tracking raw materials (API); 2) reducing the likelihood of counterfeits; 3) reducing control costs; 4) increasing transparency; 5) increasing trust between producers and clients; and 6) reducing other costs such as transaction costs.

The main objective of this study was, therefore, to identify the drivers of use intention to adopt Smart Contract in this industrial environment. More specifically, I applied the dimensions of the Technology-Organization-Environment Theory (TOE) as a framework for measuring the factors that shape the use intention of smart contracts between pharmaceutical enterprises and their raw material suppliers. This research aimed to answer the following research question:

What are the factors that contribute to Smart Contract Use Intention between Pharmaceutical Enterprises and their Raw Material Suppliers?

In order to answer this research question, I developed a research model based on the TOE theory containing eight dependent variables and one independent variable. After collecting the data from 136 pharmaceutical suppliers across different countries, such as Brazil, China, and India, the results proved Top Management Support (TMS) and Business Partner Pressure (BPP) had a significant impact on the Smart Contract Use Intention (UI). Moreover, two independent variables were marginally supported: Perceived Non-Complexity (PNC) and Organization Readiness (OR).

In terms of academic contribution, this study contributes to advance the theories related to the application of new technologies in international markets. This research added value to the literature by performing a study about the intention to use of a novel technology (blockchain - smart contract) within an area of the supply chain of the pharmaceutical industry that has been not well explored yet (raw material supplier – manufacturer). Moreover, this research aimed to leverage the Technology – Organization – Environment theory (TOE) by exploring some of its dimensions. Although the TOE theory has been widely used to assess technology adoption among organizations since Tornatzky and Fleischer developed it in 1990, there are few (if any) studies adopting this theory to assess adoption intent of a new supply chain technology in the pharmaceutical industry.

The results have the potential to benefit the pharmaceutical industry and other industries with similar supply chain operations. As a result, in terms of managerial implications, I can stress that having TMS is vital when considering adopting a new technology. In addition, two other factors were marginally supported and should be considered during the decision process of adopting smart contract: perceived non-complexity and organization readiness. Regarding external factors, this study revealed that BPP has a substantial influence when organizations decide to adopt a new technology. Finally, this study provided evidence that companies should adopt different approaches according to company size and country during the decision process of adopting smart contracts. The decision matrix presented in the managerial implication section (table 22), could be used as a starting point for pharmaceutical organizations considering using smart contracts in their supply chain operations.

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APPENDICES

Appendix A - Consent Form (English version)

FLORIDA INTERNATIONAL UNIVERSITY

INFORMATIONAL LETTER

FACTORS INFLUENCING THE USE INTENTION OF SMART CONTRACTS BETWEEN PHARMACEUTICAL ENTERPRISES AND THEIR RAW MATERIAL SUPPLIERS

Hello, my name is Alexandre Prati. You have been chosen at random to be in a research study about the Factors Influencing the Use Intention of Smart Contracts Between Pharmaceutical Enterprises and Their Raw Material Suppliers. The purpose of this study is to further the knowledge of companies that are making the decision about the use intention of smart contract between buyer and suppliers within the pharmaceutical industry. Participation in this study will take 20 minutes of your time. If you agree to be in the study, I will ask you to do the following things:

1. You will be requested to give your consent.
2. You will be requested to complete an online questionnaire consisting of a pre-determined number of questions.

There are no foreseeable risks or benefits to you for participating in this study. It is expected that this study will benefit society by further the knowledge of companies that are making the decision about the use intention of smart contract between buyer and suppliers within the pharmaceutical industry. In addition, companies with similar supply chain operation, might benefit from the results of this study.

There is no cost or payment to you. If you have questions while taking part, please stop me and ask. You will remain anonymous, and your answers are confidential. The records of this study will be kept private and will be protected to the fullest extent provided by law. Research records will be stored securely and only the researcher team will have access to the records.

If you have questions for one of the researchers conducting this study, you may contact Alexandre Prati at (954) 803-4740. If you would like to talk with someone about your rights of being a subject in this research study or about ethical issues with this research study, you may contact the FIU Office of Research Integrity by phone at 305-348-2494 or by email at ori@fiu.edu.

Your participation in this research is voluntary, and you will not be penalized or lose benefits if you refuse to participate or decide to stop. You may keep a copy of this form for your records.

