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Supply Chain Management

Postgraduate Dissertation

Perceived Benefits and Challenges in Adopting Block Chain Technology in
Greek Supply Chain Sector

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To the memory of my mother and father

Πρόλογος

Το blockchain είναι μία από τις ταχύτερα αναπτυσσόμενες αναδύόμενες τεχνολογίες παγκοσμίως. Η τεχνολογία αυτή βοηθά διάφορους τομείς, συμπεριλαμβανομένων της εφοδιαστικής αλυσίδας, του μάρκετινγκ, των οικονομικών και της πληροφορικής. Η παρούσα έρευνα έχει ως στόχο να αντιμετωπίσει τις προκλήσεις στην υιοθέτηση της τεχνολογίας blockchain στον ελληνικό τομέα της εφοδιαστικής αλυσίδας και να επισημάνει τα αντιληπτά οφέλη και προκλήσεις της. Οι δημογραφικές ερωτήσεις αποτελούν τις ανεξάρτητες μεταβλητές της μελέτης, ενώ τα αντιληπτά οφέλη της τεχνολογίας blockchain και οι τεχνολογικές, οργανωτικές, οικονομικές, διοικητικές, κανονιστικές και κοινωνικές προκλήσεις αποτελούν τις εξαρτώμενες μεταβλητές. Η έρευνα ακολουθεί ποσοτική προσέγγιση για τη διεξαγωγή της και συλλέγει δεδομένα από 36 συμμετέχοντες που ανήκουν στην Ελληνική εφοδιαστική αλυσίδα με τη βοήθεια ερωτηματολογίου σχετικά με την υιοθέτηση της τεχνολογίας blockchain στην εταιρεία τους. Τα συλλεγόμενα δεδομένα αναλύονται με τη βοήθεια στατιστικής ανάλυσης, δηλαδή ανάλυση αξιοπιστίας, συσχέτισης, παλινδρόμησης και μη παραμετρικής ανάλυσης. Το αποτέλεσμα της ανάλυσης αξιοπιστίας επιβεβαιώνει ότι το ερευνητικό όργανο είναι έγκυρο και αξιόπιστο για την περαιτέρω ανάλυση. Η ανάλυση συσχέτισης επιβεβαιώνει ότι υπάρχει ισχυρή συσχέτιση μεταξύ των περισσότερων μεταβλητών. Η ανάλυση παλινδρόμησης καθώς και η μη παραμετρική ανάλυση επιβεβαιώνει ότι μόνο λίγες ανεξάρτητες μεταβλητές έχουν σημαντική επίδραση στα αντιληπτά οφέλη και προκλήσεις της τεχνολογίας blockchain. Στο μέλλον, η έρευνα μπορεί να πραγματοποιηθεί στη σύγκριση δύο τομέων, π.χ. αλυσίδα εφοδιασμού και λιανεμπορίου, για την ανάλυση των οφελών του blockchain σε αμφοτέρους τους τομείς.

Λέξεις-κλειδιά: Εφοδιαστική Αλυσίδα, Blockchain, Προκλήσεις του Blockchain, Οφέλη του Blockchain, Ελλάδα.

Abstract

Blockchain is one of the fastest growing emerging technologies across the globe. The technology helps various sector including supply chain, marketing, finance, and Information Technology. The current research aims to address the challenges in adopting the blockchain technology in Greek supply chain sector and highlights its perceived benefits and challenges. The demographic questions are independent variables of the study whereas perceived benefit of blockchain and technological, organizational, financial, administrative, regulatory and social challenges are the dependent variable. The research adopts quantitative research approach for conducting the research and collects data from 36 respondents with the help of questionnaire. The data collected from the respondents belong to Greek supply chain sector for providing the relevant information related to blockchain adoption in their company. The collected data analyzed with the help of statistical analysis i.e., reliability, correlation, regression analysis and non-parametric test. The result of reliability analysis confirms that the research instrument is valid and reliable for conducting further analysis. The correlation analysis confirms that there is strong correlation exists between most of variables. The regression analysis and the non-parametric test confirm that only a few independents variables have significant impact on perceived benefits and challenges of blockchain technology. The future research can be made by comparing the two sectors i.e., supply chain and retail, for analyzing the benefits of blockchain in both sectors.

Keywords: Supply Chain, Blockchain, Challenges of Blockchain, Benefits of Blockchain, Greece.

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Chapter 1: Introduction

1.1 Background of the Study

Blockchain is a developing technology that is beneficial for supply chain sector. According to Chang and Chen (2020), the technology's decentralized nature has made it flexible for organizations to share the data with high security. To minimize transaction and operational expenses, it is necessary for supply chain organizations to facilitate the sharing of suppliers' records among various departments. According to Moosavi et al. (2021), conventional information-sharing techniques such as encryption are deemed ineffective due to their vulnerability to numerous cyber-attacks. Li et al. (2021) attempts to highlight that blockchain technology can be the most beneficial solution to existing supply chain problems. In his research, Jabbar et al. (2021) has highlighted the diverse prospects presented by blockchain in the supply chain industry. One such opportunity is the adoption of a decentralized structure that enables information storage on a cloud-based server. The decentralized nature of blockchain technology facilitates information sharing among supply chain professionals. Another opportunity highlighted in the study conducted by Longo et al. (2019) is the strong authorization and authentication of standards to the supply chain companies. The implementation of blockchain technology improves the authentication of supply chain records, thereby benefit both research and operational endeavors. Additionally, smart contracts are emphasized as a valuable opportunity in the supply chain sector, as they provide standardized features for suppliers' data, enabling more informed decision-making processes. Moreover, blockchain technology can bring data privacy and integrity to the supplier's record and can share across the companies.

Schmidt and Wagner (2019) highlighted that maintaining and integrating blockchain technology can be costly if the organization implements the system without collaboration with other marketplaces. Some marketplaces offer pre-built modules that allow cost-effective and quick implementation of blockchain technology. Hastig et al., (2020) recommended that by using this approach for implementing blockchain in the supply chain sector, organizations can save money and time. Talented and qualified professionals are also building exceptional blockchain services and products. Using the talent, organizations can expand their smooth application of the technology in their business processes with the limited cost.

However, blockchain technology also possesses some challenges along with these benefits. Xu et al. (2021) highlighted the lack of standardization as the main challenge possessed by blockchain

technology. As blockchain technology is developing, there are no proper regulations for the technology to its implementation policy. Omar et al. (2022) recommends that this challenge can be resolved by setting the worldwide standard for the technology. The legalization of blockchain technology helps the supply chain sector easily share the companies and suppliers' data in different companies, hence reducing the operational cost for overall companies. Another challenge identified in the implementation of blockchain technology is the skill gap present in the sector (Xiong et al 2021). The demand for blockchain developers is increasing rapidly, but there are insufficient resources available for getting familiar with the updates made in technology in recent times. Wang et al. (2020) recommends that educational institutes reduce the skill gap present in the industry by offering relevant courses and conducting deep research related to block technology. Another challenge that is identified is the cost associated with the implementation of blockchain technology in supply chain sector. Shoaib et al. (2020) suggests that collaborating with different marketplaces and utilizing emerging talent may help organizations reduce blockchain implementation costs. Overall, the current research concludes that blockchain can be the turnaround factor for the supply chain sector if implemented carefully and with proper governance.

1.2 Importance of Blockchain in Supply Chain Sector

Blockchain technology can transform the mechanism of the traditional supply chain network in a decentralized manner in which data are recorded. Kusi-Sarpong et al., (2022) stated that blockchain technology is helping suppliers to put themselves in an ecosystem while improving confidentiality, security, and interoperability of the data. Wang et al., (2022) stated that promoting the implementation of Blockchain technology in supply chain records can help organizations, suppliers, research institutions, and governments to have numerous benefits. Additionally, Blockchain technology helps participants to inform with relevant information at each encounter which helps in enabling the provision of personalized and efficient supply. Blockchain has solved the problem of sharing departmental records by standardization and centralization of supply chain data.

Park and Li (2021) identified limited studies conducted on the implementation of blockchain technology in supply chain sector. Mukherjee et al. (2021) has identified different challenges and opportunities associated with blockchain technology implementation in the supply chain sector. The future work can be done by meeting those challenges by implementing the recommendations made in the study. The study recommendations will be helpful for supply chain sector to reduce the

operational cost in implementing blockchain technology. Moreover, the supply chain sector can utilize the opportunities in the blockchain and develop a framework that helps the smooth flow of information across supply chain sector (Xu et al. 2021). The educational institute must conduct advanced training to spread awareness regarding blockchain technology's rise and reduce the skill gap recently present in supply chain sector. Additionally, there is still room for further research that can be made on blockchain technology in the supply chain sector. According to Chen et al. (2020), blockchain can help the supply chain sector develop the use of technology and transform their business process. A specific framework is required for the supply chain sector with the help of blockchain technology which helps suppliers and companies to store and access data anywhere. The ease of access with solid privacy and authentication can only be possible with the effective implementation of blockchain.

1.3 Blockchain Digitization in Supply Chain

Since blockchain can keep track of safety standards, legality, ownership transfer, and asset provenance in near real-time, it may make supply chain dispute resolution a thing of the past (Dutta et al. 2020). Blockchain provides two layers of protection for supply chain data: first, hackers are deterred by the system's encryption, which is set up to prevent data tampering by requiring verified, original data inputs before proceeding with the blockchain's verification and subsequent processing (Wang et al. 2019). Second, a digital identity is assigned to each authorized member in the supply chain network, allowing for the transfer of ownership of the cargo without any physical change.

Shirmali and Patel (2022) stated that supply chain participants may monitor their orders and their status in real time thanks to blockchain technology, which also regulates embedded contract terms. In this way, businesses may coordinate their activities so that they effectively adhere to the outlined compliance framework, and the blockchain's recorded information can be easily verified through audit.

According to Lim et al. (2021), the accuracy of a forecast is dependent on the validity of the connection between past data and current data, which is always reliant on the existing historical data used to forecast periods. Since blockchain can give both real-time data and secure historical data that extends back to the blockchain's genesis block, it has the potential to enhance demand forecasting (Jabbar et al. 2021).

According to Hastig and Sodhi (2020), many participants in a supply chain now rely largely on centralized intermediaries like banks or legal companies to act as brokers of trust and ensure that all transactions are properly recorded, validated, and coordinated. Customs and other government regulators also play a role in the supply chain to ensure regulatory compliance. Xu et al. (2021) stated that supply chains are made more difficult by the presence of intermediaries and regulators due to the additional burden of proof, data transmission, unequal trust, variability, and expenses that they introduce. Omar et al. (2022) stated that blockchain can be used to address this growing web of complexity. Park and Li (2021) stated that the problems come up when the process alignment is needed for effective communication and data exchange between an internal legacy systems like PLM or ERP and blockchain systems. Mukherjee et al. (2021) highlighted that there is still a flaw in the blockchain interaction with the legacy systems. Since the organizations are not ready to restructure, update, and support legacy systems, it is a major hindrance in smooth data transfer between legacy systems and blockchain systems

When the supply chain partners are not open to information sharing to the organizations, it could cause a negative effect on the benefits of choosing blockchain and even reduce the effectiveness of implementing block chain with supply chain partners. Since blockchain is a decentralized process, it gives freedom to blockchain coders and developers. Therefore, due to limited standardization of IT sector, various blockchain groups are unable to connect with in the absence of translation setups that could speed up the process. Gokalp et al. (2022) stated that the absence of standardization will limit the communication and cooperation of the participants of the blockchain.

1.4 Problem Statement

Blockchain is a nascent technology, and the skills needed to use and develop short in the marketplace. According to Lahkani et al. (2020), the skill gap is one of the topmost challenges faced in implementing blockchain technology in supply chain sector. The marketplace of blockchain expertise is highly competitive as the blockchain council stated that demand for blockchain engineers increased by 500% in 2019. According to Bischoff and Seuring (2021), the challenges and costs associated with talent acquisition in the field contribute to organizations' apprehensions regarding the adoption of blockchain technology and its integration with existing legacy systems. Aich et al., (2019) suggested that to counteract the skill gap that utilizes Blockchain as a service that enables the

organization to avail the benefits of Blockchain without investing heavily in the technical talent behind it.

The challenges of implementing blockchain technology are not limited to lack of skill and standardization but also cost the organization heavily. Shakhbutalov et al., (2020) stated that the implementation of blockchain technology requires heavy investment because of the advanced mechanism possessed by it. Xue et al., (2021) point out that the cost of installing a blockchain system depends on various factors such as application features, type of Blockchain in supply chain, number of suppliers, and other technology stacks. Thus, the cost of implementing blockchain technology in the supply chain sector is one of the significant challenges that needs to be resolved for the better application of technology.

1.5 Research Questions

1. What is the current status of Greek companies for adoption of blockchain technology in the supply chain sector?
2. What are the challenges for the adoption of blockchain technology in the Greek Supply Chain sector?
3. What are the perceived benefits for the adoption of blockchain technology in the Greek Supply Chain sector?

Chapter 2: Literature Review

2.1 Perceived Benefits of Block Chain Technology in Supply Chain

Litke et al. (2019) assert that blockchain's characteristics and qualities extend beyond digital currency, offering advantages over centralized methods and systems. Researchers have explored numerous areas where blockchain can prove beneficial to contracting parties and users, such as peer view and voting, transportation and logistics, accounting and assurance, supply chain management, electronic payment, and smart contracts (Gonczol et al., 2020). Supply chain management (SCM) has emerged as a particularly promising field for leveraging the benefits of blockchain technology, as demonstrated by several research studies investigating its potential applications. SCM is "the systemic, strategic collaboration of traditional business functions and the techniques between these

functions within a single organization and across businesses within the supply chain," Reliability, legality, safety, settlement of disputes and tracking are only a handful of the supply chain value factors of blockchain that could boost the long-term effectiveness of supply chains. Gokalp et al. (2022) stated that cost savings, immutability, transparency, and enhanced demand forecasting are just few of the value drivers that have been emphasized by numerous authors in relation to blockchain. In this section, we shall talk about the biggest and best value drivers in relation to supply chain management.

2.1.1 Traceability

According to Al-Farsi et al. (2021), the ability of consumers, government agencies, authorities, and supply chain stakeholders to manage and respond to risks in a timely and recorded manner is one definition of supply chain traceability. Transactions and activates that occur within supply chains can be dispersed over time and place at specific intervals since a supply chain is by definition a distributed network of engaged parties. Therefore, one of the primary goals of SCM is to increase supply chain visibility and traceability, a goal that is typically closely related to the achievement of better supply chain performance (Iqbal and Butt, 2020). As a result, a high-quality supply chain traceability system should work to reduce the manufacturing and distribution of harmful or low-quality goods by enhancing product labelling and tracking. Upstream supply chains have typically been the primary priority of traceability efforts, with origin and source tracing serving as the central focus (Pournader et al. 2020). In more recent years, however, the scope of traceability has been extended to cover downstream supply networks, allowing for the tracking of products through their various layers of distribution to their final users. Customers' growing appreciation for product traceability has inspired this range extension. According to Tan et al. (2023), customers place a high value on companies that indicate them where their products came from, who manufactured them, who delivered them, and how they got there in real time. This information might give the company that gives it a significant competitive advantage.

Researchers were unsure of how far centralized enterprise resource planning (ERP) technology was falling behind in its application to supply chain management, on the grounds that ERP was ill-prepared to accommodate the evolving requirements of the supply chain in terms of visibility, adaptability, data accessibility, and high-level decision making (Wang et al. 2019). Businesses, governments and consumers all desire more transparency and traceability from the producers, manufacturers and brands they work with. This demand has sparked a revolution in the supply chain.

According to Al-Amin et al. (2021), due to the pervasive lack of transparency and traceability in the present supply chain architecture, many customers and purchasers still face barriers to reliable and effective ways of checking product details and origins of services and product. In this setting, companies are realizing they need to improve their supply chain visibility and traceability in order to better communicate their sustainable, environmental and social credentials to consumers.

Through the use of field-sensing technologies like Radio-frequency identification (RFID), a prime example of an application within the Internet of Things, blockchains might produce actionable, shareable and unchangeable, records of products' digital footprints from beginning to finish of the supply chain (Ahmed and McCarthy, 2021). Many industries, including those dealing with food, pharmaceuticals, and luxury goods, stand to benefit greatly from the increased product awareness made possible by blockchain (Li et al. 2020). Since blockchain and its tracking capabilities can offer a complete audit record of transaction information for every touchpoint in the supply chain, and can also add immutable, transparent and verifiable records in the form of digital certificates to products' provenance, this technology has great potential. According to Yu (2021), information on the origin, validity, and data for a product can then be made available to governments, customers and all firms involved. When an incident like a food contamination epidemic occurs, businesses are now better prepared to quickly and reliably trace back the journey of a product to its source within their supply chains.

2.1.2 Dispute resolution

According to Saberi et al. (2019), supply chain issues can emerge when a company's contracted third-party vendor does not meet one or more of the following criteria: (1) it does not deliver the agreed-upon quantity of items; (2) it does not deliver the products on time; (3) products are compromised while in transit. Stakeholders in the supply chain should be able to promptly recognize and assess the situation in light of these possibilities. According to Sidorov et al. (2019), disputes over such matters frequently develop, and are ultimately resolved through fines or compensation. Companies rarely like to become involved in these kind of conflicts because of how time-consuming and expensive auditing a product's trace can be. Choi (2020) state that the escalation of these disagreements has two root causes: first, the frequent occurrence of ambiguous contract phrases, and second, a degree of missing accountability amongst the parties concerned. By incorporating smart contracts, in which corporate regulations are specified within a variety of fines, compensations or

frameworks can be activated automatically at minimal operational costs, for instance in cases where compliance with regulations and pre-set terms has been violated.

2.1.3 Cargo integrity and security

Invoices, insurance policies and bills of lading are all examples of documents that should be included in a supply chain transaction to guarantee that all parties involved are paid and that no tampered-with goods are exchanged (Wamba et al. 2020). Paper certificates, which are commonly used to establish the authenticity of priceless objects, are prone to loss and forgery. Kouhizaded et al. (2021) stated that the current system makes it difficult, if not impossible, to ascertain whether or not a traded diamond is legitimate by verifying its certificate. Unfortunately, more risk lurks around the corner as global trade becomes highly depended on electronic documents, electronic trading platforms, and IT which could badly destabilize supply chain operations; malicious hackers can create fake cargo or product documentation, employees can engage in malicious intra-company activities and hackers can also launch cyber-attacks against companies. Zhu et al. (2022) have acknowledged these risks and remarked that the risk of cybercrime has never been reduced despite many attempts using techniques such as threat warnings, malware or antivirus software and even password protection.

According to Kurdi et al. (2022), blockchain technology provides an additional layer of protection against these fraudulent activities by linking the virtual and physical transit of goods. This ensures that only authorized parties can receive the shipment, preventing its theft or misappropriation. Queiroz and Wamba (2019) have also discussed the benefits of blockchain in terms of security, noting that the distributed ledger it employs makes it impossible for hackers to exploit a weak spot in the network by rendering the network inoperable if even a single node fails. In the event that a data administrator is compromised, the entire system might be vulnerable to tampering and false information, but the consensus mechanism of blockchains prevents this.

2.1.4 Compliance

There are a variety of regulations that must be kept an eye on and followed in today's global trade. Salah et al. (2020) stated that companies who fail to comply with standards including environmental responsibility, social responsibility, technical rules, product integrity, and product safety. Sanka et al. (2021) stated that company could face regulatory scrutiny or other negative consequences to their reputation and prestige in the supply chain. Achieving efficient and effective communication and coordination of compliance standards throughout the whole supply chain are important cruxes of

managing current and developing compliance issues in the supply chain. After identifying these challenges, researchers looked at how blockchain technology could help businesses overcome them.

2.1.5 Improved demand forecasting

According to Chang and Chen (2020), demand management is essential for the success of a supply chain. In addition to effective planning, organization, and integration, a company must possess the capability to manage the need and exert influence over the supply and demand dynamics within the supply chain. Making adjustments to supply and demand within the supply chains can be instrumental in maximizing profitability for the entire network, as highlighted by Moosavi et al. (2021). "Demand management" is stated as "the coordinated efforts of supply chain stakeholders to estimate expected future demand, collaboratively influence demand, and correspondingly create their supply." Because all supply chain actors can have instantaneous access to all blockchain data, collaboration on planning can be expedited and made more accurate for all parties involved.

2.1.6 Trust and stakeholder management

To be one of the most crucial components in a devoted and cooperative relationship between supply chain stakeholders. Longo et al. (2019) in their research paper stated that "Trust and Trustworthiness in Supply Chains," the importance of trust and trustworthiness in supply chains is emphasized and how it affects information sharing and the precision of forecasts. Therefore, the degree of dependability and trust is crucial in supply chain matching. According to Schmidt and Wagner (2019), companies need to keep three things in mind in order to build trust between partners and achieve high level of clarity throughout the supply chain. First, the supply chain needs to optimize the various flows of information; second, a holistic perspective of all key activities must be developed; and third, the entire supply chain must be integrated through the use of cutting-edge technologies. Blockchain relies on a distributed network of computers to record and verify transactions in a series of connected, time-stamped blocks of data. In this regard, the data kept on the chain cannot be changed or altered, and all parties participating in the supply chain can view, verify, and audit the data at any time. Information about products, transactions, and supply chain partners' credentials and reputations may all be accessed in real time and at reasonable prices. According to Cai et al. (2021), this not only achieves the neutralization of pre-existing unequal trust but also allows for the exact and forthright identification of a product's source.

2.2 Challenges and Barriers to blockchain implementation

Wang et al. (2020) recommend that for a fruitful implementation of blockchain technology, companies must identify the issues and barriers. For this, the supply chain partners can play a positive role by supporting the companies to realize the challenges and then inculcate them in the execution plan of incorporating blockchain technology in the company. Shoaib et al. (2020) stated that there are certain major concerns in the wholesale acceptance of blockchain in the company. The implementation of blockchain in the organization have multiple barriers that can be categorized to four major types; 1. Intra-organizational barrier, 2. Inter-organizational barriers, 3. System-related barriers, and 4. External barriers.

2.2.1 Intra-organizational barriers

Intra-organizational barriers can be defined as the barriers that are related to the organizations' internal operations. Many intra-organizational factors play a key part in realizing the organizations' willingness to integrate blockchain technology in their supply chain sector.

2.2.2 Lack of top management awareness

The support from top management is essential for an organization to inculcate a major change in the company. Bischoff and Seuring (2021) stated that integration of blockchain for smooth supply chain experience requires strong commitment from top management for a longer stretch of time owing to technological advancements of the system. Aich et al. (2019) stated that blockchain implementation demands massive support in terms of finances and other resources, a lack of commitment from top management can prove to be a hindrance for the successful implementation of blockchain.

2.2.3 Lack of interoperability and integration problems

One of the key barriers are integration and interoperability. According to Shakhbulatov et al. (2020), they impact both internal and external data transfer, thereby making it intra and inter-organizational barrier. When various people, systems, or things work together to enable data sharing in a presentable way for both groups involved in the process, it is interoperability. Xue et al. (2021) stated that there are two appearances of interoperability challenges: data exchange between two individual blockchain systems, and exchange of data between a legacy system and blockchain system. The former issue stems from an increasing number of blockchain applications, resulting in too many heterogeneous blockchain solutions. Wang et al. (2022) stated that it results in many blockchain features that make

the compatibility a challenging process for various blockchain. It is also difficult to integrate blockchain in the preexisting organizational IT systems.

2.2.4 Inter-organizational barriers

When an organization aligns the blockchain of the company with the supply chain setup, certain barriers may appear, these are inter-organization barriers. Xu et al. (2021) stated that the technology alignment process is laced with challenges owing to the types of organizations and the mode of information transmission. Additionally, limited standardization and a lack of cooperation from supply chain is also an inter-organization barrier.