Appendix A.1 - Consent Form (Portuguese version)

FIU | FLORIDA INTERNATIONAL UNIVERSITY

CARTA INFORMATIVA

FATORES QUE INFLUENCIAM A INTENÇÃO DE USO DE SMART CONTRACTS ENTRE EMPRESAS FARMACÊUTICAS E SEUS FORNECEDORES DE MATÉRIA-PRIMA

Olá, meu nome é Alexandre Prati. Você foi escolhido aleatoriamente para participar de uma pesquisa sobre os fatores que influenciam a intenção de uso de smart contracts (contratos inteligentes) entre empresas farmacêuticas e seus fornecedores de matérias-primas. O objetivo deste estudo é aprofundar o conhecimento das empresas que estão tomando a decisão sobre a intenção de uso de smart contracts entre comprador e fornecedores dentro da indústria farmacêutica. A participação neste estudo levará aproximadamente 10 minutos do seu tempo. Se você concordar em participar do estudo, pedirei que você faça o seguinte:

1. Você será solicitado a dar seu consentimento.
2. Você será solicitado a responder um questionário online que consiste em um número pré-determinado de perguntas.

Não há riscos ou benefícios previsíveis para você por participar deste estudo. Espera-se que este estudo beneficie a sociedade ao aprofundar o conhecimento das empresas que estão tomando a decisão sobre a intenção de uso de smart contract entre comprador e fornecedores dentro da indústria farmacêutica. Além disso, empresas com operações semelhantes em outros segmentos podem se beneficiar dos resultados deste estudo.

Não há nenhum custo ou pagamento para você. Você permanecerá anônimo e suas respostas são confidenciais. Os registros deste estudo serão mantidos em sigilo e serão protegidos em toda a extensão prevista por lei. Os registros da pesquisa serão armazenados de forma segura e somente a equipe de pesquisadores terá acesso aos registros.

Se você tiver perguntas para um dos pesquisadores que conduzem este estudo, entre em contato com Alexandre Prati em +1 (954) 803-4740. Se você gostaria de falar com alguém sobre seus direitos de ser objeto neste estudo de pesquisa ou sobre questões éticas com este estudo de pesquisa, você pode entrar em contato com o Escritório de Integridade de Pesquisa da FIU pelo telefone +1 305-348-2494 ou por e-mail em ori@fiu.edu.

Sua participação nesta pesquisa é voluntária e você não será penalizado ou perderá benefícios caso se recuse a participar ou decida parar. Você pode manter uma cópia deste formulário para seus registros.

Appendix B.1 - Instrumentation (English Version)

Cod	Question	Scale	Reference
Demographic Questions			
DM1	How many employees does your company have?	Multiple Choice	
DM2	How many years of work experience do you have?		
DM3	What is the highest level of education that you have completed?		
DM4	What is your current hierarchical level?		
DM5	Where is your company located?		
INTRO	Smart Contract Introduction		
DM6	How familiar are you with blockchain technology?		
DM7	Has your company used smart contracts?		
Perceived Relative Advantage			
PRA1	A smart contract reduces payout time.	5 points Likert scale	Technological, organisational and environmental determinants of smart contracts adoption: UK construction sector viewpoint Badi et al., (2021)
PRA2	A smart contract reduces transaction cost.		
PRA3	A smart contract provides secured payments.		
PRA4	A smart contract protects contracting parties from insolvencies and late payments.		
PRA5	A smart contract reduces the occurrence of disputes among contracting parties.		
PRA6	A smart contract increases trust among contracting parties.		
Perceived Compatibility			
PC1	A smart contract is compatible with the existing contract management systems in my organization.	5 points Likert scale	
PC2	A smart contract is compatible with the contract management needs of my organization.		
PC3	A smart contract is consistent with the existing values and believes of my organization.		

PC4	Smart contracts would be **compatible** to integrate with our current processes	
PC5	The current structure and processes of our organization are well-suited for the integration of smart contracts.	
PC6	I believe that would not require extensive reworking of our current contract processes.	
Perceived Non-Complexity		
PNC1	A smart contract is easy to understand	5 points Likert scale
AQ1	For this question, please select somewhat agree	
PNC2	A smart contract is easy to use and is manageable	
PNC3	A smart contract is easy to integrate with existing contractual processes in my organization.	
PNC4	It would not be difficult to understand how smart contracts work.	
PNC5	Smart Contracts do not appear to be particularly challenging.	
Perceived Trialability		
PT1	I intend to try out a smart contract in a limited scope in my works, before deciding whether to adopt it in practice.	5 points Likert scale
PT2	A trial period before adopting a smart contract in practice will reduce my perceived risks.	
PT3	Being able to try out a smart contract is important in my decision to adopt it in the future.	
PT4	I think it would be feasible for our organization to conduct trials or pilot projects with smart contracts to assess their benefits and compatibility.	
PT5	Our organization would be open to experience smart contracts in a controlled trial or pilot setting.	
PT6	Smart contracts would be easy to try out on a limited basis	