2.2.5 Lack of supply chain collaboration

The first step to integrate block chain in the supply chain is the openness from the supply chain partners to accept it. Chen et al. (2020) stated that the purpose of block chain is to collect data and ensure transparency, the supply chain partners agreeing to it must be ready to release their information. Not all companies are open towards sharing their information. According to Litke et al. (2019), there are many reasons to it, firstly, information sharing is taken as a competitive vulnerability. Gonczol et al. (2022) stated that along with information sharing reluctance, supply chain collaboration can also be negatively impacted by limited privacy policies, or overbearing privacy policies.

2.2.6 Lack of standardization

According to Al-Farsi et al. (2021), lack of standardization is an inter-organizational barrier, and it is also an intra-organizational barrier owing to its features. Iqbal and Butt (2020) stated that standard setting for data is crucial to ensure smooth data transfer amongst the organizations. Studies highlight that the blockchain does not have a single strong platform, rather its technologies and platforms are scattered. This leads to lack of standardization of blockchain.

2.2.7 Technology / System-related barriers

Since blockchain is still in its early developmental stages, it is considered as an immature technology. Pournader et al. (2020) stated that this notion is confirmed by the level of data security, scalability, data manipulation, data security, transaction process, and privacy issues. Tan et al. (2023) stated that the aforementioned issues can be grouped in two basic concepts that will make them system-based barriers to adopting blockchain: security issues and performance issues.

2.2.8 Security issues

According to Al-Amin et al. (2021), the overall mechanism and configuration of blockchain makes it susceptible to security problems, making it a key concern for any company adopting blockchain. Severe security threats are possible while operating with blockchain. Wang et al. (2019) highlighted various types of blockchain threats like Sybil's attack, cryptography cracking, DDo attacks, 51% attacks, and double spending. Every attack has a different technicality. This study will only cover majority and minority attack at the broad spectrum, followed by anonymity and privacy concerns as major security concerns.

2.2.9 Majority and minority attacks

Some of the major security incidents occur via majority and minority attacks. According to Ahmed and MacCarthy (2021), the blockchain usually functions via consensus mechanism with immutability as a key feature, it is possible to come across majority attacks, which are also called 51% attacks. Li et al. (2020) stated that they occur when one of the partners hold more than 51% connected miners of the blockchain. In this case, erroneous block can be connected to the blockchain during the writing process by hijacking it and the process is authorized by the party that controls more than 50 percent of the miners. Yiu (2021) stated that the risk of 51% attacks is always high because of the mark-based centralization of the mining power that is controlled by large mining pools, irrespective of the concept that blockchain mechanism runs on the assumption of controlling by honest nodes.

Another majority attack comes in from of history-revision attack. According to Saberi et al. (2019), it occurs when the hostile party has foolish levels of computational powers. With a high level of computational power, the hostile party can manipulate many of the computers' features with normal nodes, and can also develop and publish alternate history. Sidorov et al. (2019) stated that it may lead to elimination of the real history from blockchain to store alternative history. Minority attacks can be equally dangerous for the blockchain security. Therefore, any party owning less than 50% of the computational authority could also attack the blockchain significantly. A key example of such an attack is selfish mining. It is the process of blockchain mining, in which the minority attacker is the miner. According to Choi (2020), the attacker places mined blocks contrary to regular practices of broadcasting, in a private channel. Then, when the private branch is not a public chain, the miner would reveal it. this will result in public chain being replaced by the private faulty chain. As a result, the mining rewards would be impacted, and the attacker will get maximum of the mining rewards,

thereby effecting the mining rewards for the miners belonging to original public chain (Dutta et al. 2020). Hence, selfish mining could create a snowball impact that would increase the numbers of miners choosing the villainous approach to mining owing to the benefits it has to offer compared to the ethical practices, which could be hacked easily.

2.2.10 Anonymity and privacy

It is possible for the end users to hide their identity while operating blockchain. It comes from the capability of the blockchain to offer anonymity options. Wamba et al. (2020) stated that respective of the available options, the systems often catch the remnants of information that may enable others to access the information of the original end user of a particular blockchain, irrespective of their anonymity (Kouhizadeh et al. 2021). For instance, the transactions may be linked back to the IP addresses that may disclose the information of the user. Likewise, certain apps can be used to collect information about the currencies, user data, and profiles, which could be hacked and misused. Zhu et al. (2022) suggested that it is not possible to have a full-proof system to completely secure online trading platforms owing to the third parties and keys that enable it. hence, when a business uses blockchain, they must consider their options to avoid any such circumstances in case an impermissible blockchain is implemented.

2.2.11 Data input

A major complication offered by blockchain is the immutability of the information saved via blockchain. Kurdi et al. (2022) stated that this feature refers to the inability to alter the data which had been input and locked without a consensus. However, it is possible for the users to enter new data. Wang et al. (2019) stated that this can be exploited by the hackers to input malicious data that may result in issues in future. despite the possibility of removing the malicious data from the blockchain, it remains visible even after removal. Hence it can cause issues with false information like presence of inventory when it is not, or vice versa.

2.2.12 Performance issues

There are many resource-based apprehensions that come with the use of blockchain, owing to internet of things, cloud computing, big data, and edge. Since blockchain is based on the consensus model, it can cause a wastage of many resources. Moreover, the decentralized structure trades with computer power and resources in for sake of substantial benefits.

2.2.13 Scalability

Scalability can largely impact the outcome of blockchain. A research study asserts that since blockchain accumulates all the previous transactions, its size continues to increase with each transaction that would take place. According to Salah et al. (2020), it will require more storage space for the data. This will lead to increasing costs. The high levels of data storage may also hinder distribution and transaction speed in the network.

This problem can be solved by implementing certain solutions. The two key methods to deal with it are: 1. Storage optimization and 2. Blockchain redesign. Storage optimization enables lightweight nodes existence and also eliminate old transaction records to free up space. Shirmali and Patel (2022) stated that blockchain redesign, on the other hand manages the decoupling of data blocks to allocate each block to a specific feature. Despite these solutions, it is vital to have a much viable program to deal with the scalability issue of the blockchain.

2.2.14 Availability and applicability

The second key factor of the performance scope is availability and applicability of blockchain for its operators. Blockchain is used as a distributed ledger in supply chain. It depends mainly on availability and applicability of blockchain. Sanka et al. (2021) stated that there are other considerable factors as well, however, latency and throughput of transaction are still massive factors for blockchain availability. It had been believed that larger blocks may lead to technical discrepancies and may reduce the impact of decentralization in the network, hence, the block size is limited to 1MB per year. However, a smaller block size also means that only limited number of transactions can be supported by blockchain.

2.3 External barriers

All the barriers to blockchain that come from external sources like institutes, government, and industries are termed as external barriers. Wang et al. (2019) highlighted one of the major external barriers is the environmental uncertainty about appropriate laws, rules and regulations, and policies regarding blockchain. A research study explains that technology does not necessarily require any kind of regulation, however, the way the technology could be exploited compels the authorities to place regulations. Zhu et al. (2022) stated that the purpose of blockchain is to provide governance and security; however, to ensure its sound use, regulations must be implemented on it. An example

of external barrier is that there is ambiguity regarding the accountability about the use of blockchain by the users. Since a vivid ownership blueprint is unavailable in case of automatic executions. Moreover, it is challenging to keep up with the rules and regulations and finally, there is no understanding of who handles the safety of cryptographic keys and the consequences in case they are lost or stolen (Kurdi et al. 2022). A study revealed that blockchain is subjected to uncertainties about regulation and governance. Since there is no clarity about taxation for transactions, for instance, selling of consumer product nationwide whereas one organization manages the blockchain.

2.4 Research Hypotheses:

H1: Independent variables IV1, IV2, IV3, IV4, IV5, IV6* exhibit a positive and statistically influence on the technological challenges for the adoption of block chain technology in Greek Supply Chain Sector.

H2: Independent variables IV1, IV2, IV3, IV4, IV5, IV6* exhibit a positive and statistically influence on the organizational challenges for the adoption of block chain technology in Greek Supply Chain Sector.

H3: Independent variables IV1, IV2, IV3, IV4, IV5, IV6* exhibit a positive and statistically influence on the financial challenges for the adoption of block chain technology in Greek Supply Chain Sector.

H4: Independent variables IV1, IV2, IV3, IV4, IV5, IV6* exhibit a positive and statistically influence on the regulatory challenges for the adoption of block chain technology in Greek Supply Chain Sector.

H5: Independent variables IV1, IV2, IV3, IV4, IV5, IV6* exhibit a positive and statistically influence on the administrative challenges for the adoption of block chain technology in Greek Supply Chain Sector.

H6: Independent variables IV1, IV2, IV3, IV4, IV5, IV6* exhibit a positive and statistically influence on the social challenges for the adoption of block chain technology in Greek Supply Chain Sector.

H7: Independent variables IV1, IV2, IV3, IV4, IV5, IV6* exhibit a positive and statistically influence on the perceived benefits for the adoption of block chain technology in Greek Supply Chain Sector.

* Independent variables IV1, IV2, IV3, IV4, IV5, IV6 are listed in Appendix A

Chapter Three: Research Design and Methodology

3.1 Introduction

This section delineates the steps taken by the researcher to address the key inquiries of the study and gather the required data. The following aspects will be addressed in this paper: (1) the research philosophy; (2) the study design; (3) the procedures for data collection, sampling, and population; (4) evaluation of the primary variables of interest (dependent, and independent variables); (5) methodologies for data analysis; and (6) a selection of findings.

3.2. Research Philosophy:

Researchers can choose the best research approach to enhance their knowledge of their subject by keeping in mind a small set of fundamental conceptual frameworks that underpin all research difficulties. Researchers in the field of management, as stated by John and Clark (2006), must have a firm grasp on these philosophical assumptions because of their central significance in the development of the study's foundational concepts and driving factors. The three cornerstones of any philosophical system are ontology, epistemology and axiology. The "assumptions on the nature of reality" are central to ontology, as stated by Saunders et al. (2016). What kinds of information regarding society are considered adequate for making informed decisions (Bryman & Bell, 2015)? How does one know what they know? and similar questions are asked. How much does the individual who knows affect what is known? "(Antwi and Hamza, 2015) In the words of Saunders et al. (2016), axiology is the examination of the ethical dimensions of scientific enquiry.

The three philosophical principles are extremes on the spectrum between objectivism and subjectivism. Objectivists that take an ontological viewpoint believe that all social actors have the same experience of the world, making their philosophy more grounded in realism. Objectivism is a school of thought that bases its guidelines for social conduct on an examination of the world around us rather than on abstract principles. Isolation, axiological and isolating one's values from the outside world, is a technique used by scientists to ensure objectivity and reduce prejudice in their research (Saunders et al., 2016). The inquiry is premised on the three tenets of objectivism outlined above, which make up the "positivism" conceptual framework. Researchers in the field of management who share the positivist worldview of Johnson and Duberley (2000) are expected to uphold a few central dogmas.

Identifying casual vs coincidental correlations is an initial hurdle that needs to be overcome in this study. A couple of ways to do this are to adopt a cross-sectional study design and to take an empirical stance towards observation. Secondly, the same scientific method utilized in the field of natural science must be applied to the study of social phenomena. Nevertheless, questions of credibility must be answered, such as how the results can be implemented, if they can be trusted, if they can be generalized, and whether or not the results are causal. Thirdly, removing bias and preconceptions from research by keeping an open mind while you observe the world around you. According to Saunders et al. (2016), positivist researchers' values have no impact on survey respondents' answers. Because of this, the study will adhere to the "positivism" research philosophy (Bryman, 1984), which promotes the use of a quantitative approach.

3.3. Research Design

Every researcher is aware that the research philosophy they subscribe to is responsible for dictating the methodology, the best design, and the overall strategy of their study. Research designs are written testimonies with the primary goal of establishing the foundation for studies in a manner that maximizes the likelihood that the studies will be successfully completed (Wilson, 2014). Research designs can range from a straightforward case study to an intricate longitudinal investigation project, from a cross-sectional investigation to a comparative study (Easterby-Smith, 2015). One of the most common research designs is the comparative study. It can be deduced that positivism is closely associated with the achievements of quantitative research that makes use of a rational research technique. In a quantitative study, the graphical and statistical methods are utilized in order to evaluate the observable and quantifiable relationships that exist between the variables under study (Saunders et al. 2016).

The vast majority of researchers are of the opinion that a cross-sectional study is the most appropriate research design for this particular analysis. According to Lind et al. (2013), "a cross-sectional research methodology permits the collection of data from various occurrences, generally far more than one," at a single moment in time and in connection to a minimum of two (typically many more) variables, which are then analyzed to construct a trend. This type of research is used to determine whether or not there is a trend.

That statement contains a significant number of ambiguities. The purpose of conducting multiple scenario analyses is to generate a variety of possible outcomes by investigating a wide range of

possible combinations of individuals, organizations, and nations. Second, because we are limited by time, it is absolutely necessary that all of the data be gathered at exactly the right moment. This requires responses to multiple surveys at the same time, each of which contains a number of different factors (Johnson and Duberley, 2000). It is for this reason that it is beneficial to use a cross-sectional approach to study rather than a longitudinal one; doing so saves both time and money. In conclusion, in order to establish the variances in the variables, a conventional method of determining the level of variation is required. Studies that are cross-sectional are helpful for examining causal pathways which brings us to our final point. A survey research strategy that makes use of probability sampling grants the researcher more control over the process of conducting the research, produces data that is statistically more generalized in terms of a true reflection of the population, and results in cost savings. To phrase this another way, studies that use surveys as a method of research tend to have higher levels of external validity (Hair et al. 1998). For the purpose of this study, a cross-sectional design was selected because of the many advantages it provides for a quantitative positivist methodology. The data for this study were collected through the use of a questionnaire.

3.4. Population, Sampling, and Data Collection Procedures

Whether quantitative or qualitative in character, Easterby-Smith et al. (2015) argue that data gathering is an essential part of management research. The "Census" method and the "Sampling" method are both widely used in their respective sectors for collecting data. Performing a census, which requires information from every person of the community, may not necessarily yield a precise population figure. Sampling is a more realistic method because it only requires selecting a portion of the population that is statistically significant (Bryman and Bell, 2015). Most researchers agree that sampling is preferable to collecting data from the complete population when doing so would be impractical owing to time or resource constraints (Bryman, 1984).

The investigator of the research used Google Form to create an online survey for supply chain sector in Greece who were free to respond anonymously. Many experts agree that surveys make up the most efficient data collection tools if they are properly distributed, double-checked and well-constructed. This is due to the fact that questionnaires offer multiple benefits over other means of gathering data, such as lower costs and the capacity to extract just relevant information (Oliver, 2021). The interviewees and the interviewer both benefit from the quick administration time and the fact that the survey can be completed at the interviewees' leisure (Lunch and Oancea, 2014). Furthermore, there are a number of reasons why this kind of web-based survey is used by researchers:

Participants should have no trouble getting to the questionnaire's URL. If it's sent directly to the right people via email, one can have more faith that only people who should be filling it out will. There is also very little risk of information becoming illegitimate or skewed. The same rule holds true when sending to more distant locations. Furthermore, between 30% and 50% of the overall population should fill out the online questionnaires (Kumar, 2018). Finally, after data collection is complete, this method simplifies data extraction by doing away with the need for manual entry. There will be fewer errors and less time will be required as a direct result of this (Cresswell, 2012).

In the course of this project, there will be more than one phase devoted to the collection of data. In order to obtain data for the study, the researcher first developed an online questionnaire using Google Forms. Afterwards, a suitable email was drafted, which was then submitted to the survey's intended respondents. The collection of data was completed without any problems. Following a period of forty-five days, the responses to the survey were made inaccessible, and the data that had been gathered was retrieved for the purposes of statistical analysis.

3.5. Data Analysis Techniques

The aforementioned procedures were employed in the statistical analysis, which was conducted using the IBM SPSS program:

- a) An overview of the respondents' characteristics can be synthesized using descriptive statistics like mean, standard deviation and frequency.
- b) The validity and reliability of each scale were assessed through the use of Cronbach's alpha, a measure of internal consistency.
- c) The significance of the pattern and the degree of correlation between the variables were analyzed using suitable tests.
- d) According to the results there is no linear relationship for the majority of values among the dependent and independent variables, and non-parametric analysis was employed.

3.6. Ethical Considerations

Since this is a managerial investigation based on feedback from the public, it must be conducted in a morally responsible manner. Bell and Water (2018) suggest the following moral considerations:

- a. maintaining respect for the individual's worth during the procedure. To ensure the emotional and physical safety of the participants.

- b. All participants should give their informed consent before any data is collected to guarantee that they are participating voluntarily.
- c. Avoiding unethical actions in the course of research. In the interest of secrecy and personal space. The confidentiality of the participants requires it.
- d. The plan is for complete and open disclosure of the study's findings. In order to avoid providing or releasing misleading data.

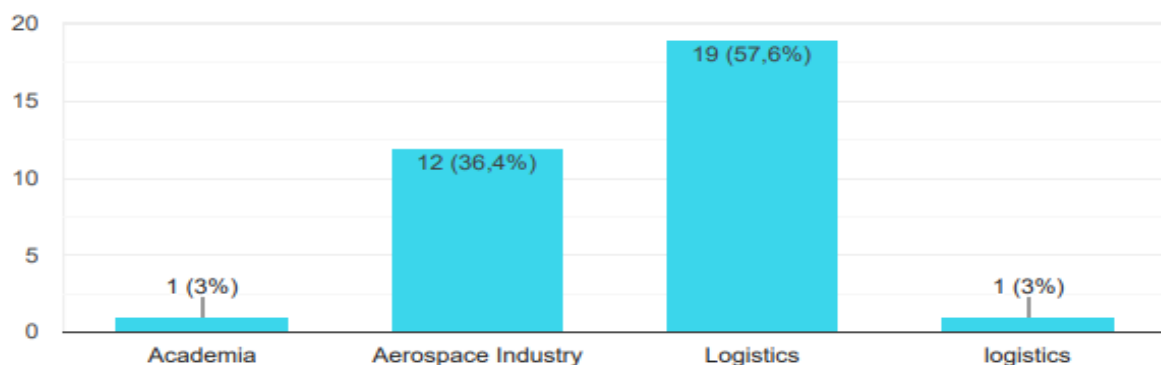
In this research, these ethical considerations were embedded deeply. The researcher explained the purpose of the study, provided background information, and asked for participant feedback in which researcher also reassured them that they are under no obligation to continue with the program if they so want. Furthermore, no personal details about the participants were recorded.

Chapter 4: Data Analysis

This section discusses using SPSS for statistical analysis of the data collected. Data analysis can be done using a variety of statistical methods; however, picking the right method requires thinking about the goals of the study beforehand. In the current study, researcher will be using statistical methods to navigate through the data and draw conclusions. These statistical analyses will help the researcher draw conclusions about the research based on hard data.

4.1 Demographic Analysis

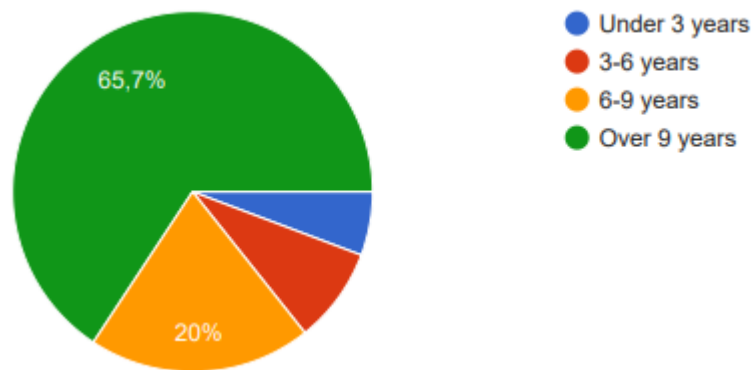
There is a total of 36 respondents who participated in the research and a total of 33 respondents who took part in the first general question. As a break up 20 participants answered (60.6%) in relation to logistics industry, 12 participants (36.4%) related to aerospace industry and only 1 participant had experience in academia industry.



graph 1

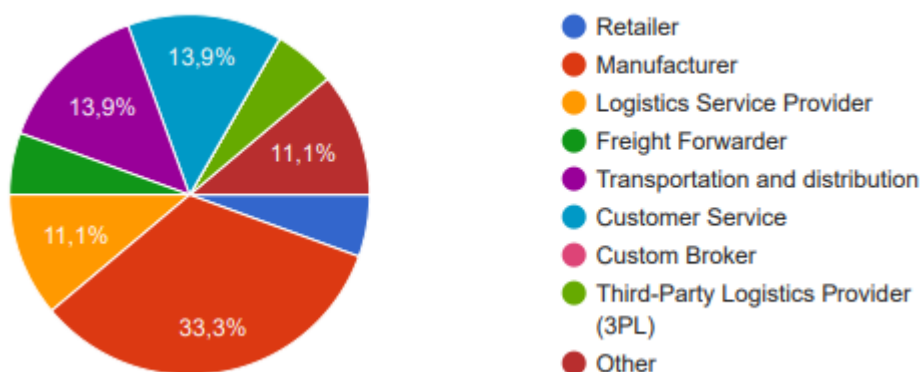
in Adopting Block Chain Technology in Greek Supply Chain Sector

When asking about how long companies offer its services in the supply chain sector. Mostly respondents around 65.7% reflect that the company have over 9 years of experience for providing services in the supply chain sector.



graph 2

When asking about which domain of supply chain the company belongs to, respondents responded that almost 33.3% of the companies are belonged to manufacturing supply chain. On the other hand, 13.9% respondents reflects that the companies are related to transportation and distribution and customer service supply chain. 11.1% respondents respond that the companies are related to logistics service provider.

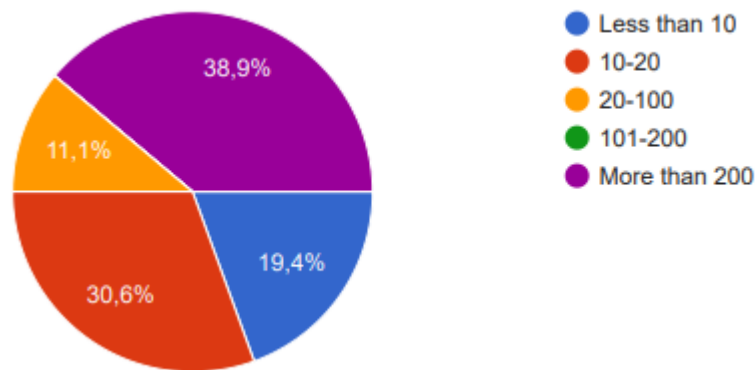


graph 3

According to the survey, the number of employees in the company is also included in the questionnaire. Hence, upon asking the question, 38.9% respondents reflect that the company have

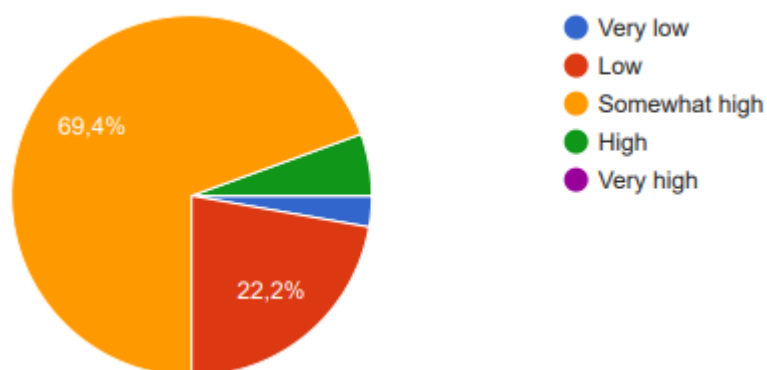
in Adopting Block Chain Technology in Greek Supply Chain Sector

more than 200 employees, 30.6% respondents respond that the company have 10-20 employees, 19.4% respondents respond that the company have less than 10 employees, and 11.1% respondents respond that the company have 20-100 employees.



graph 4

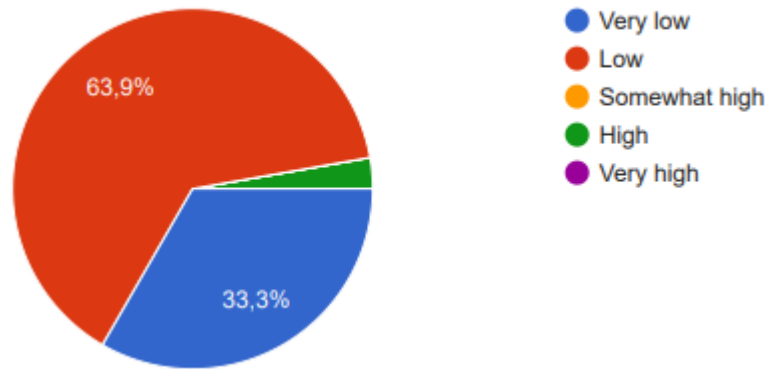
IT solutions are very important for any supply chain activity. Therefore, it is important to ask to what extent at which company is investing in IT solution for its supply chain activities. Around 69.4% respondents stated that the company is investing somewhat high for providing IT solutions for supply chain activities.



graph 5

The main objective of the research is to determine the impact of blockchain adoption in supply chain. The questionnaire consists of question that ask the current state of blockchain adoption in the supply

chain sector. Mostly respondents i.e., 63.9% respondents respond that the companies have low adoption of blockchain in supply chain sector.



graph 6

4.2 Reliability Analysis

Data analysis can't begin until it's established whether or not the information can be trusted for statistical purposes. Reliability analysis has been performed to assess the trustworthiness of collected data. The value of Cronbach's alpha, an indicator of data reliability, is commonly agreed upon to be greater than 0.6. This means that the reliability of the data collected must be at least 60% before it can be used in subsequent studies. If the value is less than 0.6, the data may not be suitable for the study. Cronbach's alpha for each item in the table below is greater than 0.6. This demonstrates the validity of the research data and its applicability to other studies.

Scale: Technological Challenges (TC)

Case Processing Summary

		N	%
Cases	Valid	36	100,0
	Excluded ^a	0	,0
	Total	36	100,0

a. Listwise deletion based on all variables in the procedure.

Table 1

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0,525	0,515	9

Table 2

Cronbach's alpha = 0,525 < 0,6

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
TC1	27,03	4,885	,581	,586	,358
TC2	26,89	5,702	,282	,479	,479
TC3	26,58	4,536	,611	,524	,328
TC4	25,50	6,371	,132	,314	,530
TC5	25,39	6,244	,375	,366	,468
TC6	25,61	5,387	,489	,615	,408
TC7	24,97	6,371	,232	,326	,497
TC8	25,58	9,050	-,553	,485	,705
TC9	25,33	6,457	,201	,518	,506

Table 3

In the above table, we observe that if we exclude TC8 (Integration of blockchain with other technologies), the Cronbach's alpha will be improved and get 0,705. Therefore, for research purposes, TC8 is excluded and the above tables are the following:

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,705	,696	8

Table 4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
TC1	23,50	6,314	,598	,586	,626
TC2	23,36	7,094	,340	,428	,692
TC3	23,06	5,883	,639	,524	,610
TC4	21,97	7,856	,187	,241	,722
TC5	21,86	7,952	,348	,335	,689
TC6	22,08	6,650	,584	,511	,634
TC7	21,44	8,025	,237	,319	,706
TC9	21,81	7,990	,251	,512	,703

Table 5

Scale: Organizational Challenges (OC)

Case Processing Summary

	N	%
Cases Valid	36	100,0
Excluded ^a	0	,0
Total	36	100,0

a. Listwise deletion based on all variables in the procedure.

Table 6

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0,422	0,488	7

Table 7

Cronbach's alpha =0,422<0,6

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
OC1	18,56	4,425	,398	,638	,299
OC2	16,94	4,340	,278	,280	,338
OC3	18,75	3,964	,523	,602	,220
OC4	16,50	4,771	,232	,343	,369
OC5	16,14	5,266	,017	,411	,460
OC6	16,81	5,304	-,117	,555	,586
OC7	18,47	4,199	,253	,614	,348

Table 8

In the above table, we observe that if we exclude OC5 (Organization size), OC6 (Lack of knowledge/expertise for the implementation of blockchain solutions), the Cronbach's alpha will be improved and get 0,726. Therefore, for research purposes, OC5, OC6 are excluded and the above tables are the following:

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,726	,735	5

Table 9

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
OC1	10,78	3,835	,593	,578	,646
OC2	9,17	4,429	,176	,109	,800
OC3	10,97	3,513	,653	,570	,615
OC4	8,72	4,092	,443	,198	,696
OC7	10,69	2,961	,663	,490	,597

Table 10

Scale: Financial Challenges (FC)

Case Processing Summary

		N	%
Cases	Valid	36	100,0
	Excluded ^a	0	,0
	Total	36	100,0

a. Listwise deletion based on all variables in the procedure.

Table 11

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,453	,455	4

Table 12

Cronbach's alpha = 0,453 < 0,6

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
FC1	9,83	2,257	-,146	,440	,691
FC2	10,03	1,056	,733	,947	-,167 ^a
FC3	10,00	,971	,792	,949	-,277 ^a

FC4	9,47	1,913	-,026	,283	,659
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a. The value is negative due to a negative average covariance among items.

Table 13

In the above table, we observe that if we exclude FC1 (Cost of implementing blockchain), the Cronbach's alpha will be improved and get 0,691. Therefore, for research purposes, FC1 is excluded and the above tables are the following:

Reliability Statistics

	Cronbach's Alpha Based on Standardized Items	N of Items
Cronbach's Alpha		
,691	,708	3

Table 14

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
FC2	6,75	,993	,748	,931	,281
FC3	6,72	1,006	,692	,930	,350
FC4	6,19	1,475	,190	,070	,981

Table 15

Scale: Administrative Challenges (AC)

Case Processing Summary

	N	%
Cases Valid	36	100,0
Excluded ^a	0	,0
Total	36	100,0

a. Listwise deletion based on all variables in the procedure.

Table 16

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
AC1	12,28	3,063	,379	,289	,433
AC3	12,56	2,940	,393	,341	,420
AC4	11,31	2,504	,522	,358	,318
AC5	11,42	3,850	,086	,224	,574
AC6	10,89	3,016	,166	,239	,586

Table 17

In the above table, we observe that if we exclude AC5 (Significant "resistance to change" attitude), AC6 (Strategic necessity) the Cronbach's alpha will be improved and get the value of 0,612. Therefore, for research purposes, AC5, AC6 are excluded and the below tables are the following:

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,612	,619	3

Table 18

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
AC1	5,36	1,380	,410	,242	,529
AC3	5,64	1,152	,542	,314	,331
AC4	4,39	1,273	,329	,132	,658

Table 19

Scale: Social Challenges (SC)

Case Processing Summary

	N	%
Cases Valid	36	100,0
Excluded ^a	0	,0
Total	36	100,0

a. Listwise deletion based on all variables in the procedure.

Table 20

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,898	,898	2

Table 21

Scale: Perceived Benefits (PB)

Case Processing Summary

	N	%
Cases Valid	36	100,0
Excluded ^a	0	,0
Total	36	100,0

a. Listwise deletion based on all variables in the procedure.

Table 22

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
B1	52,94	20,568	,564	,680	,840
B2	52,78	21,835	,325	,605	,853
B3	52,75	21,050	,513	,403	,843
B4	53,31	20,733	,453	,542	,847
B5	52,61	19,787	,592	,602	,838

*Ioannis Thomaidis, Perceived Benefits and Challenges
in Adopting Block Chain Technology in Greek Supply Chain Sector*

B6	53,06	22,111	,259	,477	,857
B7	52,72	19,292	,666	,729	,833
B8	52,58	20,821	,531	,644	,842
B9	52,61	20,302	,464	,745	,847
B10	52,36	20,523	,498	,613	,844
B11	52,75	21,336	,613	,715	,841
B12	52,81	19,647	,628	,696	,836
B13	52,50	21,971	,409	,374	,849
B14	51,97	21,171	,548	,498	,842

Table 23

In conclusion, the following matrix is constructed based on the reliability analysis:

Construct	Final variables	Excluded variables	Cronbach's Alpha
Technological Challenges (TC)	7	TC8	0,705
Organizational Challenges (OC)	3	OC5, OC6	0,726
Financial Challenges (FC)	2	FC1	0,691
Administrative Challenges (AC)	3	AC5, AC6	0,612
Social Challenges (SC)	2	--	0,898
Perceived Benefits (PB)	14	--	0,854

Table 24 Reliability Analysis

4.3 Statistical Method

4.3.1 General

Every statistical technique contains assumptions. In order for the results of a statistical procedure to be precise, it is necessary that your data satisfy certain conditions.

Multiple and multivariate regression analysis is generally based on the following assumptions:

1. **Outlier detection:** The variables of interest should not contain outliers. Linear Regression is vulnerable to anomalies, or data points with values that are unconventionally high or low.
2. **Normality:** In order for all the variables to be considered normal, each variable individually should exhibit univariate normality, which is characterized by a bell-shaped curve.
3. **No Multicollinearity:** The data should exhibit minimal or no multicollinearity, which refers to a situation where the independent variables display significant correlation with each other. The correlation matrix can be used to test for multicollinearity.
4. **Linear Relationship:** A linear relationship should exist among the independent and dependent variables.
5. **Homoscedasticity:** The presence of homoscedasticity indicates that the data exhibits "equal variance." In simpler terms, it means that the residuals are consistent and have uniform variability across the regression line.
6. **No Autocorrelation:** The data should show minimal or no autocorrelation, which refers to the situation where values exhibit interdependence or a relationship with each other.

4.3.2 Outlier Detection

Mahalanobis distance (MD) is a statistical indicator utilized to determine the degree to which instances can be considered multivariate outliers, determined by a chi-square distribution and evaluated using $p < .001$.

The table below presents the critical chi-square values for 2 to 10 degrees of freedom, considering a critical alpha level of 0.001. If the maximum MD value surpasses the critical chi-square value corresponding to the degrees of freedom (df)= k (the number of predictor variables in the model), it suggests the existence of one or more multivariate outliers.

<i>df</i>	Critical value
2	13.82
3	16.27
4	18.47

5	20.52
6	22.46
7	24.32
8	26.13
9	27.88
10	29.59

Table 25

Residuals Statistics ^a					
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	2,5938	3,7679	3,1979	,30354	36
Std. Predicted Value	-1,990	1,878	,000	1,000	36
Standard Error of Predicted Value	,071	,186	,103	,031	36
Adjusted Predicted Value	2,4975	3,8093	3,1962	,31050	36
Residual	-,46884	,42737	,00000	,22196	36
Std. Residual	-1,923	1,753	,000	,910	36
Stud. Residual	-2,435	1,957	,002	1,066	36
Deleted Residual	-,75220	,62747	,00176	,31173	36
Stud. Deleted Residual	-2,683	2,064	,001	1,102	36
Mahal. Distance	1,995	19,460	5,833	4,477	36
Cook's Distance	,000	,512	,069	,130	36
Centered Leverage Value	,057	,556	,167	,128	36

a. Dependent Variable: TC

Table 26

Since maximum mahal. Distance =19,460<22,46, no outliers exist for TC

Residuals Statistics ^a					
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	1,7671	3,0581	2,5167	,25358	36
Std. Predicted Value	-2,956	2,135	,000	1,000	36
Standard Error of Predicted Value	,126	,332	,183	,056	36
Adjusted Predicted Value	1,4567	3,0122	2,4816	,33809	36
Residual	-,70988	1,14187	,00000	,39495	36
Std. Residual	-1,636	2,632	,000	,910	36
Stud. Residual	-1,863	4,079	,030	1,132	36
Deleted Residual	-,92016	2,74333	,03504	,64147	36
Stud. Deleted Residual	-1,951	6,139	,091	1,390	36

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Mahal. Distance	1,995	19,460	5,833	4,477	36
Cook's Distance	,000	3,334	,126	,553	36
Centered Leverage Value	,057	,556	,167	,128	36

a. Dependent Variable: OC

Table 27

Since maximum mahal. Distance =19,460<22,46, no outliers exist for OC

Residuals Statistics^a

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	2,8536	3,7827	3,2778	,18385	36
Std. Predicted Value	-2,307	2,746	,000	1,000	36
Standard Error of Predicted Value	,149	,391	,216	,066	36
Adjusted Predicted Value	2,5979	4,6266	3,2919	,34368	36
Residual	-1,18694	,73269	,00000	,46582	36
Std. Residual	-2,319	1,432	,000	,910	36
Stud. Residual	-2,890	1,668	-,010	1,077	36
Deleted Residual	-1,95991	1,06872	-,01414	,66803	36
Stud. Deleted Residual	-3,365	1,724	-,041	1,167	36
Mahal. Distance	1,995	19,460	5,833	4,477	36
Cook's Distance	,000	,902	,076	,182	36
Centered Leverage Value	,057	,556	,167	,128	36

a. Dependent Variable: FC

Table 28

Since maximum mahal. Distance =19,460<22,46, no outliers exist for FC

Residuals Statistics^a

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	2,0182	2,8585	2,5648	,18004	36
Std. Predicted Value	-3,036	1,631	,000	1,000	36
Standard Error of Predicted Value	,154	,405	,224	,068	36
Adjusted Predicted Value	1,3523	3,1313	2,5483	,31396	36
Residual	-,85849	1,47485	,00000	,48281	36
Std. Residual	-1,619	2,781	,000	,910	36
Stud. Residual	-1,807	3,105	,012	1,039	36
Deleted Residual	-1,07044	1,83898	,01647	,64724	36
Stud. Deleted Residual	-1,885	3,734	,036	1,123	36
Mahal. Distance	1,995	19,460	5,833	4,477	36
Cook's Distance	,000	,805	,057	,144	36
Centered Leverage Value	,057	,556	,167	,128	36

a. Dependent Variable: AC

Table 29

Since maximum mahal. Distance =19,460<22,46, no outliers exist for AC

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Residuals Statistics^a

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	3,8577	5,0669	4,6944	,22381	36
Std. Predicted Value	-3,739	1,664	,000	1,000	36
Standard Error of Predicted Value	,152	,398	,220	,067	36
Adjusted Predicted Value	4,1244	5,1485	4,7148	,24333	36
Residual	-,96266	,58401	,00000	,47467	36
Std. Residual	-1,846	1,120	,000	,910	36
Stud. Residual	-2,550	1,285	-,014	1,050	36
Deleted Residual	-2,06068	,87558	-,02032	,65694	36
Stud. Deleted Residual	-2,844	1,300	-,034	1,086	36
Mahal. Distance	1,995	19,460	5,833	4,477	36
Cook's Distance	,000	1,302	,068	,218	36
Centered Leverage Value	,057	,556	,167	,128	36

a. Dependent Variable: RC

Table 30

Since maximum mahal. Distance =19,460<22,46, no outliers exist for RC

Residuals Statistics^a

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	2,8232	4,6389	3,8750	,41065	36
Std. Predicted Value	-2,561	1,860	,000	1,000	36
Standard Error of Predicted Value	,193	,507	,281	,085	36
Adjusted Predicted Value	2,6574	4,6791	3,8993	,50092	36
Residual	-1,82322	1,05912	,00000	,60440	36
Std. Residual	-2,746	1,595	,000	,910	36
Stud. Residual	-3,811	1,747	-,016	1,121	36
Deleted Residual	-3,51238	1,34262	-,02432	,94035	36
Stud. Deleted Residual	-5,301	1,815	-,070	1,332	36
Mahal. Distance	1,995	19,460	5,833	4,477	36
Cook's Distance	,000	1,922	,104	,345	36
Centered Leverage Value	,057	,556	,167	,128	36

a. Dependent Variable: SC

Table 31

Since maximum mahal. Distance =19,460<22,46, no outliers exist for SC

Residuals Statistics^a

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	3,5391	4,5084	4,0536	,22599	36
Std. Predicted Value	-2,277	2,013	,000	1,000	36
Standard Error of Predicted Value	,085	,223	,123	,037	36
Adjusted Predicted Value	3,5146	4,4084	4,0657	,22335	36
Residual	-,73010	,39010	,00000	,26573	36
Std. Residual	-2,501	1,336	,000	,910	36
Stud. Residual	-3,168	1,413	-,018	1,065	36
Deleted Residual	-1,17135	,49455	-,01210	,37258	36
Stud. Deleted Residual	-3,849	1,439	-,045	1,146	36
Mahal. Distance	1,995	19,460	5,833	4,477	36
Cook's Distance	,000	,866	,069	,189	36
Centered Leverage Value	,057	,556	,167	,128	36

a. Dependent Variable: PB

Table 32

Since maximum mahal. Distance = 19,460 < 22,46, no outliers exist for PB

4.3.3 Normal distribution

The Kolmogorov-Smirnov and Shapiro-Wilk tests determine if the pattern of distribution of the dependent variables significantly deviates from normality. These are interpreted as follows: if p(sig) is less than 0.05, it indicates that the distribution deviates substantially from normality. Due to its superior efficacy with small samples, Pituch and Stevens (2016) prefer the Shapiro-Wilk test (p.228).

Technological Challenges (TC)

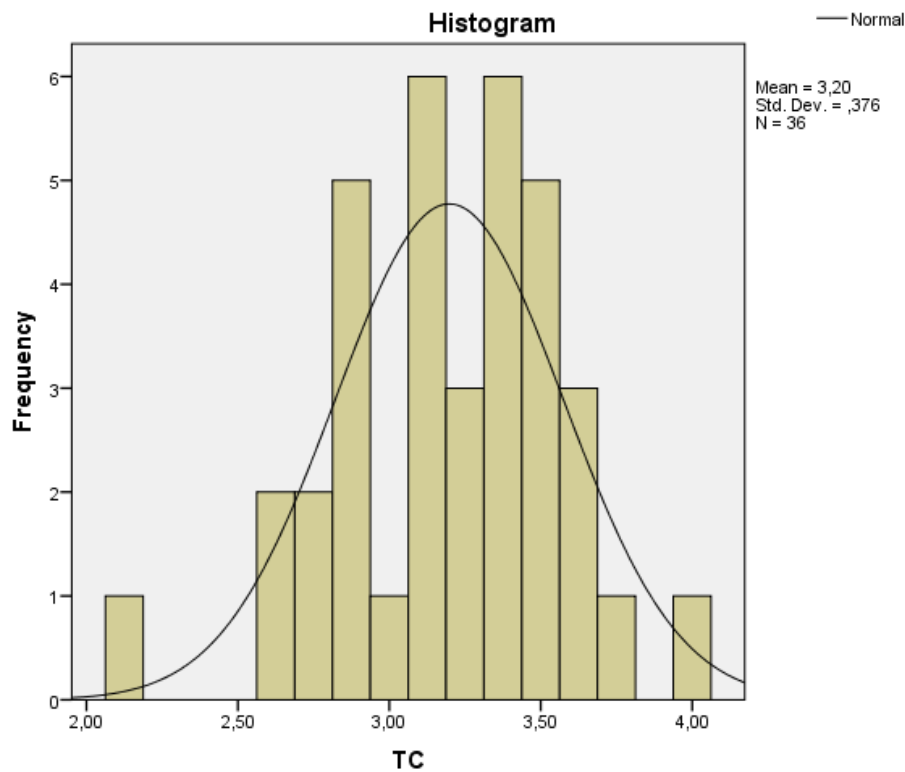
Tests of Normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
TC	,126	36	,164	,969	36	,397

a. Lilliefors Significance Correction

Table 33

As the p-value is high (sig > 0,05), we can accept such a null hypothesis and say that the sample of TC has been generated from a normal distribution.



graph 7

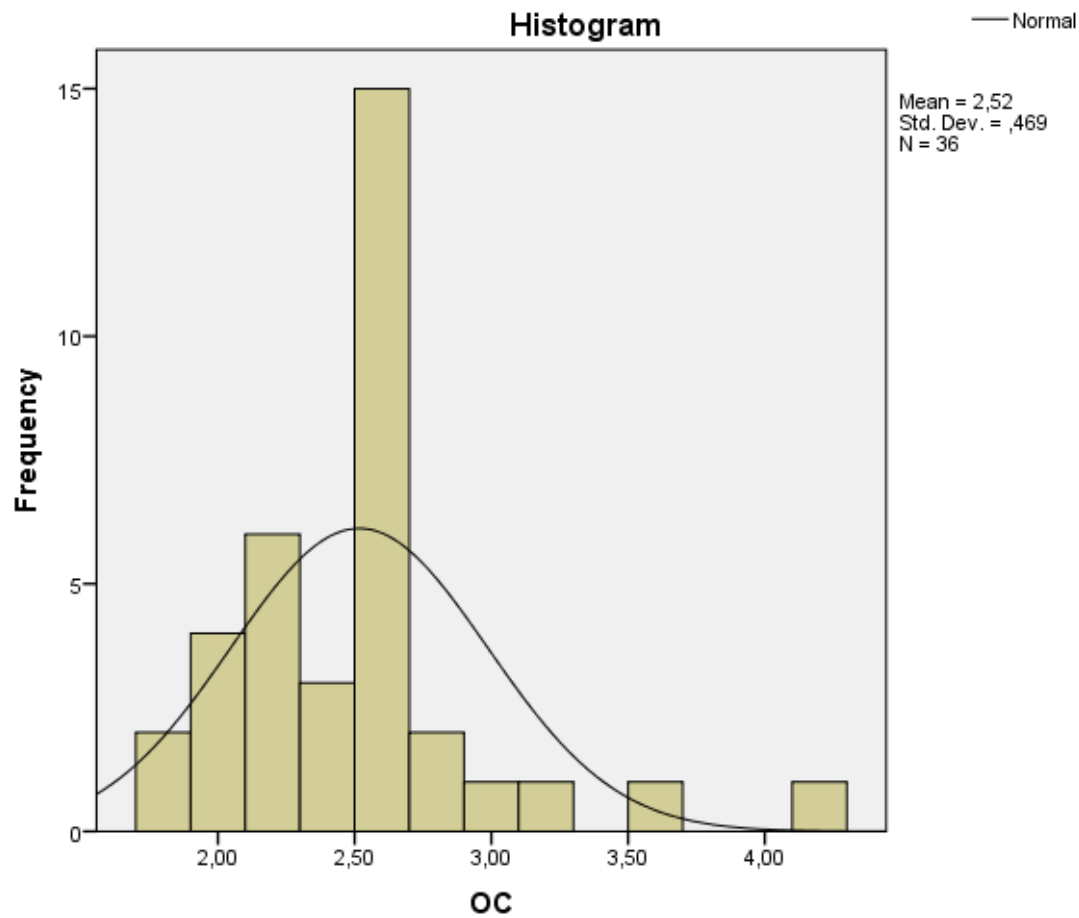
Organizational Challenges (OC)

Tests of Normality						
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
OC	,263	36	,000	,852	36	,000

a. Lilliefors Significance Correction

Table 34

As the p-value is low ($\text{sig} < 0,05$), we can reject such a null hypothesis and say that the sample of OC has not been generated from a normal distribution.