Top Management Support		
TMS1	Top management in my organization is aware of the benefits that smart contracts can provide	5 points Likert scale
TMS2	Top management influences employees to increase awareness of the importance/ advantages that smart contracts can bring.	
TMS3	Top management provides adequate resources for employees to adopt smart contracts.	
TMS4	There is visible support from top management for the adoption of smart contracts.	
TMS5	Top management have expressed interest in exploring potential benefits offered by smart contracts.	
Organizational Readiness		
OR1	My organization has the needed resources to support smart contract adoption.	5 points Likert scale
OR2	Existing technologies in my organization support smart contract adoption.	
OR3	Information Technology (IT) staff within my organization have the adequate skills and experience to support smart contract adoption.	
AQ2	For this question, please select somewhat agree	
OR4	My organization is ready to adopt smart contracts, and there are no significant barriers preventing us from doing so.	
Competitive Pressure		
CP1	The use of smart contracts would offer my organization a stronger competitive advantage.	5 points Likert scale
CP2	The use of smart contracts would increase the ability of my organization to outperform the competition.	
CP3	The use of smart contracts will allow the generation of higher profits to my organization.	
CP4	My organization have experienced competitive pressure to adopt smart contracts.	
CP5	My organization would have experienced a competitive disadvantage if smart contracts had not been adopted.	
Business Partner Pressure		

BPP1	My organization's business partners recommend the adoption of smart contracts.	5 points Likert scale	
BPP2	My organization's business partners have requested the adoption of smart contracts.		
BPP3	My organization have experienced pressure from business partners to adopt smart contracts.		
BPP4	Important business partners are likely to push the adoption of smart contracts.		
BPP5	Our business partners would be more likely to keep working with us if we adopt smart contracts.		
Smart Contract Use Intention			
UI1	My organization intends to use smart contracts actively.	5 points Likert scale	
UI2	My organization intends to actively recommend smart contracts to others.		
UI3	My organization intends to use smart contracts continuously in various projects.		
UI4 (-)	My organization has no intention to use smart contracts in business interactions with other companies.		
UI6	My organization intends to use smart contract as much as possible.		
UI7	My organization plans to implement smart contracts in business interactions with other companies.		

Appendix B.2 - Instrumentation (Portuguese Version)

Cod	Question	Scale	Reference
Demographic Questions			
DM1	Quantos funcionários sua empresa possui?	Multiple Choice	
DM2	Quantos anos de experiência profissional você tem?		
DM3	Qual é o nível de ensino mais elevado que você completou?		
DM4	Qual é o seu nível hierárquico atual?		
DM5	Onde sua empresa está localizada?		
INTRO	Smart Contract Introduction		
DM6	Quão familiarizado você está com a tecnologia blockchain?		
DM7	Sua empresa ja usou contratos inteligentes (Smart Contracts)?		
Vantagem Relativa Percebida			
PRA1	Um contrato inteligente reduz o tempo de pagamento.	5 points Likert scale	Technological, organisational and environmental determinants of smart contracts adoption: UK construction sector viewpoint Badi et al., (2021)
PRA2	Um contrato inteligente reduz o custo de transação.		
PRA3	Um contrato inteligente oferece pagamentos seguros.		
PRA4	Um contrato inteligente protege as partes contratantes de insolvências e atrasos nos pagamentos.		
PRA5	Um contrato inteligente reduz a ocorrência de disputas entre as partes contratantes.		
PRA6	Um contrato inteligente aumenta a confiança entre as partes contratantes.		
Compatibilidade Percebida			
PC1	Um contrato inteligente é compatível com os sistemas de gestão de contratos existentes na minha organização.	5 points Likert scale	
PC2	Um contrato inteligente é compatível com as necessidades de gerenciamento de contratos da minha organização.		
PC3	Um contrato inteligente é consistente com os valores e crenças existentes na minha organização.		

PC4	Os contratos inteligentes seriam compatíveis de integrar aos nossos processos atuais.		
PC5	A estrutura e os processos atuais da nossa organização são adequados para a integração de contratos inteligentes.		
PC6	Acredito que isso não exigiria reformas extensas de nossos processos de contrato atuais.		
Não Complexidade Percebida			
PNC1	Um contrato inteligente é fácil de entender.	5 points Likert scale	
AQ1	Para esta pergunta, selecione concordo um pouco		
PNC2	Um contrato inteligente é fácil de usar e gerir		
PNC3	Um contrato inteligente é fácil de integrar aos processos contratuais existentes na minha organização.		
PNC4	Não seria difícil entender como funcionam os contratos inteligentes.		
PNC5	Os Contratos Inteligentes não parecem ser particularmente desafiadores.		
Testabilidade Percebida			
PT1	Pretendo testar um contrato inteligente em um escopo limitado, antes de decidir se vou adotá-lo na prática.	5 points Likert scale	
PT2	Um período experimental antes de adotar um contrato inteligente na prática, reduzirá os riscos percebidos.		
PT3	Ser capaz de experimentar um contrato inteligente é importante na minha decisão de adotá-lo no futuro.		
PT4	Penso que seria viável para a nossa organização realizar testes ou projetos piloto com contratos inteligentes para avaliar os seus benefícios e compatibilidade.		
PT5	Nossa organização estaria aberta para experimentar contratos inteligentes em um teste controlado ou em um ambiente piloto.		
PT6	Seria fácil testar contratos inteligentes de forma limitada.		