graph 8

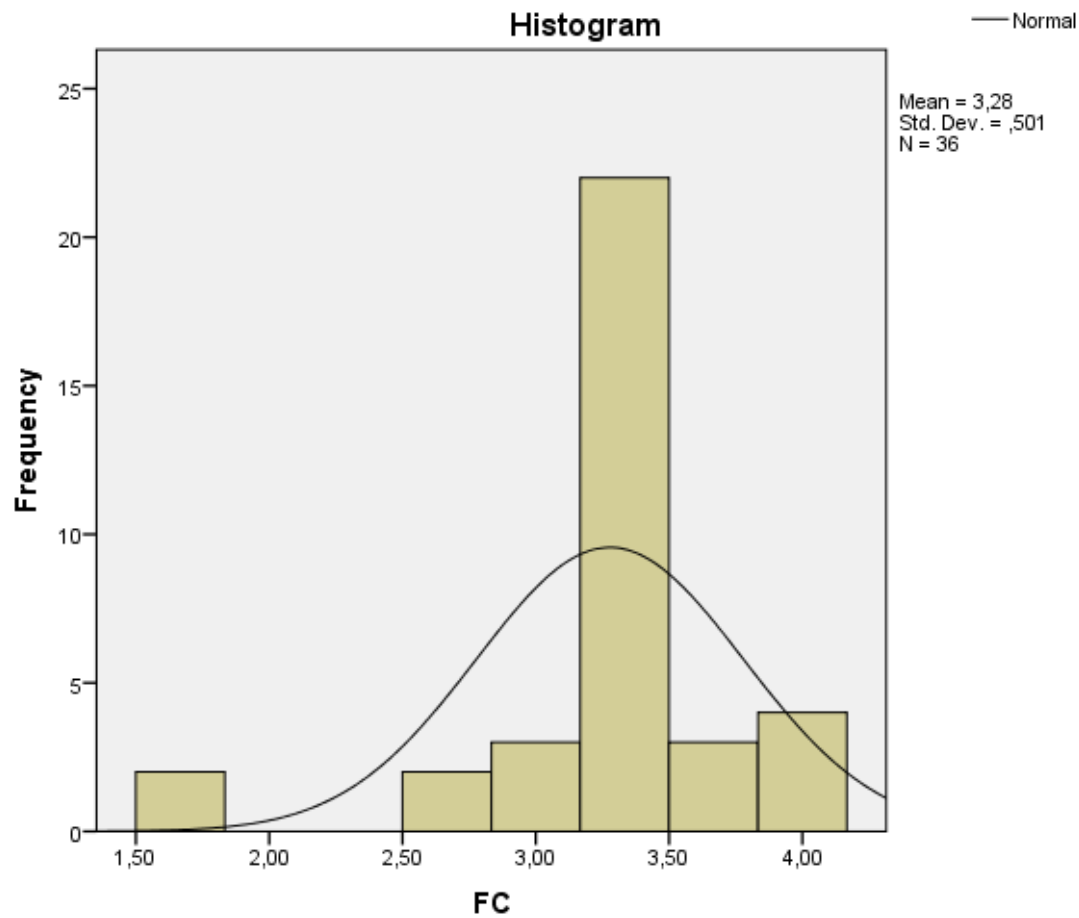
Financial Challenges (OC)

Tests of Normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
FC	,350	36	,000	,737	36	,000

a. Lilliefors Significance Correction **Table 35**

As the p-value is low (sig<0,05), we can reject such a null hypothesis and say that the sample of FC has not been generated from a normal distribution.



graph 9

Administrative Challenges (AC)

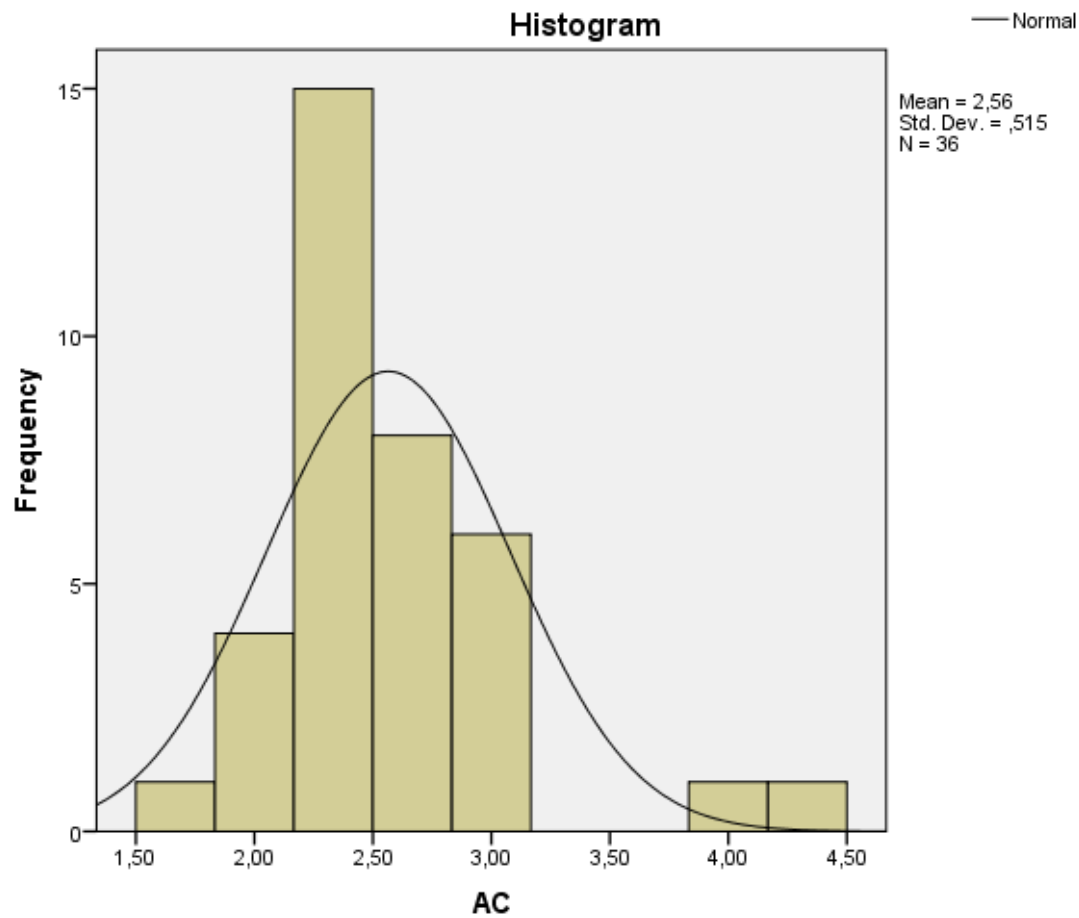
Tests of Normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
AC	,229	36	,000	,828	36	,000

a. Lilliefors Significance Correction

Table 36

As the p-value is low (sig<0,05), we can reject such a null hypothesis and say that the sample of AC has not been generated from a normal distribution.



graph 10

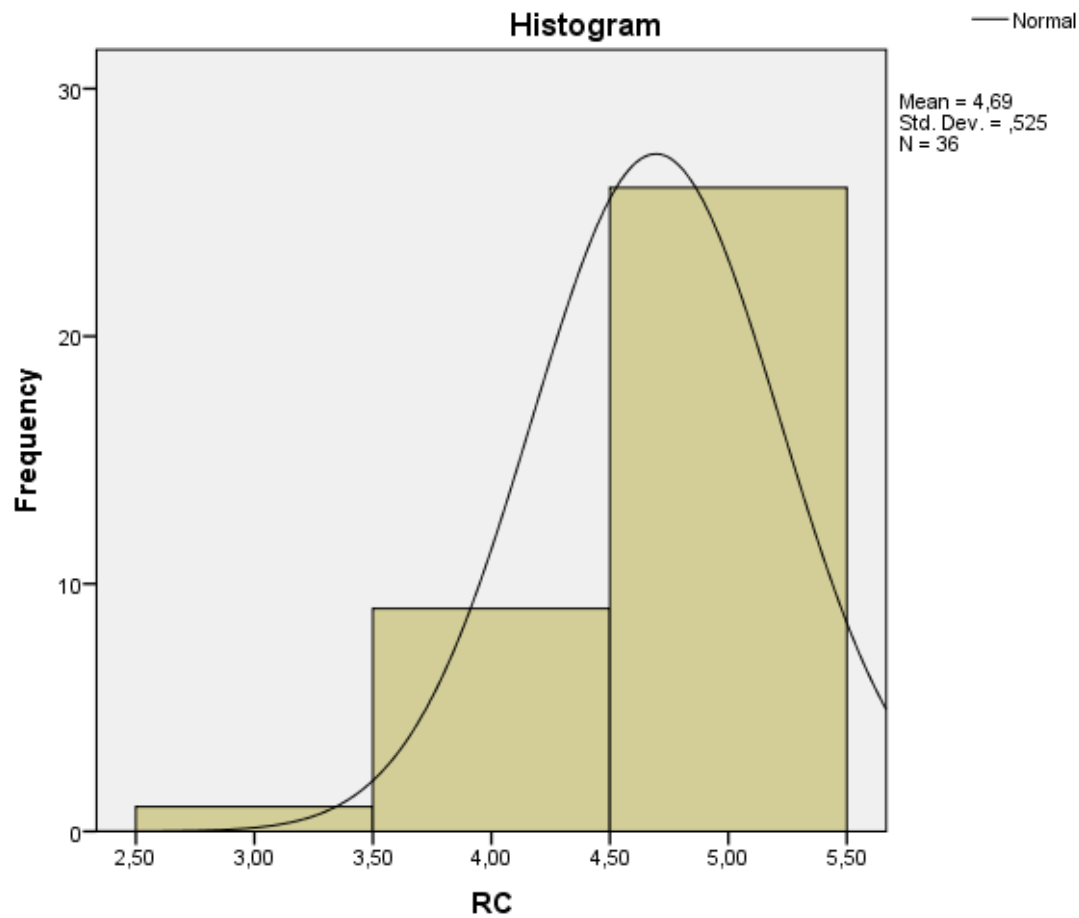
Regulatory Challenges (RC)

Tests of Normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
RC	,442	36	,000	,601	36	,000

a. Lilliefors Significance Correction **Table 37**

As the p-value is low ($\text{sig} < 0,05$), we can reject such a null hypothesis and say that the sample of RC has not been generated from a normal distribution.



graph 11

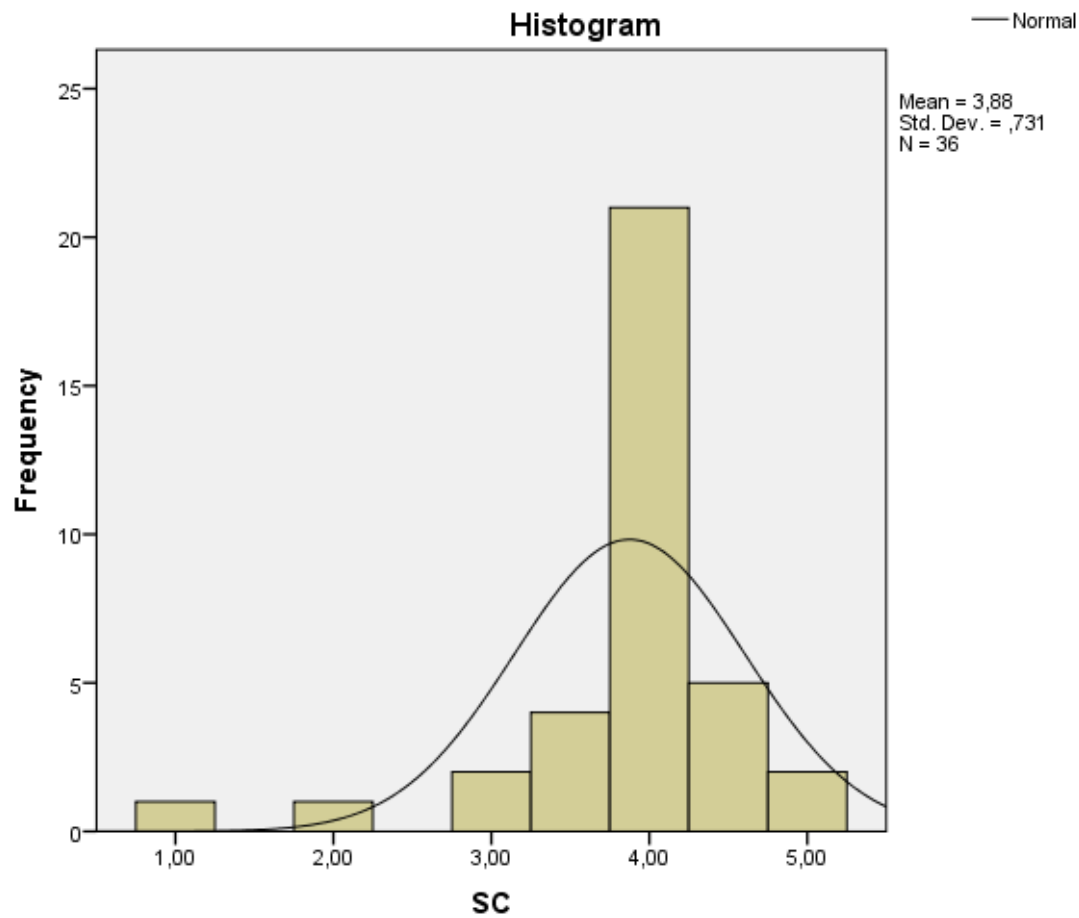
Social Challenges (SC)

Tests of Normality						
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
SC	,346	36	,000	,735	36	,000

a. Lilliefors Significance Correction

Table 38

As the p-value is low ($\text{sig} < 0,05$), we can reject such a null hypothesis and say that the sample of SC has not been generated from a normal distribution.



graph 12

Perceived Benefits (PB)

Tests of Normality

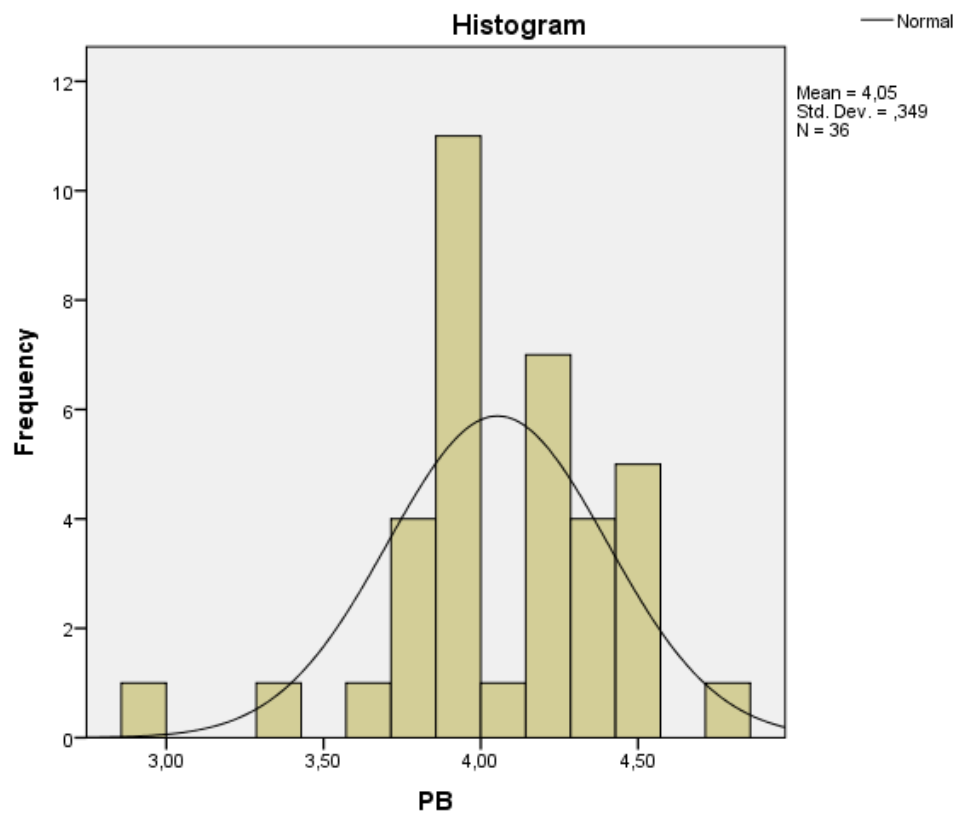
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
PB	,110	36	,200*	,938	36	,05

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Table 39

This figure is in the lower bound of the true significance therefore, we can accept such a null hypothesis and say that the sample of PB has been generated from a normal distribution.



graph 13

4.3.4 Multicollinearity

The Pearson correlation coefficient, denoted as r_{XY} , quantifies the degree of linear relationship between two variables X and Y. It ranges between -1 and +1, with $r_{XY} = +1$ representing a perfect positive relationship, $r_{XY} = 0$ indicating no observed relationship, and $r_{XY} = -1$ denoting a perfect negative relationship between X and Y based on the available data and observations.

Regarding the spectrum of values of the Pearson correlation coefficient among X and Y, the following situations can be distinguished:

- If $r_{XY} = 1$, it indicates a perfect positive correlation between the dependent variable Y and the independent variable X.
- When the Pearson correlation coefficient falls within the range of $0.8 < r_{XY} < 1$, it indicates a strong positive correlation between the dependent variable Y and the independent variable X.

- When the Pearson correlation coefficient falls within the range of $0.3 < r_{XY} < 0.6$, it indicates a moderate positive correlation between the dependent variable Y and the independent variable X.
- When the Pearson correlation coefficient falls within the range of $0 < r_{XY} < 0.3$, it indicates a weak positive correlation between the dependent variable Y and the independent variable X.
- When $r_{XY} \approx 0$, it suggests that there is no significant linear correlation between the dependent variable Y and the independent variable X.
- When the Pearson correlation coefficient falls within the range of $0 < r_{XY} < -0.3$, it indicates a weak negative correlation between the dependent variable Y and the independent variable X.
- When the Pearson correlation coefficient falls within the range of $-0.3 < r_{XY} < -0.6$, it indicates a moderate negative correlation between the dependent variable Y and the independent variable X.
- When the Pearson correlation coefficient falls within the range of $-0.8 < r_{XY} < -1$, it indicates a strong negative correlation between the dependent variable Y and the independent variable X.
- If $r_{XY} = -1$, it indicates a perfect negative correlation between the dependent variable Y and the independent variable X.

The determination of a strong or satisfactory correlation value for r_{XY} between variables X and Y is context-dependent and relies on the nature of the specific research problem. In fields such as the physical sciences, a high degree of precision is typically expected between the dependent and independent variables. Consequently, a value of $r_{XY} = 0.70$ may be considered relatively low in such cases.

If the correlation is greater than 0,7, then for the purposes of the regression, the independent variables are multicollinear, which this statement violates the principle of no multicollinearity.

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		TC	IV1	IV2	IV3	IV4	IV5	IV6
Pearson Correlation	TC	1,000	,542	,353	,729	,171	,492	,631
	IV1	,542	1,000	,118	,552	,373	,546	,409
	IV2	,353	,118	1,000	,444	,181	,102	,295
	IV3	,729	,552	,444	1,000	,104	,343	,661
	IV4	,171	,373	,181	,104	1,000	,262	,140
	IV5	,492	,546	,102	,343	,262	1,000	,160
	IV6	,631	,409	,295	,661	,140	,160	1,000

Table 40

It is noticed that there is no correlation between the independents variables as their value $< 0,7$. Furthermore the correlation between the dependent variable IV4 and dependent variable TC is $0 < 0,171 < 0,3$, therefore there is weak positive correlation and for the purposes of the research we are going to exclude IV4 from the regression.

		Correlations						
		OC	IV1	IV2	IV3	IV4	IV5	IV6
Pearson Correlation	OC	1,000	,348	-,051	,199	,096	,360	,373
	IV1	,348	1,000	,118	,552	,373	,546	,409
	IV2	-,051	,118	1,000	,444	,181	,102	,295
	IV3	,199	,552	,444	1,000	,104	,343	,661
	IV4	,096	,373	,181	,104	1,000	,262	,140
	IV5	,360	,546	,102	,343	,262	1,000	,160
	IV6	,373	,409	,295	,661	,140	,160	1,000

Table 41

It is noticed that there is no correlation between the independents variables as their value $< 0,7$. Furthermore the correlation between the independent variables IV2, IV3, IV4 and dependent variable OC is very low, therefore there is weak correlation and for the purposes of the research we are going to exclude IV2, IV3, IV4 from the regression.

		Correlations						
		FC	IV1	IV2	IV3	IV4	IV5	IV6
Pearson Correlation	FC	1,000	-,155	,308	,130	-,011	-,197	,103
	IV1	-,155	1,000	,118	,552	,373	,546	,409
	IV2	,308	,118	1,000	,444	,181	,102	,295

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IV3	,130	,552	,444	1,000	,104	,343	,661
IV4	-,011	,373	,181	,104	1,000	,262	,140
IV5	-,197	,546	,102	,343	,262	1,000	,160
IV6	,103	,409	,295	,661	,140	,160	1,000

Table 42

It is noticed that there is no correlation between the independents variables as their value $<0,7$. However the correlation between all independent variables and dependent variable FC apart from IV2 is very low, therefore there is weak correlation between them and for the purposes of the research we are going to exclude all the variables apart from IV2.

		Correlations						
		AC	IV1	IV2	IV3	IV4	IV5	IV6
Pearson Correlation	AC	1,000	,357	-,097	,072	,080	,392	-,002
	IV1	,357	1,000	,118	,552	,373	,546	,409
	IV2	-,097	,118	1,000	,444	,181	,102	,295
	IV3	,072	,552	,444	1,000	,104	,343	,661
	IV4	,080	,373	,181	,104	1,000	,262	,140
	IV5	,392	,546	,102	,343	,262	1,000	,160
	IV6	-,002	,409	,295	,661	,140	,160	1,000

Table 43

It is noticed that there is no correlation between the independents variables as their value $<0,7$. However the correlation between all independent variables and dependent variable FC apart from IV1, IV5 is very low, therefore there is weak correlation between them and for the purposes of the research we are going to exclude all the variables apart from IV1, IV5 from the regression.

		Correlations						
		RC	IV1	IV2	IV3	IV4	IV5	IV6
Pearson Correlation	RC	1,000	-,050	-,062	-,108	-,041	-,107	-,359
	IV1	-,050	1,000	,118	,552	,373	,546	,409
	IV2	-,062	,118	1,000	,444	,181	,102	,295
	IV3	-,108	,552	,444	1,000	,104	,343	,661
	IV4	-,041	,373	,181	,104	1,000	,262	,140

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IV5	-,107	,546	,102	,343	,262	1,000	,160
IV6	-,359	,409	,295	,661	,140	,160	1,000

Table 44

It is noticed that there is no correlation between the independents variables as their value $<0,7$. However the correlation between all independent variables and dependent variable RC apart from IV6 is very low, therefore there is weak correlation between them and for the purposes of the research we are going to exclude all the variables apart from IV6 from the regression.

		Correlations						
		SC	IV1	IV2	IV3	IV4	IV5	IV6
Pearson Correlation	SC	1,000	,095	-,174	,316	,132	,087	,143
	IV1	,095	1,000	,118	,552	,373	,546	,409
	IV2	-,174	,118	1,000	,444	,181	,102	,295
	IV3	,316	,552	,444	1,000	,104	,343	,661
	IV4	,132	,373	,181	,104	1,000	,262	,140
	IV5	,087	,546	,102	,343	,262	1,000	,160
	IV6	,143	,409	,295	,661	,140	,160	1,000

Table 45

It is noticed that there is no correlation between the independents variables as their value $<0,7$. However the correlation between all independent variables and dependent variable SC apart from IV3 is very low, therefore there is weak correlation between them and for the purposes of the research we are going to exclude all the variables apart from IV3 from the regression.

		Correlations						
		PB	IV1	IV2	IV3	IV4	IV5	IV6
Pearson Correlation	PB	1,000	,462	,096	,532	,188	,337	,547
	IV1	,462	1,000	,118	,552	,373	,546	,409
	IV2	,096	,118	1,000	,444	,181	,102	,295
	IV3	,532	,552	,444	1,000	,104	,343	,661
	IV4	,188	,373	,181	,104	1,000	,262	,140
	IV5	,337	,546	,102	,343	,262	1,000	,160

	IV6	,547	,409	,295	,661	,140	,160	1,000
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Table 46

It is noticed that there is no correlation between the independent variables as their value $< 0,7$. Furthermore the correlation between the independent variables IV2, IV4 and dependent variable PB is very low, therefore there is weak correlation and for the purposes of the research we are going to exclude IV2, IV4 from the regression.

In conclusion, the following table excludes independent variables that were not statistically significant with respect to dependent variables.

Construct	Final Independent variables	Excluded Independents variables
Technological Challenges (TC)	IV1, IV2, IV3, IV5, IV6	IV4
Organizational Challenges (OC)	IV1, IV5, IV6	IV2, IV3, IV4
Financial Challenges (FC)	IV2	IV1, IV3, IV4, IV5, IV6
Administrative Challenges (AC)	IV1, IV5	IV2, IV3, IV4, IV6
Regulatory Challenges (RC)	IV6	IV1, IV2, IV3, IV4, IV5
Social Challenges (SC)	IV3	IV1, IV2, IV4, IV5, IV6
Perceived Benefits (PB)	IV1, IV3, IV5, IV6	IV2, IV4

Table 47

4.3.5 Linearity

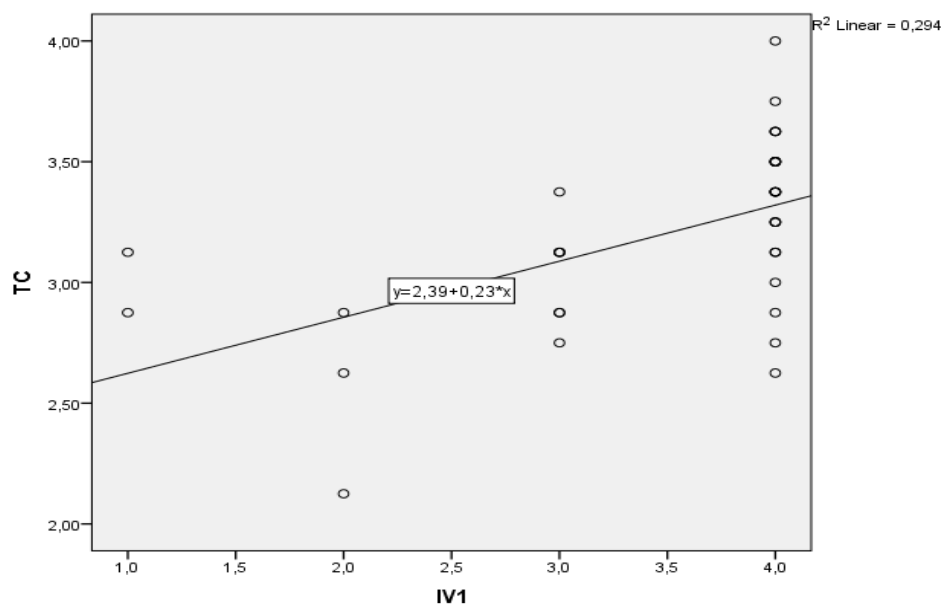
The linearity test serves the objective of determining whether the relationship between independent variables and dependent variables is linear. This is crucial in correlation and linear regression analysis. In the regression model, it is essential to establish a linear relationship between the independent and dependent variables.

- **TC * IV1**

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
TC * IV1	Between Groups	(Combined)	2,065	3	,688	7,636	,001
		Linearity	1,453	1	1,453	16,121	,000
		Deviation from Linearity	,612	2	,306	3,394	,046
	Within Groups		2,884	32	,090		
	Total		4,949	35			

Table 48



graph 14

According to the above, there is significant linearity between TC and IV1 as $\text{sig} < 0,05$, however the deviation from linearity is significant as $\text{sig} < 0,05$. One more parameter needs to be checked is the R^2 value. If $R^2 > 0,3$ indicates that there is linear relationship.

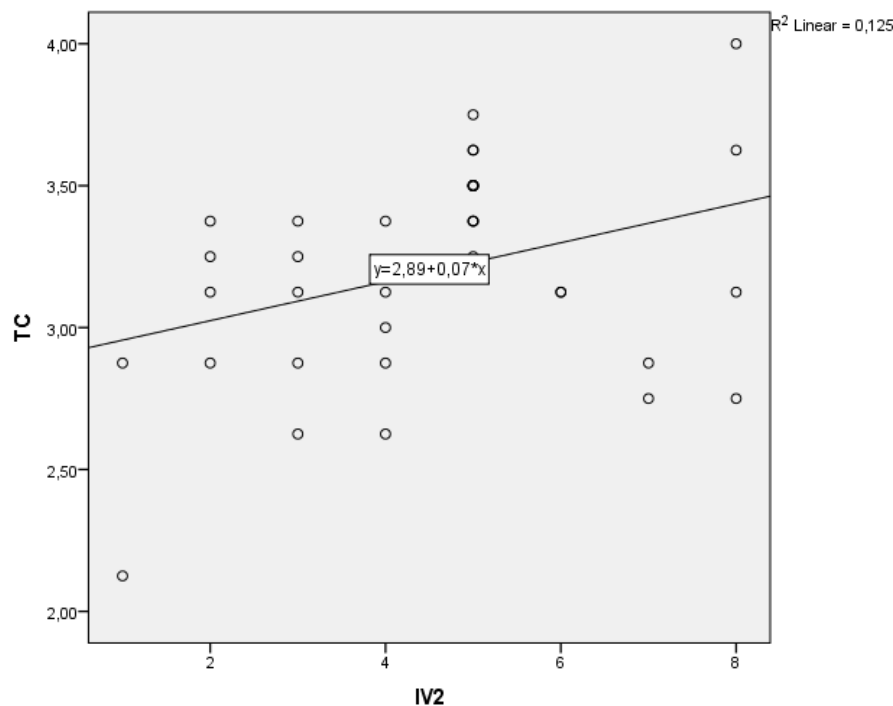
Therefore, there is not significant linearity between TC and IV1.

- **TC * IV2**

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
TC * IV2	Between	(Combined)	2,740	7	,391	4,963	,001
	Groups	Linearity	,617	1	,617	7,822	,009
		Deviation from Linearity	2,123	6	,354	4,486	,003
	Within Groups		2,209	28	,079		
	Total		4,949	35			

Table 49



graph 15

According to the above, there is significant linearity between TC and IV2 as $\text{sig} < 0,05$, however the deviation from linearity is significant as $\text{sig} < 0,05$. One more parameter needs to be checked is the R^2 value. If $R^2 > 0,3$ indicates that there is linear relationship.

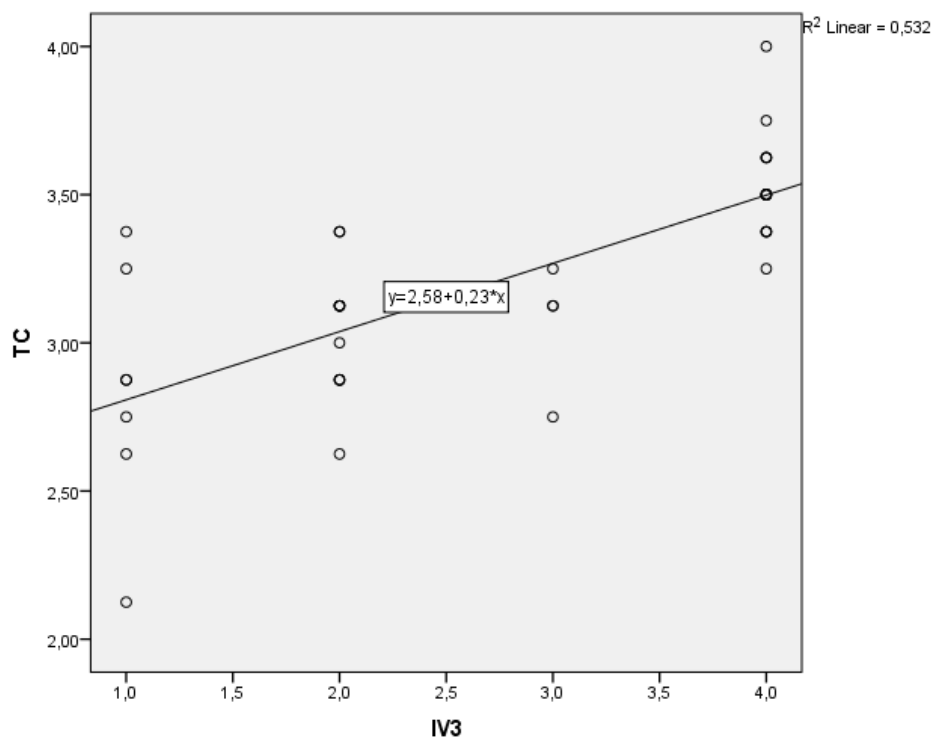
Therefore, there is not significant linearity between TC and IV2.

- **TC * IV3**

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
TC * IV3	Between Groups	(Combined)	2,827	3	,942	14,207	,000
		Linearity	2,631	1	2,631	39,662	,000
		Deviation from Linearity	,196	2	,098	1,480	,243
	Within Groups		2,122	32	,066		
	Total		4,949	35			

Table 50



graph 16

According to the above, there is significant linearity between TC and IV3 as $\text{sig} < 0,05$. Furthermore, the deviation from linearity is not significant as $\text{sig} > 0,05$. One more parameter needs to be checked is the R^2 value. If $R^2 > 0,3$ indicates that there is linear relationship.

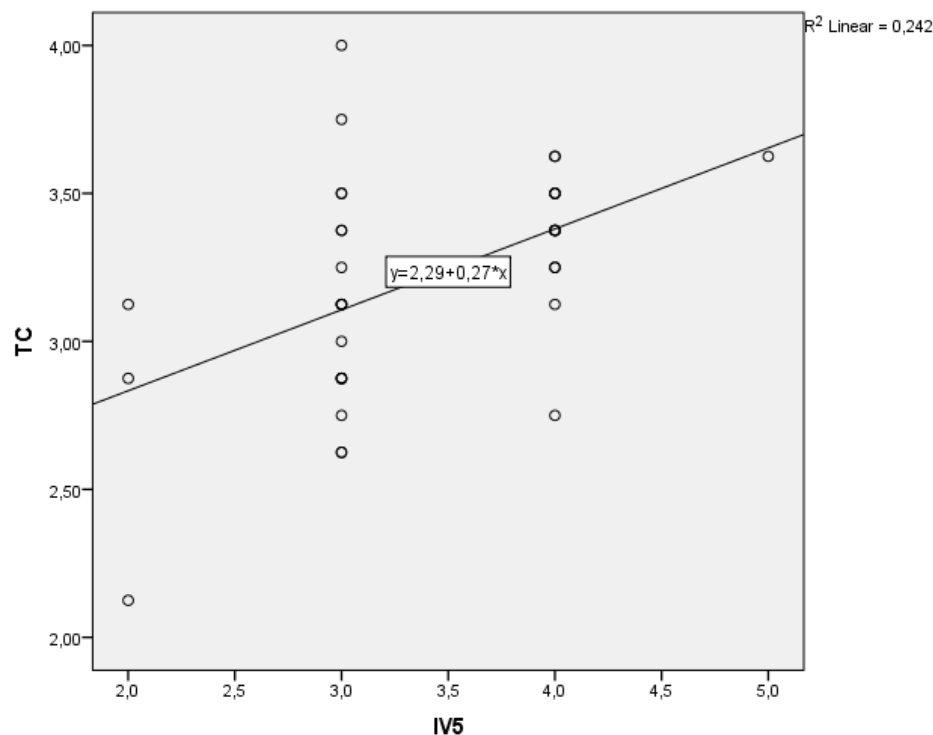
Therefore, there is significant linearity between TC and IV3.

- **TC * IV5**

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
TC * IV5	Between Groups	(Combined)	1,279	3	,426	3,718	,021
		Linearity	1,196	1	1,196	10,431	,003
		Deviation from Linearity	,083	2	,041	,361	,700
	Within Groups		3,670	32	,115		
	Total		4,949	35			

Table 51



graph 17

According to the above, there is significant linearity between TC and IV5 as $\text{sig} < 0,05$. Furthermore, the deviation from linearity is not significant as $\text{sig} > 0,05$. One more parameter needs to be checked is the R^2 value. If $R^2 > 0,3$ indicates that there is linear relationship.

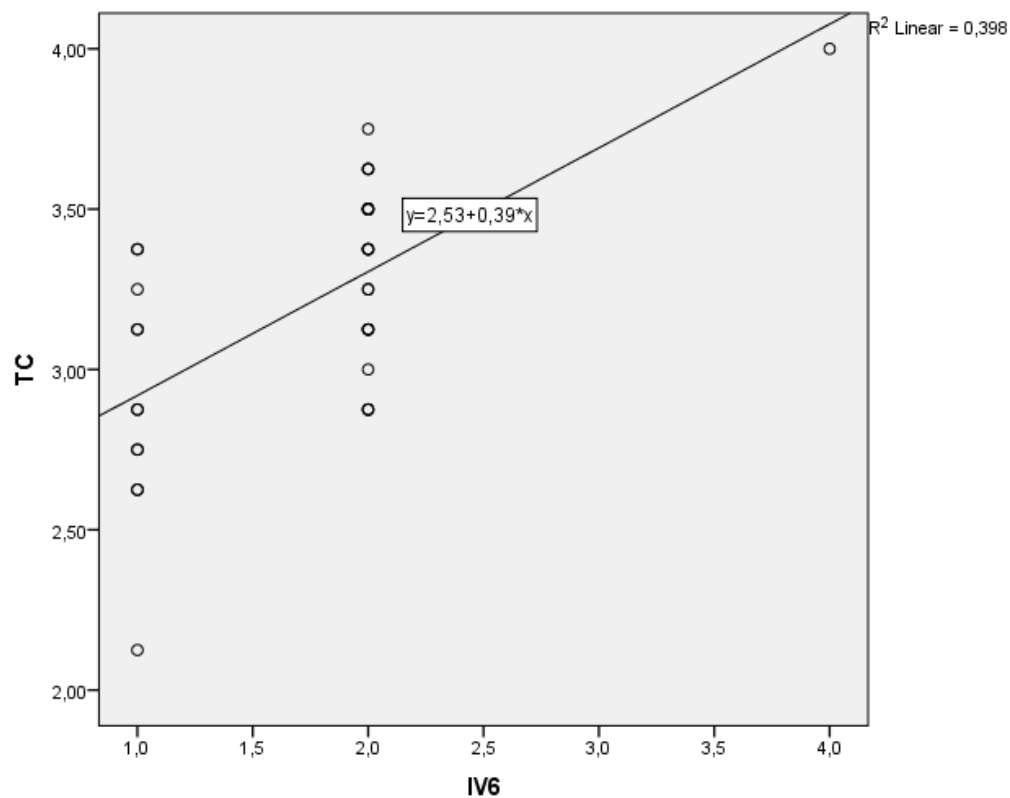
Therefore, there is not significant linearity between TC and IV5.

- **TC * IV6**

ANOVA Table

	Sum of Squares	df	Mean Square	F	Sig.
TC * IV6 Between Groups	1,981	2	,990	11,009	,000
(Combined) Linearity	1,970	1	1,970	21,903	,000
Deviation from Linearity	,010	1	,010	,114	,737
Within Groups	2,969	33	,090		
Total	4,949	35			

Table 52



graph 18

According to the above, there is significant linearity between TC and IV6 as $\text{sig} < 0,05$. Furthermore, the deviation from linearity is not significant as $\text{sig} > 0,05$. One more parameter needs to be checked is the R^2 value. If $R^2 > 0,3$ indicates that there is linear relationship.

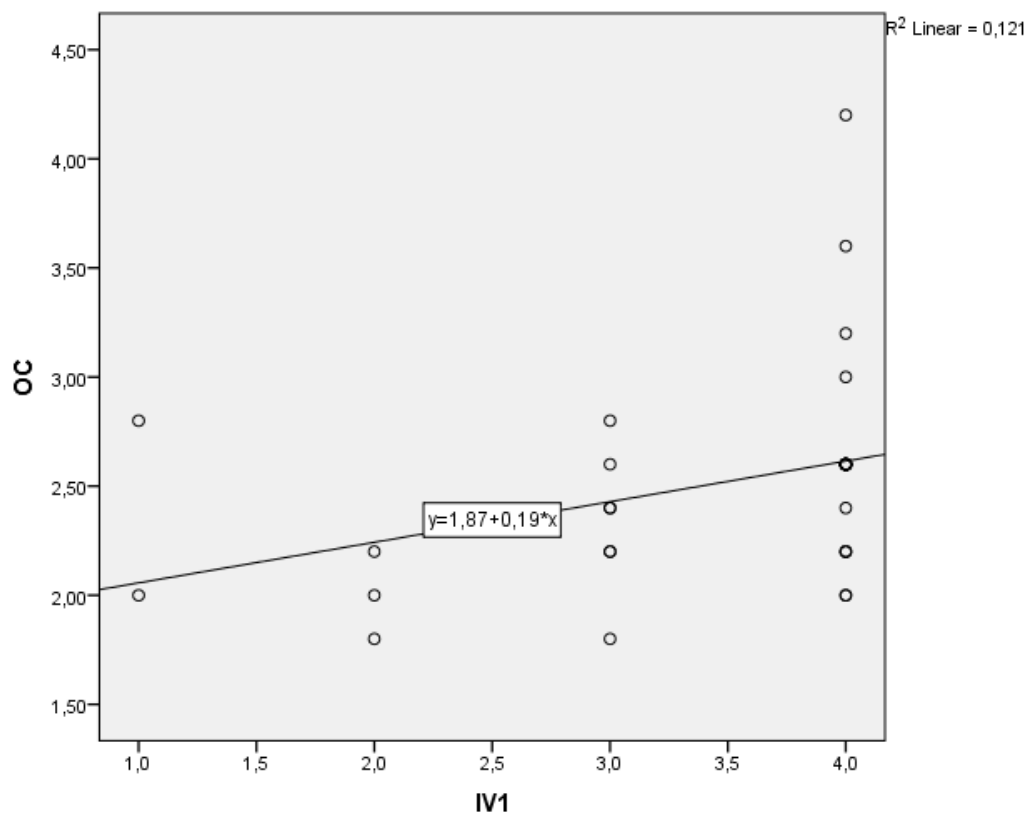
Therefore, there is significant linearity between TC and IV6.

- **OC * IV1**

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
OC * IV1	Between Groups	(Combined)	1,415	3	,472	2,397	,086
		Linearity	,933	1	,933	4,743	,037
		Deviation from Linearity	,481	2	,241	1,224	,308
	Within Groups		6,295	32	,197		
	Total		7,710	35			

Table 53



graph 19

According to the above, there is significant linearity between OC and IV1 as $\text{sig} < 0,05$. Furthermore, the deviation from linearity is not significant as $\text{sig} > 0,05$. One more parameter needs to be checked is the R^2 value. If $R^2 > 0,3$ indicates that there is linear relationship.

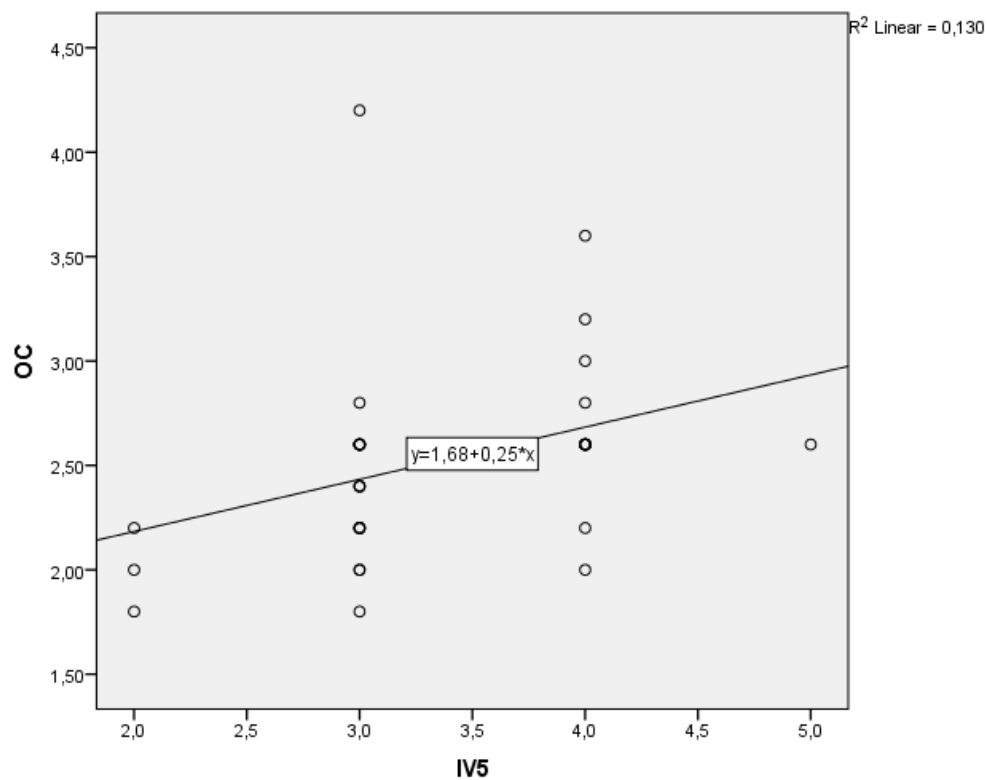
Therefore, there is no significant linearity between OC and IV1.

- **OC * IV5**

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
OC * IV5	Between Groups	(Combined)	1,244	3	,415	2,052	,126
		Linearity	1,000	1	1,000	4,949	,033
		Deviation from Linearity	,244	2	,122	,604	,553
	Within Groups		6,466	32	,202		
	Total		7,710	35			

Table 54



graph 20

According to the above, there is significant linearity between OC and IV5 as $\text{sig} < 0,05$. Furthermore, the deviation from linearity is not significant as $\text{sig} > 0,05$. One more parameter needs to be checked is the R^2 value. If $R^2 > 0,3$ indicates that there is linear relationship.

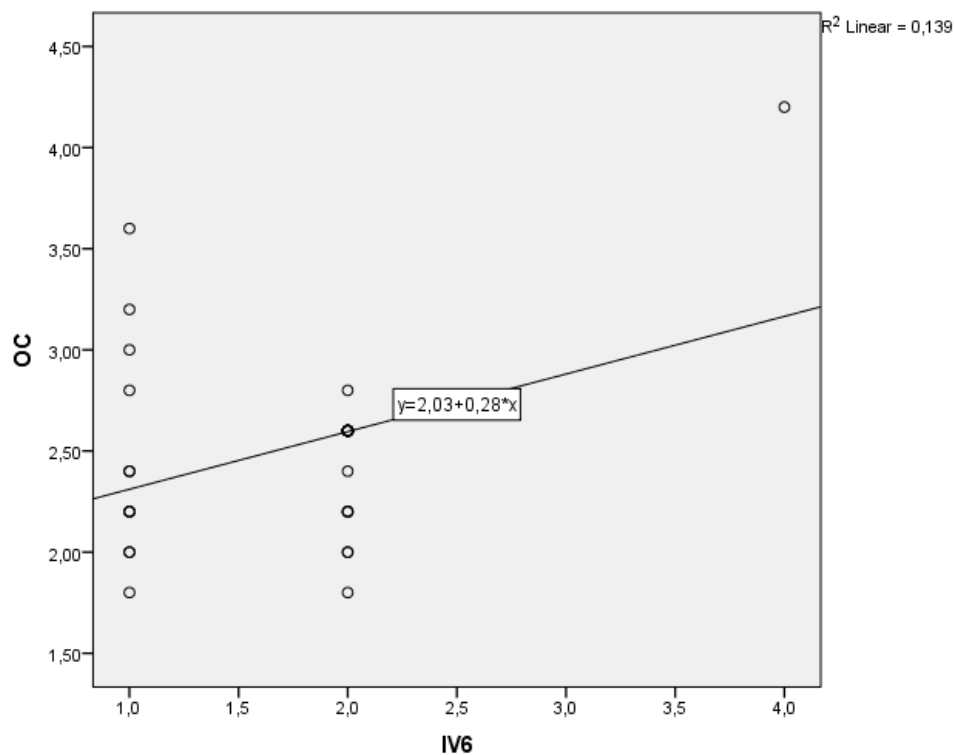
Therefore, there is no significant linearity between OC and IV5.