Suporte da Diretoria		
TMS1	A alta administração da minha organização está ciente dos benefícios que os contratos inteligentes podem oferecer.	5 points Likert scale
TMS2	A alta administração influencia os funcionários a aumentar a conscientização sobre a importância/vantagens que os contratos inteligentes podem trazer.	
TMS3	A alta administração fornece recursos adequados para que os funcionários adotem contratos inteligentes.	
TMS4	Há apoio visível da alta gerência para a adoção de contratos inteligentes.	
TMS5	A alta administração tem manifestado interesse em explorar os benefícios potenciais oferecidos pelos contratos inteligentes.	
Prontidão Organizacional		
OR1	Minha organização possui os recursos necessários para apoiar a adoção de contratos inteligentes.	5 points Likert scale
OR2	As tecnologias existentes na minha organização apoiam a adoção de contratos inteligentes.	
OR3	A equipe de Tecnologia da Informação (TI) da minha organização possui as habilidades e a experiência adequadas para apoiar a adoção de contratos inteligentes.	
AQ2	Para esta pergunta, selecione concordo um pouco	
OR4	A minha organização está pronta para adotar contratos inteligentes e não existem barreiras significativas que nos impeçam de o fazer.	
OR5	~~A minha organização alocaria os recursos e o orçamento necessários para a implementação de contratos inteligentes.~~	
Pressão Competitiva		
CP1	O uso de contratos inteligentes ofereceria à minha organização uma vantagem competitiva mais forte.	5 points Likert scale
CP2	O uso de contratos inteligentes aumentaria a capacidade da minha organização de superar a concorrência.	
CP3	A utilização de contratos inteligentes permitirá a geração de maiores lucros para minha organização.	

CP4	Minha organização tem sofrido pressão competitiva para adotar contratos inteligentes.		
CP5	A minha organização sofreria uma desvantagem competitiva se os contratos inteligentes não forem adotados.		
Pressão dos Parceiros de Negócio			
BPP1	Os parceiros de negócios da minha organização recomendam a adoção de contratos inteligentes.	5 points Likert scale	
BPP2	Os parceiros comerciais da minha organização solicitaram a adoção de contratos inteligentes.		
BPP3	Minha organização tem sofrido pressão de parceiros de negócios para adotar contratos inteligentes.		
BPP4	É provável que parceiros comerciais importantes pressionem pela adoção de contratos inteligentes.		
BPP5	É mais provável que os nossos parceiros de negócios continuem a trabalhar conosco se adotarmos contratos inteligentes.		
Intenção de Uso de Contrato Inteligente			
UI1	Minha organização pretende usar contratos inteligentes ativamente.	5 points Likert scale	
UI2	Minha organização pretende recomendar ativamente contratos inteligentes para outras empresas.		
UI3	Minha organização pretende usar contratos inteligentes continuamente em vários projetos.		
UI4 (-)	Minha organização não tem intenção de usar contratos inteligentes em interações comerciais com outras empresas.		
UI5	~~Minha organização está considerando ativamente o uso de contratos inteligentes.~~		
UI6	Minha organização pretende usar contratos inteligentes tanto quanto possível.		
UI7	Minha organização planeja implementar contratos inteligentes em interações comerciais com outras empresas.		

Appendix C – Data Collection Table

Data Collection

Student Name: Alexandre Prati

Direct Supplier Link https://fiu.qualtrics.com/jfe/form/SV_8G4BqdfGU3co3jg

Indirect Supplier Link https://fiu.qualtrics.com/jfe/form/SV_cBayLXY5vczAdlY

Brazilian Supplier Link https://fiu.qualtrics.com/jfe/form/SV_ezlZYuxcfbO63Ns

				Reminder		
			MON	MON (1st)	MON (2nd)	MON (Final)
Supplier	Contact (email)	Country	6-Nov	13-Nov	20-Nov	27-Nov

VITA

ALEXANDRE PRATI

Born, Santa Helena, Brazil

2003-2008	B.A., Business Administration University of Maringa - UEM Maringa, Brazil
2008-2010	Supply Chain Manager Prati-Donaduzzi Toledo – Brazil
2010-2012	MBA – Master of Business Administration University of Pittsburgh Pittsburgh, Pennsylvania
2012-2019	Co-Founder and Sales Director Vizeme Cosmeticos Toledo, Brazil
2016-2021	Co-Founder and School Principal Harbor Bilingual School Toledo, Brazil
2021-2024	DBA – Doctoral of Business Administration Candidate Florida International University Miami - Florida
2021 - Present	Global Expansion Director Prati-Donaduzzi Miami - Florida