- **OC * IV6**

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
OC * IV6	Between Groups	(Combined)	2,919	2	1,459	10,050	,000
		Linearity	1,073	1	1,073	7,390	,010
		Deviation from Linearity	1,846	1	1,846	12,711	,001
	Within Groups		4,791	33	,145		
	Total		7,710	35			

Table 55



graph 21

According to the above, there is no significant linearity between OC and IV6 as $\text{sig} > 0,05$. One more parameter needs to be checked is the R^2 value. If $R^2 > 0,3$ indicates that there is linear relationship.

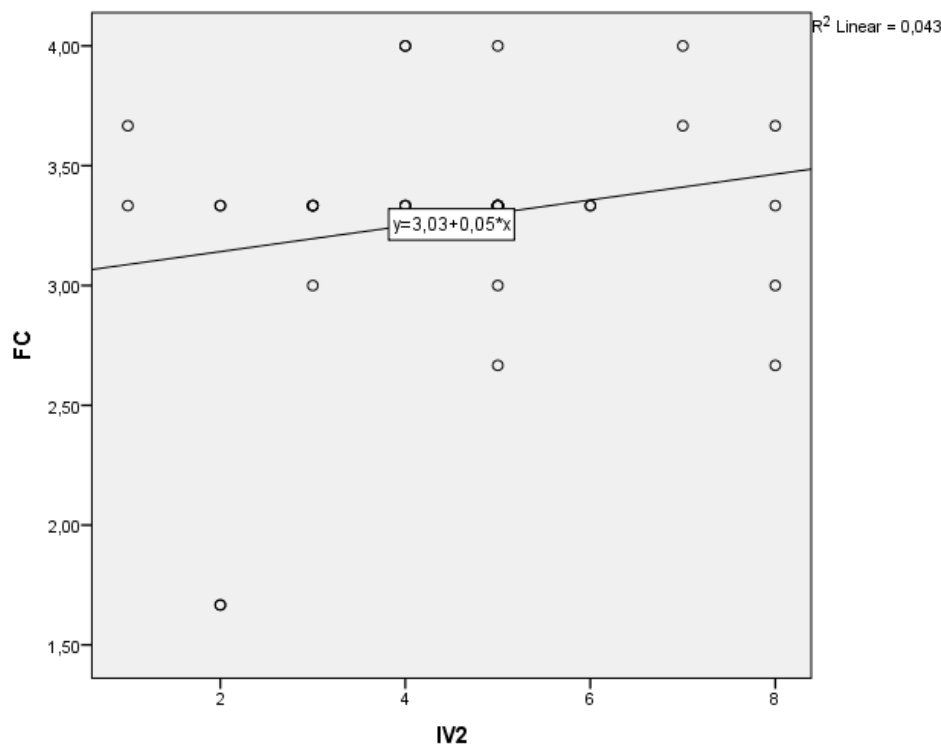
Therefore, there is no significant linearity between OC and IV6.

- **FC * IV2**

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
FC * IV2	Between Groups	(Combined)	3,720	7	,531	2,943	,019
		Linearity	,380	1	,380	2,104	,158
		Deviation from Linearity	3,340	6	,557	3,082	,019
	Within Groups		5,057	28	,181		
	Total		8,778	35			

Table 56



graph 22

According to the above, there is no significant linearity between FC and IV2 as $\text{sig} > 0,05$. One more parameter needs to be checked is the R^2 value. If $R^2 > 0,3$ indicates that there is linear relationship.

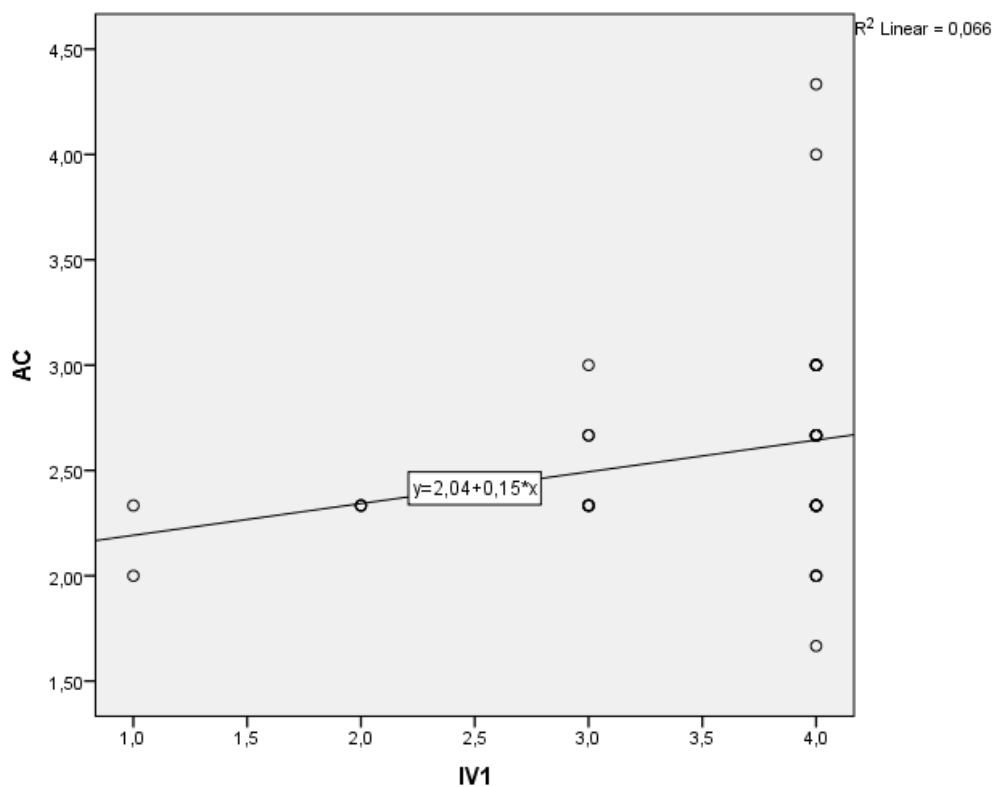
Therefore, there is no significant linearity between FC and IV2.

- AC * IV1

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
AC * IV1	Between	(Combined)	2,065	3	,688	7,636	,001
	Groups	Linearity	1,453	1	1,453	16,121	,000
		Deviation from Linearity	,612	2	,306	3,394	,046
	Within Groups		2,884	32	,090		
	Total		4,949	35			

Table 57



graph 23

According to the above, there is significant linearity between AC and IV1 as $\text{sig} < 0,05$, however the deviation from linearity is significant as $\text{sig} < 0,05$. One more parameter needs to be checked is the R^2 value. If $R^2 > 0,3$ indicates that there is linear relationship.

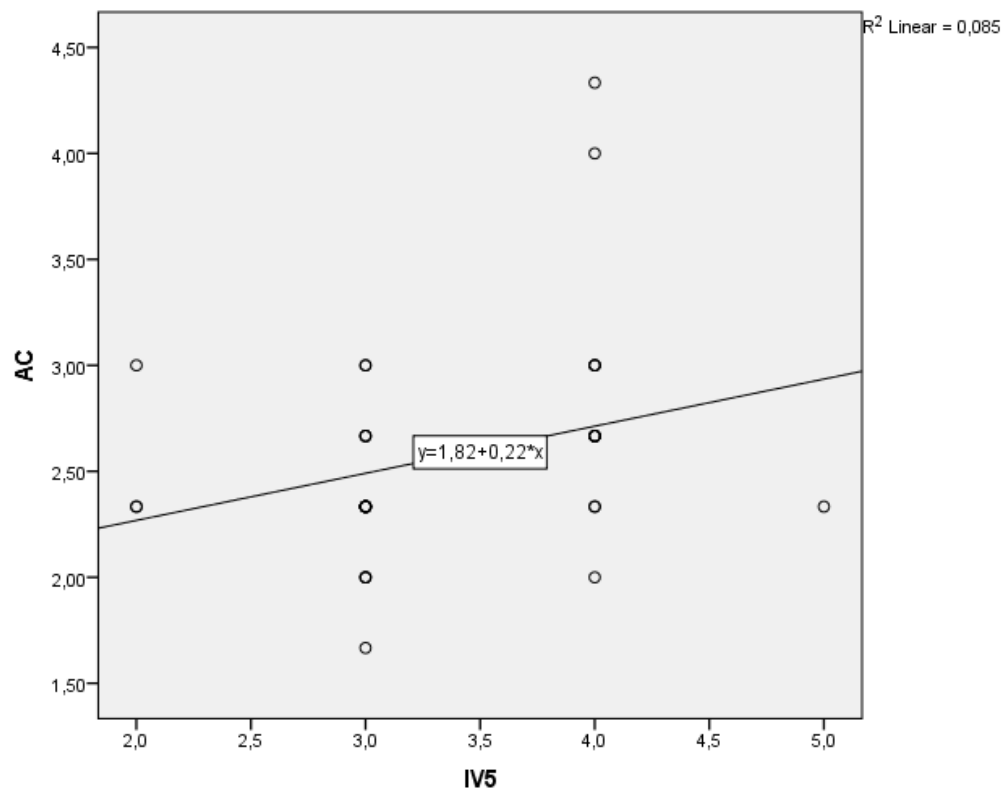
Therefore, there is not significant linearity between AC and IV1.

- AC * IV5

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
AC * IV5	Between Groups	(Combined)	2,012	3	,671	2,947	,048
		Linearity	,790	1	,790	3,472	,072
		Deviation from Linearity	1,222	2	,611	2,684	,084
	Within Groups		7,281	32	,228		
	Total		9,293	35			

Table 58



graph 24

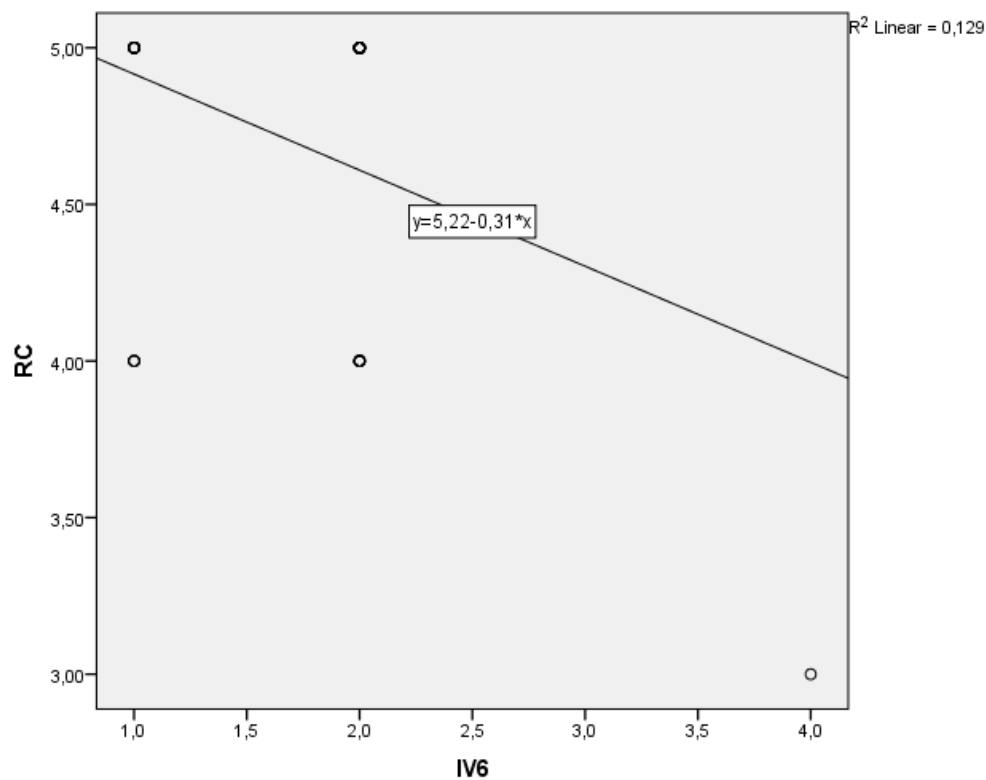
According to the above, there is no significant linearity between AC and IV5 as $\text{sig} > 0,05$. One more parameter needs to be checked is the R^2 value. If $R^2 > 0,3$ indicates that there is linear relationship. Therefore, there is no significant linearity between AC and IV5.

- **RC * IV6**

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
RC * IV6	Between	(Combined)	2,954	2	1,477	7,292	,002
	Groups	Linearity	1,244	1	1,244	6,141	,018
		Deviation from Linearity	1,710	1	1,710	8,442	,006
	Within Groups		6,685	33	,203		
	Total		9,639	35			

Table 59



graph 25

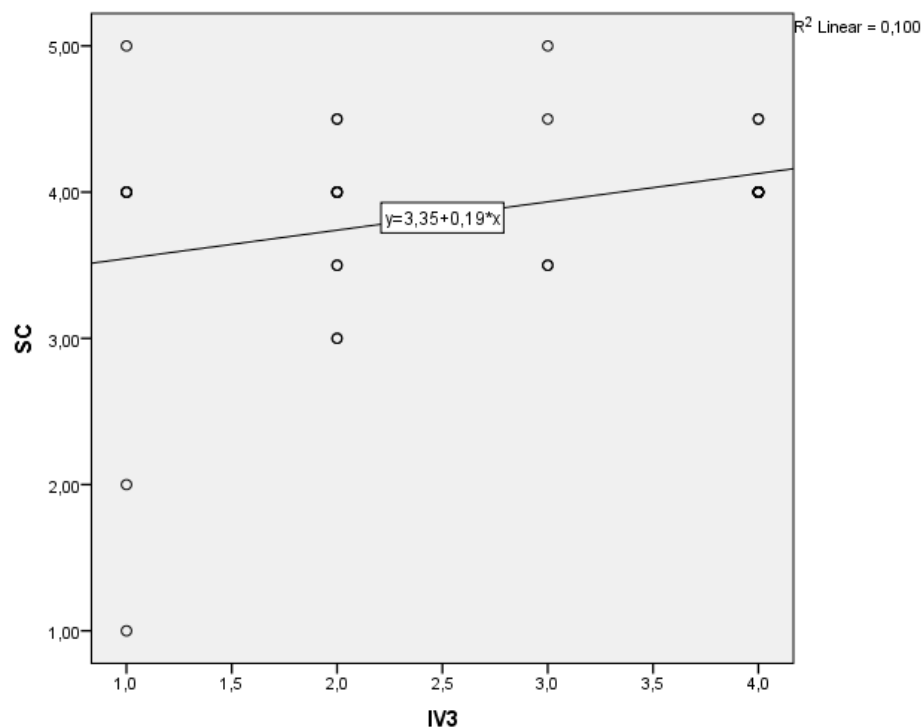
According to the above, there is no significant linearity between RC and IV6 as $\text{sig} > 0,05$. One more parameter needs to be checked is the R^2 value. If $R^2 > 0,3$ indicates that there is linear relationship. Therefore, there is no significant linearity between RC and IV6.

- **SC * IV3**

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
SC * IV3	Between	(Combined)	2,221	3	,740	1,439	,250
	Groups	Linearity	1,866	1	1,866	3,627	,066
		Deviation from Linearity	,354	2	,177	,344	,711
	Within Groups		16,467	32	,515		
	Total		18,688	35			

Table 60



graph 26

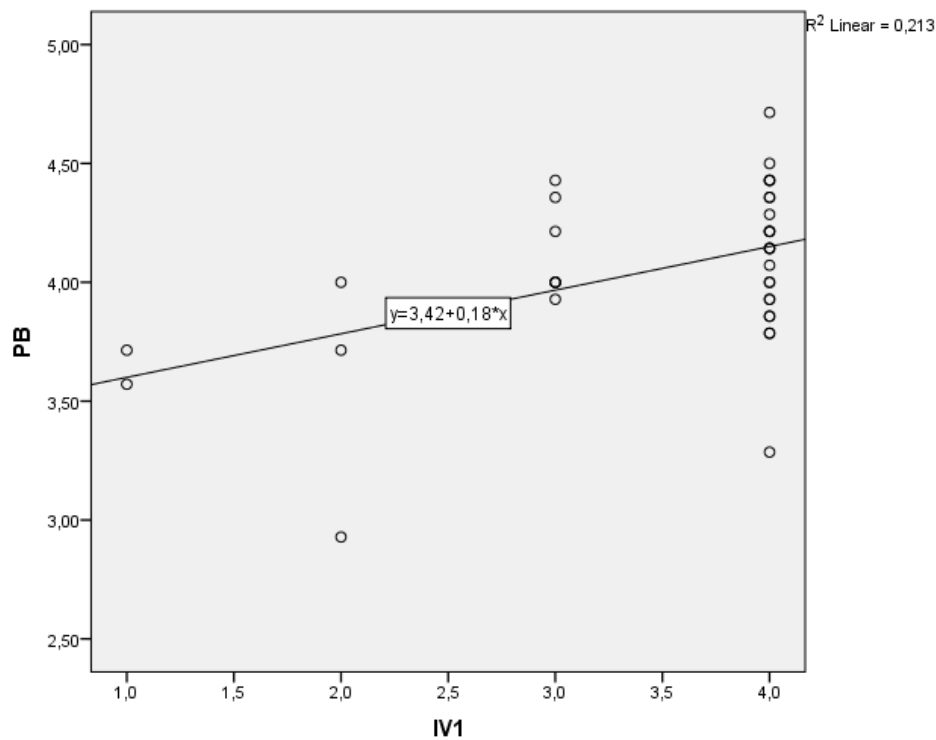
According to the above, there is no significant linearity between SC and IV3 as $\text{sig} > 0,05$. One more parameter needs to be checked is the R^2 value. If $R^2 > 0,3$ indicates that there is linear relationship. Therefore, there is no significant linearity between SC and IV3.

- **PB * IV1**

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
PB * IV1	Between	(Combined)	1,282	3	,427	4,593	,009
	Groups	Linearity	,907	1	,907	9,751	,004
		Deviation from Linearity	,375	2	,187	2,015	,150
	Within Groups		2,977	32	,093		
	Total		4,259	35			

Table 61



graph 27

According to the above, there is significant linearity between PB and IV1 as $\text{sig} < 0,05$. Furthermore, the deviation from linearity is not significant as $\text{sig} > 0,05$. One more parameter needs to be checked is the R^2 value. If $R^2 > 0,3$ indicates that there is linear relationship.

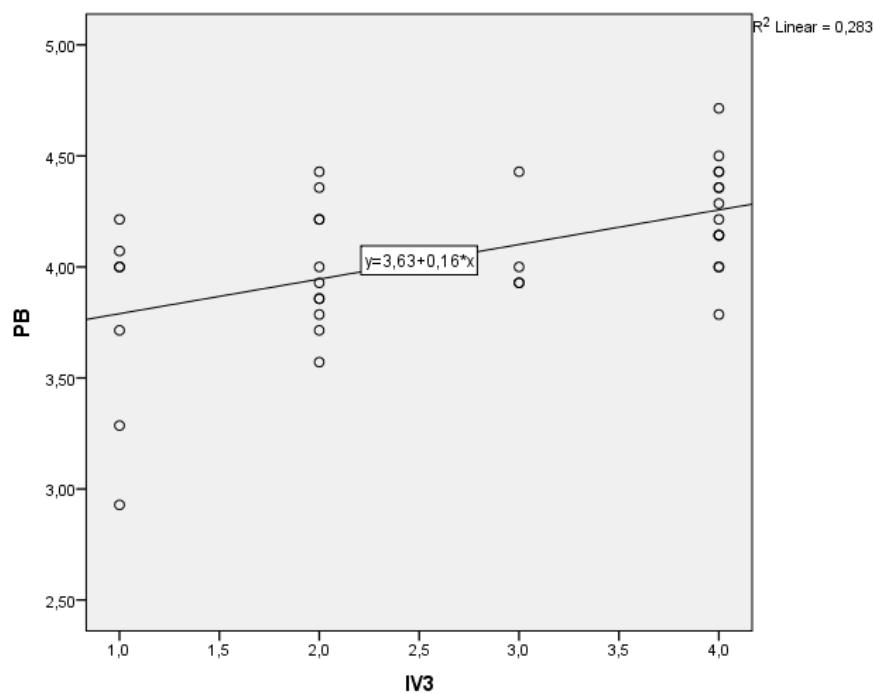
Therefore, there is not significant linearity between PB and IV1.

- **PB * IV3**

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
PB * IV3	Between	(Combined)	1,248	3	,416	4,422	,010
	Groups	Linearity	1,204	1	1,204	12,801	,001
		Deviation from Linearity	,044	2	,022	,232	,794
	Within Groups		3,011	32	,094		
	Total		4,259	35			

Table 62



graph 28

According to the above, there is significant linearity between PB and IV3 as $\text{sig} < 0,05$. Furthermore, the deviation from linearity is not significant as $\text{sig} > 0,05$. One more parameter needs to be checked is the R^2 value. If $R^2 > 0,3$ indicates that there is linear relationship.

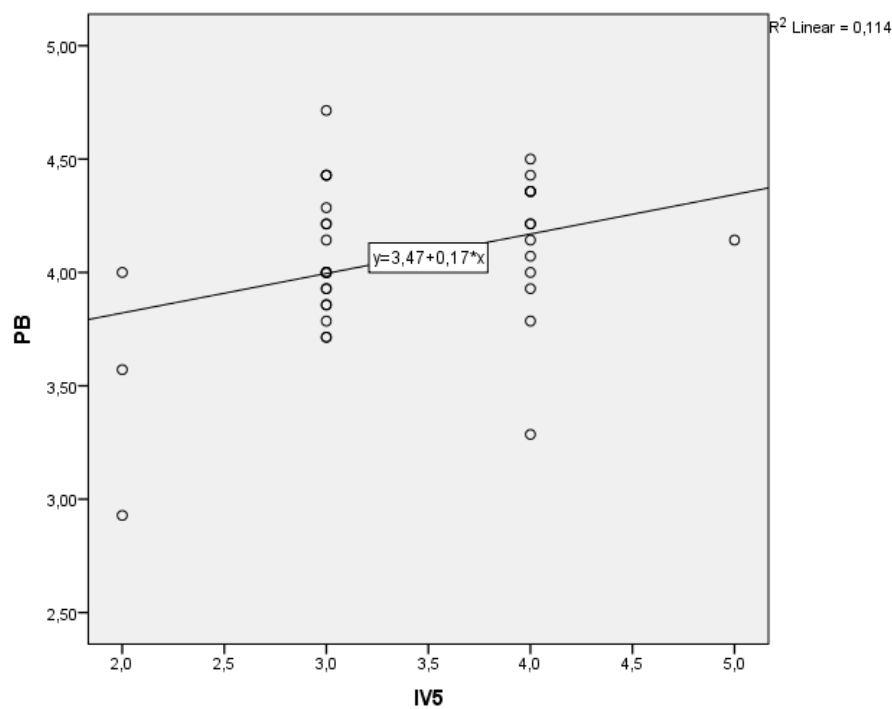
Therefore, there is not significant linearity between PB and IV3.

• **PB * IV5**

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
PB * IV5	Between	(Combined)	1,017	3	,339	3,345	,031
	Groups	Linearity	,485	1	,485	4,787	,036
		Deviation from Linearity	,532	2	,266	2,624	,088
	Within Groups		3,242	32	,101		
	Total		4,259	35			

Table 63



graph 29

According to the above, there is significant linearity between PB and IV5 as $\text{sig} < 0,05$, however the deviation from linearity is not significant as $\text{sig} > 0,05$. One more parameter needs to be checked is the R^2 value. If $R^2 > 0,3$ indicates that there is linear relationship.

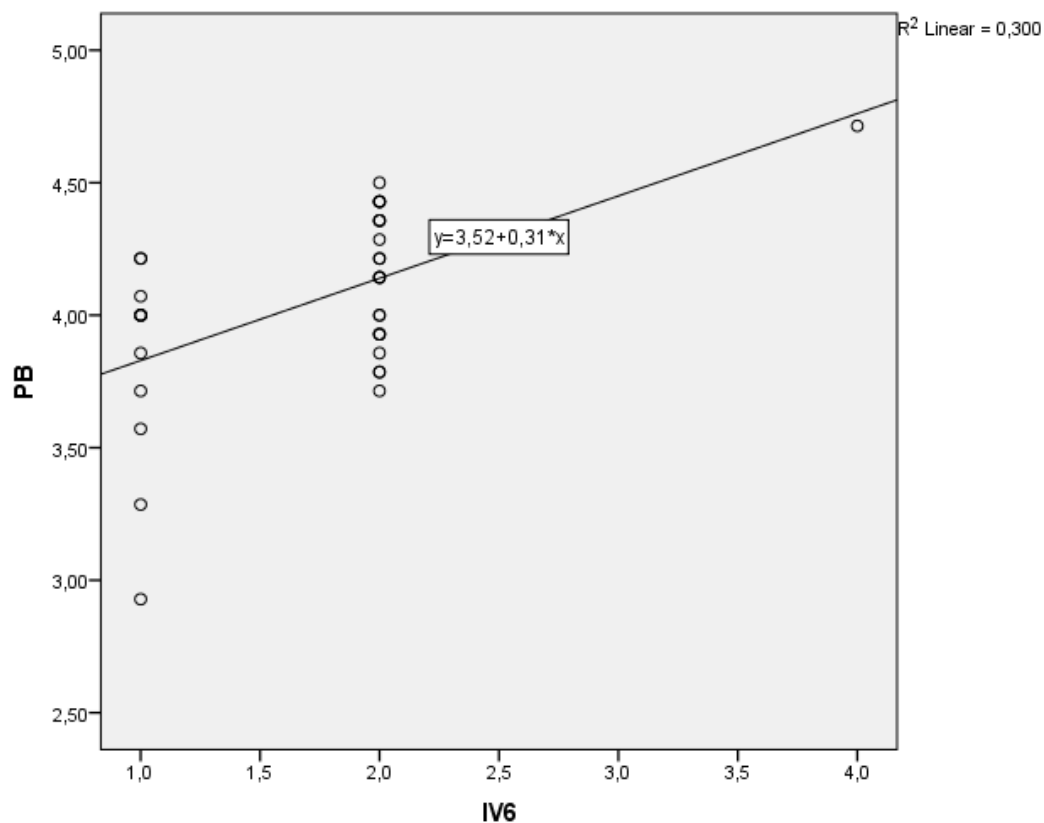
Therefore, there is not significant linearity between PB and IV5.

- **PB * IV6**

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
PB * IV6	Between Groups	(Combined)	1,280	2	,640	7,086	,003
		Linearity	1,276	1	1,276	14,131	,001
		Deviation from Linearity	,004	1	,004	,042	,839
	Within Groups		2,979	33	,090		
	Total		4,259	35			

Table 64



graph 30

According to the above, there is significant linearity between PB and IV6 as $\text{sig} < 0,05$. Furthermore, the deviation from linearity is not significant as $\text{sig} > 0,05$. One more parameter needs to be checked is the R^2 value. If $R^2 > 0,3$ indicates that there is linear relationship.

Therefore, there is significant linearity between PB and IV6.

4.3.6 Homoscedasticity

This section employs Levene's test. An essential assumption is that the variances of sample groups for a single variable are approximately equal, or that the variances of the samples are homogeneous. In hypothesis testing, groups with unequal variances will increase the likelihood of error.

In the null hypothesis there is no significant difference between the levels of the independent variables across the level of the dependent variables. When $\text{sig} > 0,05$, we accept the null hypothesis, otherwise there is significance difference in homogeneity.

- For IV1, the following SPSS output is depicted below:

Levene's Test of Equality of Error Variances ^a				
	F	df1	df2	Sig.
TC	,502	3	32	,684
OC	,311	3	32	,818
FC	,277	3	32	,841
AC	1,725	3	32	,182
RC	2,892	3	32	,051
SC	2,113	3	32	,118
PB	1,926	3	32	,145

Table 65

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + IV1

According to the above table the Leven's test outcome is non-significant and equal variances are assumed as $\text{sig} > 0.05$.

- For IV2, the following SPSS output is depicted below:

Levene's Test of Equality of Error Variances ^a				
	F	df1	df2	Sig.
TC	4,726	7	28	,001
OC	2,977	7	28	,018
FC	8,245	7	28	,000

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AC	2,311	7	28	,054
RC	2,053	7	28	,083
SC	5,250	7	28	,001
PB	4,890	7	28	,001

Table 66

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + IV2

According to the above table, the Leven's test outcome is non-significant and equal variances are assumed for all the groups of AC, RC variables as sig>0.05. However, Leven's test outcome is significant for TC, OC, FC, SC, PB, so there are not equal variances.

- For IV3, the following SPSS output is depicted below:

Levene's Test of Equality of Error Variances ^a				
	F	df1	df2	Sig.
TC	1,496	3	32	,234
OC	1,629	3	32	,202
FC	7,910	3	32	,000
AC	1,987	3	32	,136
RC	5,370	3	32	,004
SC	11,406	3	32	,000
PB	2,237	3	32	,103

Table 67

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + IV3

According to the above table, the Leven's test outcome is non-significant and equal variances are assumed for all the groups of TC, OC, AC, PB variables as sig>0.05. However, Leven's test outcome is significant for FC, RC, SC, so there are not equal variances.

- For IV4, the following SPSS output is depicted below:

Levene's Test of Equality of Error Variances ^a				
	F	df1	df2	Sig.
TC	,744	3	32	,534
OC	,493	3	32	,689
FC	,643	3	32	,593
AC	,531	3	32	,664
RC	3,317	3	32	,032
SC	15,435	3	32	,000
PB	2,591	3	32	,070

Table 68

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + IV4

According to the above table, the Leven's test outcome is non-significant and equal variances are assumed for all the groups of TC, OC, FC, AC, PB variables as sig>0.05. However, Leven's test outcome is significant for RC, SC so there are not equal variances.

- For IV5, the following SPSS output is depicted below:

Levene's Test of Equality of Error Variances ^a				
	F	df1	df2	Sig.
TC	2,036	3	32	,129
OC	,474	3	32	,702
FC	2,426	3	32	,084
AC	1,642	3	32	,199
RC	3,869	3	32	,018
SC	,772	3	32	,518
PB	1,195	3	32	,327

Table 69

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + IV5

According to the above table, the Leven's test outcome is non-significant and equal variances are assumed for all the groups of the variables as sig>0.05.

- For IV6, the following SPSS output is depicted below:

Levene's Test of Equality of Error Variances ^a				
	F	df1	df2	Sig.
TC	1,745	2	33	,190
OC	6,048	2	33	,006
FC	7,751	2	33	,002
AC	4,032	2	33	,027
RC	1,494	2	33	,239
SC	3,696	2	33	,036
PB	2,127	2	33	,135

Table 70

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + IV6

According to the above table, the Leven's test outcome is non-significant and equal variances are assumed for all the groups of TC, RC, PB variables as sig>0.05. However, Leven's test outcome is significant for OC, FC, AC, SC so there are not equal variances.

4.3.7 Autocorrelation

One of the key assumptions in linear regression is the absence of correlation between consecutive residuals. In other words, the residuals are assumed to be independent. When this assumption is violated, it is likely that the standard errors of the regression model's coefficients are underestimated, leading to an increased likelihood of incorrectly identifying predictor variables as statistically significant. To assess whether this assumption holds, the Durbin-Watson test can be employed. This test helps detect the presence of autocorrelation in the residuals of a regression model. The Durbin-Watson test uses the following hypotheses:

H0 (null hypothesis): There is no correlation among the residuals.

HA (alternative hypothesis): The residuals are autocorrelated.

The test statistic always ranges from 0 to 4 where:

- $d = 2$ indicates absence of autocorrelation
- $d < 2$ indicates presence of positive serial correlation
- $d > 2$ indicates presence of negative serial correlation

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Typically, if the Durbin-Watson (d) value is below 1.5 or above 2.5, it suggests the presence of a significant autocorrelation issue. In such cases, there may be a serious concern regarding autocorrelation. Conversely, if the d value falls between 1.5 and 2.5, it is generally considered that autocorrelation is not a major concern.

Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,807 ^a	,652	,580	,24384	1,874

Table 71

a. Predictors: (Constant), IV6, IV5, IV2, IV1, IV3

b. Dependent Variable: TC

As $1,5 < d = 1,874 < 2,5$ no autocorrelation

Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,540 ^a	,292	,145	,43389	1,670

Table 72

a. Predictors: (Constant), IV6, IV5, IV1

b. Dependent Variable: OC

As $1,5 < d = 1,670 < 2,5$ no autocorrelation

Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,367 ^a	,135	-,044	,51175	1,709

Table 73

a. Predictors: (Constant), IV2

b. Dependent Variable: FC

As $1,5 < d = 1,709 < 2,5$ no autocorrelation

Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,349 ^a	,122	-,060	,53041	2,574

Table 74

a. Predictors: (Constant), IV5, IV1

b. Dependent Variable: AC

As $1,5 < d = 2,5 < 2.5$ no autocorrelation

Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,426 ^a	,182	,013	,52146	1,919

Table 75

a. Predictors: (Constant), IV6

b. Dependent Variable: RC

As $1,5 < d = 1,919 < 2.5$ no autocorrelation

Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,562 ^a	,316	,174	,66398	2,157

Table 76

a. Predictors: (Constant), IV3

b. Dependent Variable: SC

As $1,5 < d = 2,157 < 2.5$ no autocorrelation

Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,648 ^a	,420	,300	,29192	1,786

Table 77

a. Predictors: (Constant), IV6, IV5, IV1, IV3

b. Dependent Variable: PB

As $1,5 < d = 1,786 < 2.5$ no autocorrelation

In summary, the following tables are formulated:

Construct	TC	OC	FC	AC	RC	SC	PB
Outliers	No	No	No	No	No	No	No

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Normal distribution	Yes	No	No	No	No	No	Yes
Autocorrelation	No	No	No	No	No	No	No

Table 78

Construct		TC	OC	FC	AC	RC	SC	PB
Linearity	IV1	No	No	--	No	--	--	No
	IV2	No	--	No	--	--	--	--
	IV3	Yes	--	--	--	--	No	No
	IV4	--	--	--	--	--	--	--
	IV5	No	No	--	No	--	--	No
	IV6	Yes	No	--	--	No	--	Yes

Table 79

Construct		TC	OC	FC	AC	RC	SC	PB
Homoscedasticity	IV1	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	IV2	No	No	No	Yes	Yes	No	No
	IV3	Yes	Yes	No	Yes	No	No	Yes
	IV4	Yes	Yes	Yes	Yes	No	No	Yes
	IV5	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	IV6	Yes	No	No	No	Yes	No	Yes

Table 80

According to the preceding tables only three combinations apply the assumptions in total:

- **TC-IV3**
- **TC-IV6**
- **PB-IV6**

The variables listed above will use linear regression, whereas the remaining variables will employ non-parametric tests because one or more assumptions have been violated.

4.3.8 Linear Regression

A sort of statistical procedure called linear regression is employed to forecast the interaction of two variables. Linear regression seeks to find the line of best fit that accurately captures the relationship between the independent and dependent variables. This line is assumed to be linear, representing the most optimal representation of the connection between the variables.

As described by Zikmund, William G. (2000), the coefficient of determination, denoted as R^2 , measures the proportion of variance in the dependent variable that can be explained by the independent variable. It allows for the interpretation of the strength of the relationship between the variables as follows:

1. if R^2 value < 0.3 , it is usually regarded as indicative of a None or Very weak effect size,
2. if R^2 value $0.3 < r < 0.5$, it is usually regarded as indicative of a weak or low effect size,
3. if R^2 value $0.5 < r < 0.7$, it is usually regarded as indicative of a a Moderate effect size,
4. if R^2 value $r > 0.7$, it is usually regarded as indicative of a strong effect size,

- **TC- IV3**

Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,729 ^a	,532	,518	,26114	1,964

Table 81

a. Predictors: (Constant), IV3

b. Dependent Variable: TC

$R^2 = 53,2\% > 50\%$, meaning that 53,2% of the variance in TC is predicted from IV3 and is considered a Moderate effect size.

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2,631	1	2,631	38,574	,000 ^b
	Residual	2,319	34	,068		
	Total	4,949	35			

Table 82

a. Dependent Variable: TC

b. Predictors: (Constant), IV3

The significance value means that our model using IV3 as a predictor is significantly better than prediction without IV3 in the model. Therefore, there is statistically significant relationship between IV3 and TC variable.

Coefficients^a

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
1 (Constant)	2,578	,109		23,661	,000	2,356	2,799
IV3	,230	,037	,729	6,211	,000	,155	,306

Table 83

a. Dependent Variable: TC

According to B, the TC will rise by 0,230 points for every 1 unit increase in IV3, and this is statistically significant as sig<0,05.

- TC- IV6**

Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,631 ^a	,398	,380	,29600	1,865

Table 84

a. Predictors: (Constant), IV6

b. Dependent Variable: TC

$R^2 = 39,8\% > 30\%$, meaning that 39,8% of the variance in TC is predicted from IV6 and is considered a weak or low effect size.

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1,970	1	1,970	22,489	,000 ^b
	Residual	2,979	34	,088		
	Total	4,949	35			

Table 85

a. Dependent Variable: TC

b. Predictors: (Constant), IV6

The significance value means that our model using the IV6 as a predictor is significantly better than prediction without IV6 in the model. Therefore, there is statistically significant relationship between IV3 and TC variable.

Coefficients ^a							
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
1 (Constant)	2,533	,149		17,044	,000	2,231	2,835
IV6	,386	,081	,631	4,742	,000	,221	,551

Table 86

a. Dependent Variable: TC

According to B, the TC will rise by 0,386 points for every 1 unit increase in IV6, and this is statistically significant as sig<0,05.

• PB- IV6

Model Summary ^b					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,547 ^a	,300	,279	,29621	1,696

Table 87

a. Predictors: (Constant), IV6

b. Dependent Variable: PB

$R^2 = 30,0\% > 30\%$, meaning that 30,0% of the variance in PB is predicted from IV6 and is considered a weak or low effect size.

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1,276	1	1,276	14,540	,001 ^b
	Residual	2,983	34	,088		
	Total	4,259	35			

Table 88

a. Dependent Variable: PB

b. Predictors: (Constant), IV6

The significance value means that our model using the IV6 as a predictor is significantly better than prediction without IV6 in the model. Therefore, there is statistically significant relationship between IV6 and PB variable.

Coefficients ^a							
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
1 (Constant)	3,519	,149		23,658	,000	3,216	3,821
IV6	,311	,081	,547	3,813	,001	,145	,476

Table 89

a. Dependent Variable: PB

According to B, the PB will rise by 0,311 points for every 1 unit increase in IV6, and this is statistically significant as sig<0,05.

4.3.9 Non parametric test

The application of a multivariate analysis (MANOVA) and multiple linear regression is improper due to the foregoing violations of linearity, normality, etc., hence a non-parametric test, namely the Kruskal-Wallis test, will be utilized.

The Kruskal-Wallis test serves as a non-parametric alternative to the One-Way ANOVA. Unlike parametric tests, non-parametric tests do not make assumptions about the distribution pattern of the data. When the requirements for ANOVA, such as the assumption of normality, are not met, the Kruskal-Wallis test, denoted as H test, is employed. This test utilizes the rankings of the data values instead of the actual data points, and hence, it is often referred to as the one-way ANOVA on ranks. The purpose of the test is to determine whether there is a significant difference between the medians of two or more groups. Similar to other statistical tests, you calculate a test statistic and compare it to a threshold value from a specific distribution. In the case of the Kruskal-Wallis test, the H statistic is the test statistic utilized to evaluate the hypothesis.

The Kruskal-Wallis test is utilized to determine whether there is a statistically significant difference between groups.

The output from the SPSS program is as follows:

- **TC- IV1**

Kruskal-Wallis Test

Ranks			
	IV1	N	Mean Rank
TC	Under 3 years	2	11,25
	3-6 years	3	3,83
	6-9 years	7	12,50
	Over 9 years	24	22,69
	Total	36	

Table 90

Test Statistics ^{a,b}	
	TC
Chi-Square	13,024
df	3
Asymp. Sig.	,005

Table 91

a. Kruskal Wallis Test

b. Grouping Variable: IV1

According to the above results, there is highly significant result for TC related to IV1 as sig<0,05.

- **TC- IV2**

Kruskal-Wallis Test

Ranks			
	IV2	N	Mean Rank
TC	Retailer	2	4,50
	Logistics Service Provider	4	16,25
	Customer Service	5	13,50
	Transportation and distribution	5	11,90
	Manufacturer	12	27,96
	Freight Forwarder	2	14,50

Third-Party 2 Provider (3PL)	2	6,25
Other	4	22,00
Total	36	

Table 92

Test Statistics ^{a,b}	
	TC
Chi-Square	20,219
df	7
Asymp. Sig.	,005

Table 93

a. Kruskal Wallis Test

b. Grouping Variable: IV2

According to the above results, there is highly significant result for TC related to IV2 as sig<0,05.

• TC- IV5

Kruskal-Wallis Test

Ranks			
	IV5	N	Mean Rank
TC	Low	3	7,83
	Somewhat high	19	16,08
	High	13	23,38
	Very high	1	33,00
	Total	36	

Table 94

Test Statistics ^{a,b}	
	TC
Chi-Square	8,904
df	3
Asymp. Sig.	,031

Table 95

a. Kruskal Wallis Test

b. Grouping Variable: IV5

According to the above results, there is highly significant result for TC related to IV5 as sig<0,05.

- **OC- IV1**

Kruskal-Wallis Test

Ranks			
	IV1	N	Mean Rank
OC	Under 3 years	2	18,00
	3-6 years	3	5,17
	6-9 years	7	14,71
	Over 9 years	24	21,31
	Total	36	

Table 96

Test Statistics ^{a,b}	
	OC
Chi-Square	8,057
df	3
Asymp. Sig.	,045

Table 97

a. Kruskal Wallis Test

b. Grouping Variable: IV1

According to the above results, there is highly significant result for OC related to IV1 as sig<0,05.

- **OC- IV5**

Kruskal-Wallis Test

Ranks			
	IV5	N	Mean Rank
OC	Low	3	5,17
	Somewhat high	19	16,79
	High	13	23,73
	Very high	1	23,00
	Total	36	

Table 98

Test Statistics^{a,b}

	OC
Chi-Square	9,434
df	3
Asymp. Sig.	,024

Table 99

a. Kruskal Wallis Test

b. Grouping Variable: IV5

According to the above results, there is highly significant result for OC related to IV5 as sig<0,05.

- OC- IV5**

Kruskal-Wallis Test

Ranks

	IV6	N	Mean Rank
OC	Very low	12	16,71
	Low	23	18,67
	High	1	36,00
	Total	36	

Table 100

Test Statistics^{a,b}

	OC
Chi-Square	3,378
df	2
Asymp. Sig.	,185

Table 101

a. Kruskal Wallisz Test

b. Grouping Variable: IV6

According to the above results, there is not significant result for OC related to IV6 as sig>0,05.

- FC- IV2**

Kruskal-Wallis Test

Ranks

	IV2	N	Mean Rank
FC	Retailer	2	24,75

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Logistics Service Provider	4	10,00
Customer Service	5	16,00
Transportation and distribution	5	24,90
Manufacturer	12	17,54
Freight Forwarder	2	18,50
Third-Party 2 Provider (3PL)	2	32,75
Other	4	14,75
Total	36	

Table 102

Test Statistics^{a,b}

	FC
Chi-Square	12,604
df	7
Asymp. Sig.	,082

Table 103

a. Kruskal Wallis Test

b. Grouping Variable: IV2

According to the above results, there is not significant result for FC related to IV2 as $\text{sig} > 0,05$.

- **AC- IV1**

Kruskal-Wallis Test

Ranks			
	IV1	N	Mean Rank
AC	Under 3 years	2	8,25
	3-6 years	3	13,00
	6-9 years	7	18,93
	Over 9 years	24	19,92
	Total	36	

Table 104

Test Statistics^{a,b}

	AC
Chi-Square	3,463
df	3
Asymp. Sig.	,326

Table 105

a. Kruskal Wallis Test

b. Grouping Variable: IV1

According to the above results, there is not significant result for AC related to IV1 as $\text{sig} > 0,05$.

- AC- IV5**

Kruskal-Wallis Test

Ranks

	IV5	N	Mean Rank
AC	Low	3	19,17
	Somewhat high	19	14,63
	High	13	24,42
	Very high	1	13,00
	Total	36	

Table 106

Test Statistics^{a,b}

	AC
Chi-Square	7,632
df	3
Asymp. Sig.	,05

Table 107

a. Kruskal Wallis Test

b. Grouping Variable: IV5

According to the above results, there is significant result for AC related to IV5 as $\text{sig} < 0,05$.

- RC- IV6**

Kruskal-Wallis Test

Ranks

	IV6	N	Mean Rank
RC	Very low	12	19,13

Low	23	18,93
High	1	1,00
Total	36	

Table 108

Test Statistics ^{a,b}	
	RC
Chi-Square	4,671
df	2
Asymp. Sig.	,097

Table 109

a. Kruskal Wallis Test

b. Grouping Variable: IV6

According to the above results, there is not significant result for RC related to IV6 as sig>0,05.

• SC- IV3

Kruskal-Wallis Test

Ranks			
	IV3	N	Mean Rank
SC	Less than 10	7	16,36
	10-20	11	16,27
	20-100	4	20,13
	More than 200	14	20,86
	Total	36	

Table 110

Test Statistics ^{a,b}	
	SC
Chi-Square	1,977
df	3
Asymp. Sig.	,577

Table 111

a. Kruskal Wallis Test

b. Grouping Variable: IV3

According to the above results, there is not significant result for RC related to IV6 as sig>0,05.

- **PB- IV1**

Kruskal-Wallis Test

Ranks			
	IV1	N	Mean Rank
PB	Under 3 years	2	3,75
	3-6 years	3	7,00
	6-9 years	7	20,50
	Over 9 years	24	20,58
	Total	36	

Table 112

Test Statistics ^{a,b}	
	PB
Chi-Square	8,764
df	3
Asymp. Sig.	,033

Table 113

a. Kruskal Wallis Test

b. Grouping Variable: IV1

According to the above results, there is significant result for PB related to IV1 as sig<0,05.

- **PB- IV3**

Kruskal-Wallis Test

Ranks			
	IV3	N	Mean Rank
PB	Less than 10	7	11,71
	10-20	11	15,27
	20-100	4	17,50
	More than 200	14	24,71
	Total	36	

Table 114

Test Statistics^{a,b}

	PB
Chi-Square	8,923
df	3
Asymp. Sig.	,030

Table 115

a. Kruskal Wallis Test

b. Grouping Variable: IV3

According to the above results, there is significant result for PB related to IV3 as $\text{sig} < 0,05$.

- **PB- IV5**

Kruskal-Wallis Test

Ranks

	IV5	N	Mean Rank
PB	Low	3	6,50
	Somewhat high	19	18,26
	High	13	21,42
	Very high	1	21,00
	Total	36	

Table 116

Test Statistics^{a,b}

	PB
Chi-Square	5,004
df	3
Asymp. Sig.	,172

Table 117

a. Kruskal Wallis Test

b. Grouping Variable: IV5

According to the above results, there is not significant result for PB related to IV5 as $\text{sig} > 0,05$.

In summary, the following matrix is formulated:

Construct		TC	OC	FC	AC	RC	SC	PB
Influence	IV1	Yes	Yes	--	No	--	--	Yes
	IV2	Yes	--	No	--	--	--	--
	IV3	Yes	--	--	--	--	No	Yes
	IV4	--	--	--	--	--	--	--
	IV5	Yes	Yes	--	Yes	--	--	No
	IV6	Yes	No	--	--	No	--	Yes

Table 118

4.4 Hypothesis Interpretation

It is evident from the table's data that some of the independent variables have a significant and positive effect on the challenges and perceived benefits, while others do not. Specifically, the independent variables IV1, IV2, IV3, IV5, and IV6 have a significant impact on the technological challenges. Moreover, variables IV1, IV5, but not IV6, have a positive effect on organizational challenges. In addition, it has been observed that none of the independent variables have a substantial effect on the financial, regulatory, and social challenges. In addition, the IV5 variable has a positive effect on administrative difficulties, whereas the IV1 variable does not. The IV1, IV3, and IV6 variables have a positive and significant impact on the perceived benefits of blockchain technology, whereas the IV5 variable does not.

Chapter 5: Discussion and Conclusion

5.1 Technological challenges in adopting block chain in supply chain

There are many technological challenges that come with adopting blockchain in supply chain industry. For starters, adoption is a key technological issue. Blockchain are closed systems that require complete acceptance for success (Aich, Chakraborty, Sain, Lee, & Kim, 2019). For instance, the track and trace feature of supply chain is workable for an organization only when all the key stakeholders adopt blockchain system (Abdel-Baset & Chang, 2019). Research confirms that less than 30% of the organizations are only initiating blockchain or have completely developed it. Without complete acceptance, the complete effect of blockchain would not be handled. However,

there are chances of its overall acceptance in the supply chain. Many companies are taking step forward to develop a connective network of blockchain to deal with common issues and find solution that could be useful for everyone without exposing any viral information (Ahmed & MacCarthy, 2021). Research reports many pre-pandemic organizations coming together to form a group in their supply chain industry. This enables the companies to connect for shipment tracking, easier paper work, and better supply chain process.

Another technological barrier is the gap in the skills of the employees. Blockchain is a very new technology, and there is a need for regular training and development sessions in order to inculcate blockchain completely (Al-Amin, Sharkar, Kaiser, & Biswas, 2021). Research suggests that more than 45% of the participants experience an issue with the new skill. Studies also confirmed that the blockchain technology is rapidly taking over but there is a need for technicians to run it and also conduct training sessions for this process (Al-Farsi, Rathore, & Bakiras, 2021). Moreover, people skilled with blockchain are now paid well due to the scarcity of such professionals, thereby making it a considerable concern for many companies. Many companies have now started offering blockchain as a service, making it possible for larger companies to outsource the professionals instead of paying copiously for time and resource of training sessions (Kumar & Mahendra, 2017).

Blockchain is a technology-based phenomenon, therefore, many organizations may exhibit reluctance in trusting the technology completely (Wang, Wu, Chen, & Evans, 2020). Since technology is always considered a perk that comes with limited security, companies may have an issue with installing blockchain in the first place. It is also possible that the company hired for dealing with blockchain needs of an organization may not be considered reliable enough. Hence, when blockchain is outsourced, a company may not trust it to work with it properly (Kurdi, Alzoubi, Akour, & Alshurideh, 2022). Blockchain is generally considered safe, verified, and private. However, there is no centralization and the entire system is completely decentralized with no top management to affirm safety. Blockchain features a consensus algorithm that functions by setting a common ground regarding current situation of the ledger for complete network (Li, Maiti, Springer, & Gray, 2020). It manages to add new block as an individual entity with complete reality as accepted by all the blockchain nodes. The most trusted of the blockchain are the ones with no anonymous users. To develop user trust, systems like global networks for logistics by giants like Maersk and IBM with the Blockchain platform. This proves that contemporaries can work on a similar challenge to resolve it well.

5.2 Organizational challenges in adopting block chain in supply chain

Even when organizations deal with the technological barriers that come with adopting blockchain, there are certain organizational challenges that needs addressing for supply chain (Li, Maiti, Springer, & Gray, 2020). Many research studies have pointed out certain organizational barriers to adopting blockchain. Some of the key issues are connections amongst various organizations, organizational mindset, management style, business operations, rigidity, lack of user friendly blockchain systems, limited integration of the new system with the current system, unsure ROI, limited flexibility in the business model, improper physical infrastructure, limited trust, and limited acceptance of the company and its people for blockchain (Kumar & Mahendra, 2017). One of the key challenges, as reported by several studies is the organizational culture. When organizational culture is not open to change and is fixated on maintaining a status quo, it becomes challenging for the company to inculcate blockchain in the supply chain sector. Organizations that are not mainly ready for change and learning exhibit reluctance for blockchain adaptation in supply chain (Kumar & Mahendra, 2017). Moreover, many organizations are not ready to go through the training sessions, hence, making lack of knowledge a major problem. Similarly, limited understanding and novelty that comes with blockchain makes it a challenge for the stakeholders to learn about it. Therefore, it is essential to have mental readiness before inculcating blockchain in the supply chain of any organization. Another problem is limited awareness and training for the new system. Many companies are unable to find technicians who could introduce and guide the staff about the blockchain with complete proficiency (Yiu, 2021). The management at the higher level also presents some challenges in the successful implementation of blockchain. Lack of support and understanding from the top can lead to reluctance and more resistance to the newer system. Moreover, the top management must facilitate the employees in understanding and integrating the blockchain system in the supply chain section (Kumar & Mahendra, 2017). When the stakeholder's exhibit limited trust for IT staff, technologists, managers, security, and employees, it can be difficult to implement. Some other challenges of its implementation are scalability by the management, improper policy making, limited transparency, no accountability and responsibility by stakeholders (Kusi-Sarpong, Mubarik,, Khan, Brown, & Mubarak, 2022). Moreover, there are very few workable apps for blockchain implementation, improper understanding, and limited understanding of new policies. Moreover, legal and regulatory issues that come under the organizational domain are also challenges (Queiroz & Wamba, 2019). Organizations also face issues with implementing blockchain in supply chain because of conflicts that may arise in the process. Similarly, there are problems like taxation, and

inculcation with multiple rules and regulations. In most cases, there are problems with law-and-order situation that does not encourage the organizations to take it forward with blockchain implementation. Moreover, when the organization does not announce clear incentives and benefits for the implementation of the blockchain, employees do not show willingness to accept it completely (Kuei, 2015). In some cases, there is no standardization for the process, thereby making blockchain implementation a challenge. Many nations have set up certain standardized system for nation supported blockchain networks in order to ensure security and protection for the company. It also makes the currency exchange relatively easier on the supply chain networks and increases reliability.

5.3 Financial challenges in adopting block chain in supply chain

In the rising inflation of today's world, blockchain development is an expensive process. There are certain financial challenges that are incurred in the process and need to be addressed before adopting blockchain in supply chain (Mircheva, 2020). There are certain finances that are a must to develop a blockchain application. The level of cost depends on multiple factors like complexity, type of blockchain, platform used, technological checkpoints, and in-app features. These factors contribute to the overall costing that must be managed for this process. Therefore, any company must consider a few points before inculcating blockchain in their supply chain (Soosay, 2008). For instance, deciding if there is a need for integrated blockchain system or to develop a brand-new product. Similarly, it is also important to know the type of blockchain needed by the product, i.e., public or private blockchain. Moreover, does the supply chain blockchain relates to financial transactions or not? It is also important to realize if there is any kind of cloud computing alongside the blockchain features. The company must also realize the kind of blockchain interface needed, like mobile app, website, admin dashboard, or a combination of all three (Sutduean & Joemsittiprasert, 2019). Similarly, it is also essential to realize the number of potential users, or the need is for proof of concept. Some of the key drivers of the finances needed for the blockchain development are process, resources needed, and the level of complexity of blockchain. There are many phases of blockchain implementation, each with its own financial requirement. Some of these activities are mentioned below:

- Designing: it includes blueprint formation, used interface development with framing, prototype formation, and designing an app flow.
- Developing: this stage covers the coding stage followed by its testing.

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- Deploying: this stage, as the name says, deals with deploying the product on cloud receptions and delivering.
- Migrating: it deals with transforming the current information on to the blockchain sector.
- Upgrading: it deals with introducing new characteristics and modifying the contracts.
- Tools from third party: it involves notification system, collaboration-based projects, and host-based setups (SA, 1998).

Apart from the above-mentioned details, the installation of a blockchain setup in the supply chain required certain costs that are inevitable. Some of them are mentioned below and are responsible for financial challenges:

- For project management: when a blockchain app is developed, project management cost is compulsory (Sabeti, Kouhizadeh, Sarkis, & Shen, 2019). While developing blockchain, steps like regular discussion meetings, tracking progress, testing prototype, meeting deadlines, eliminating bugs, and finalizing deliverables are some of the steps. These steps need software like Trello and Confluence etc. Using this software requires cost of blockchain implementation. They are useful in providing deliverables and track overall progress of the organizational team.
- Side-by-side Integration: integration of the progressed outcomes is essential for quality maintenance (Kouhizadeh, Sabeti, & Sarkis, 2021). When a developer writes a code, they incorporate the code database to verify the efficiency of the code and how well it works with the relevant codes and other systems. For verifications, automation in the system is utilized. To manage the source code, certain software and tools are used that are a part of blockchain app.
- Maintenance Cost: blockchain technology is relatively new in the world and many platforms are functioning via it (Yiu, 2021). Therefore, applications switch between multiple dashboards on the basis of their elasticity, privacy, and scalability. Similarly, there are many updates that are developed by various service provider like Google, Apple, and other blockchain setups annually. The complete maintenance of blockchain requires an average of 20% of the overall implementation cost of blockchain, however, variations are possible on the basis of application complexity.

The complexity of the blockchain project is another determinant of the cost of blockchain implementation cost (Sidorov, et al., 2019). There are various factors that explain the complexity of

blockchain. Hence, it is important to know the purpose of the app, issues for the end-users, possible solutions for the problems, the overall requirement of blockchain solutions, the need for transformation from the app, and the solutions in the world today.

5.4 Regulatory challenges in adopting block chain in supply chain

There are many regulatory and governance challenges that come with adopting blockchain in supply chain. For instance, the legal framework for the overall legal situation of blockchain and shared ledgers (Abdel-Baset & Chang, 2019). It means it has geographical scenario in terms of applicable laws of a region and the possible liability in case of any issues. Since distributed ledgers do not come with specific locations, there is a challenge in terms of geographical location, the law in action in the said region, and jurisdiction regarding it (Lim, Li, Wang, & Tseng, 2021). Therefore, it is not possible to have applicable administration that would take the legal responsibility of the situation. For each distributed ledger, the locality it came from can be considered as an anchor to ensure that proper regulations are implemented to ensure regulation and law management (Omar, et al., 2022). Liability is also a major issue, since there is no legal region responsible, there may be no territory that would take the responsibility of the distributed ledger. Another regulatory challenge is that a legal framework is a must for implementing blockchain to make it a reliable source. Prior to this, there is an implementation of regulation by standardization on data protection and confirming the identity of legal personnel (Sabeti, Kouhizadeh, Sarkis, & Shen, 2019). Despite having all the cryptographers and IT professionals on the same page about the immutable blocks of a completed blockchain, mainly because it is impossible to improve the blocks in work-test or other controls related to the process of consensus. However, there is no legal identification of this dimension of blockchain making it irrelevant in court of law. With such difficulty in rules and laws, it is essential to have solutions for regulatory challenges (Truong, 2017). Studies recommend that the blockchain must be able to have the capacity to delete the conflicted information or place it under the prohibited information section. It is possible to implement this by data encryption by implementing certain conditions like smart contracts or alternate solutions to keep the classified information safe from any external party that may try to breach the barriers (Slade, 2017). The legal confirmation of the documents is placed in blockchain for proving their ownership and existence for legal framework. This is similar to realizing blockchain as unusual immutable sources of accuracy, which is the second level of recognition needed to make use of blockchain in many businesses (Sidorov, et al., 2019). Therefore, it confirms that information cannot just be changed but also confirms that being a part in a blockchain that

verifies ownership or the presence of any asset shows true ownership or true presence of the mentioned asset. Nevertheless, there is an assumption that verification about any presence before its inclusion in the document with blockchain is rigorous. Therefore, the efficiency of cryptographic mechanism used in blockchain is confirmed (Stevenson & Rosanna, 2018). The conflicting point is also the acceptance of it any geographical location since there is no fixed jurisdiction for the laws and rules in blockchain. Another study asserts that when blockchain are implemented for explaining local financial tools, like bonds etc. legal conformation of the mentioned tool becomes compulsory. One of the best financial tools for blockchain is money (Zhu, Bai, & Sarkis, 2022). However, local currency used in blockchain have many implementations for economic and monetary laws and it demands a better study of the subject. Whenever legal frameworks are developed for international trade, that can be implemented globally, there is a need to have liability and regulation present in order to ensure safety of the users.

Chapter 6: Conclusion and Recommendation

6.1 Conclusion

A blockchain is a technology based on distributed ledger. This ledger covers the transactions as a group of code blocks forming a chain. When there is a modification in the blockchain, every operating device under any operating system modifies the ledger. It means that the existence of every block lies with respect to its precedent and successive block, hence it is not possible to damage any data in a single block. This confirms that blockchain is extremely reliable, transparent, anti-tamper, and extremely verifiable technology. There are many advantages of adopting blockchain to the supply chain sector. Some of them are mentioned below:

- When blockchain is implemented in the blockchain, it activates the visibility and mapping capacity owing to the connection and bridging of various components. It makes it possible to trace every component being a part of supply chain, for instance recording supplier information, deliverables, etc.
- Moreover, blockchain develops and improves the trust level between various parties in supply chain because of its supply chain that gives access to main data points that are collected. Hence its transparency improves its traceability making it a major advantage.
- Another benefit of blockchain in supply chain is speed. Blockchain offers smart contracts that are groups of code in a single block of blockchain. There is an automatic update in the

smart contract for actions when previously known situations of actions are fulfilled. This allows the replacement of a slow and manual process which would otherwise demand a long and tedious confirmation process.

- The reliability of blockchain is very high in supply chain. Because of its distributed ledger, it is not possible to modify any data because of its many copies that would all require modification. Hence, it makes it fraud proof and very trustworthy.
- It is nearly impossible to work with blockchain in supply chain without consensus, since all the transactions can only be conducted successfully if all parties agree on a single action. Since blockchain can develop sustainable consensus, because all groups are aware that every transaction is valid and automatic.

6.2 Recommendations

Moreover, the usage of blockchain in supply chain sector is very vast. Every area of the supply chain along with various steps include blockchain. Some of the key areas of its implementation are given below:

Blockchain offers features like speed, consensus, transparency, traceability, and reliability. Therefore, it is an excellent tool in supply chain management. Blockchain connects the communication systems of the supply chain with a single database simply on the basis of its capacity for sharing information and processing. Moreover, based on the study, blockchain supports in eliminating the risk of issues caused in supply chain due to fraudulent activities, behavioral doubts, loss of data, technical errors, operational doubts, and informational challenges. Therefore, blockchain can manage and monitor many parts of supply chain.

Decreasing Costs

Blockchain supports in transactions across various geographical locations. Therefore, it becomes possible for businesses to bypass intermediaries. This not only saves time but also funds are protected by eliminating extra costs that come from rapid processing.

Modifiable Product Recall

Blockchain is extremely transparent and traceable, thereby making it possible for supply chain to modify product recalls by supporting the identification and location of the possibly impacted products in the process. Hence, modification becomes time and cost effective.

Eliminating Counterfeiting

Blockchain is a highly traceable process. Therefore, it is easier to verify the provenance of the products by studying the quality and reliability of the goods properly. Therefore, it supports in elimination of counterfeit products by ensuring a quick check for the provenance of doubtful goods. The percentage of pirated goods is very common globally. Hence, it is essential to eliminate it by inculcating supply chain. Moreover, all transactions are aided by authentication, making it impossible to develop fraud documents with a capacity to check documents and certificates.

Preserving Ethical Standards

Consumer of the world today is well aware of the ethical standards they demand from the business they acquire their products from. More than 50% people say they only look for brands channeling their own values for ecosystem and sustainability. Hence, they study company's background in terms of its ESG (environment, social, governance) before making purchase decision with them. Therefore, consumer's demands confirmation that the business they give their money to be not involved in unethical delivery process or production mechanism. Blockchain traceability makes it possible to view product manufacture and shipment details.

6.3 Future Research Direction

The current research only focuses on the Greek supply chain sector and the perceived benefits and challenges that the sector gets with the help of adopting block chain technology. The future research can be made with the help of comparing two sectors i.e., supply chain and retail sector. The comparison of two industries helps in identifying more benefits of blockchain in different industries.

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Appendix A: Questionnaire

1. Industry

2. The company offers its services in the supply chain sector **(IV1)**:

☐ Under 3 years

☐ 3-6 years

☐ 6-9 years

☐ Over 9 years

3. The company belongs to the following supply chain domain **(IV2)**:

☐ Retailer

☐ Manufacturer

☐ Logistics Service Provider

☐ Freight Forwarder

☐ Transportation and distribution

☐ Customer Service

☐ Custom Broker

☐ Third-Party Logistics Provider (3PL)

☐ Other

4. Please specify the number of employees in your company **(IV3)**?

☐ Less than 10

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☐ 10-20

☐ 20-100

☐ 101-200

☐ More than 200

5. Is your company investing in IT solutions for its supply chain activities (**IV4**)?

☐ Very low

☐ Low

☐ Somewhat high

☐ High

☐ Very high

6. IT solutions play a crucial role in the company's supply chain operations (**IV5**).

☐ Very low

☐ Low

☐ Somewhat high

☐ High

☐ Very high

7. How would you define your company's current state of blockchain adoption in the supply chain sector (**IV6**)?

☐ Very low

☐ Low

- ☐ Somewhat high
- ☐ High
- ☐ Very high

Technological Challenges (TC)

8. Do you believe the IT infrastructure of your company is sufficient and updated to support the implementation of blockchain-enabled solutions? **(TC1)**

- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high

9. Does your organization have up-to-date IT hardware and connections for the implementation of blockchain solutions? **(TC2)**

- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high

10. Do you expect blockchain system interoperability within the stakeholders throughout the company's supply chain? **(TC3)**
- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high
11. Do you believe the quality of data incorporated within the blockchain is safeguarded? **(TC4)**
- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high
12. Do you believe the blockchain ensures real time data visibility to build trust among supply chain participants? **(TC5)**
- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high

13. Do you believe that the blockchain-enabled solutions are error-free? (TC6)
- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high
14. Does the low transaction scalability play crucial role in the implementation of blockchain? (TC7)
- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high
15. Do you think that the integration of blockchain with other technologies i.e. SAP is too complicated? (TC8)
- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high

16. Do you believe that the blockchain ledger is really immutable? **(TC9)**

- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high

Organizational Challenges (OC)

17. Is there a clear plan for adoption of blockchain within your company? **(OC1)**

- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high

18. Do you believe the development and implementation of blockchain is a complicated process? **(OC2)**

- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high

19. Is there support/commitment for the adoption of blockchain solutions by CEO and top management? **(OC3)**

- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high

20. Do you believe that the blockchain technology improves information sharing within the company's supply chain? **(OC4)**

- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high

21. Do you believe that the organization size plays a crucial role in the implementation of blockchain? **(OC5)**

- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high

22. Do you believe that there is lack of knowledge/expertise for the implementation of blockchain solutions? **(OC6)**
- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high
23. Are there strong and dedicated professional IT team and proper system of training of employees? **(OC7)**
- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high

Financial Challenges (FC)

24. Do you think that the cost of implementing blockchain solutions is too high? **(FC1)**
- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high

25. Is there sufficient budget for the implementation of blockchain? **(FC2)**
- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high
26. Do you believe that the blockchain-related maintenance cost is too high? **(FC3)**
- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high
27. Do you believe that blockchain serves as a cost cutting mechanism (cost reduction) throughout the supply chain? **(FC4)**
- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high

Administrative Challenges (AC)

28. Do you believe that the stakeholders in your supply chain will embrace blockchain-related solutions? **(AC1)**
- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high
29. What is the level of awareness among supply chain stakeholders with respect to the benefits of blockchain? **(AC3)**
- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high
30. What do you think are the difficulties in dealing with business partners who do not use blockchain? **(AC4)**
- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high

31. Do you expect significant "resistance to change" attitude during a possible implementation of blockchain-related solutions in your organization? (AC5)

- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high

32. Do you believe that it would be a strategic necessity for your firm to adopt the blockchain technology to compete in the marketplace? (AC6)

- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high

Regulatory Challenges (RC)

33. Do you believe that the lack of legal framework, including the relevant privacy laws, consumer protection laws, licensing, security regulations, etc. is a crucial factor for the adoption of blockchain? (RC1)

- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high

Social Challenges (SC)

34. Do you believe that the customers will see added value for your company's implementation of blockchain? **(SC1)**
- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high
35. Do you believe that the customers will be more confident knowing that your company supports transparency and visibility supported by the blockchain technology? **(SC2)**
- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high

Perceived Benefits (PB)

36. Increased Trust **(B1)**
- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high

37. Reduced fraud & fraudulent transactions **(B2)**

- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high

38. Improvement in regulatory compliance **(B3)**

- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high

39. Increased auditability **(B4)**

- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high

40. Immutable data record **(B5)**

- ☐ Very low
- ☐ Low

☐ Somewhat high

☐ High

☐ Very high

41. Lower financial cost (**B6**)

☐ Very low

☐ Low

☐ Somewhat high

☐ High

☐ Very high

42. Increase in efficiency (**B7**)

☐ Very low

☐ Low

☐ Somewhat high

☐ High

☐ Very high

43. Streamlining the business process (**B8**)

☐ Very low

☐ Low

☐ Somewhat high

☐ High

☐ Very high

44. Data protection and accuracy (**B9**)

☐ Very low

☐ Low

☐ Somewhat high

☐ High

☐ Very high

45. Increased security (**B10**)

☐ Very low

☐ Low

☐ Somewhat high

☐ High

☐ Very high

46. Faster lead times (**B11**)

☐ Very low

☐ Low

☐ Somewhat high

☐ High

☐ Very high

47. System resilience and automation (**B12**)

- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high

48. Real-time accessibility (**B13**)

- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high

49. Improved traceability services (**B14**)

- ☐ Very low
- ☐ Low
- ☐ Somewhat high
- ☐ High
- ☐ Very high