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The Prospects of Blockchain Technology on the Counterfeit Drugs in Jordan

الأثر المتوقع لتكنولوجيا سلسلة الكتل على السيطرة على تزوير الأدوية في الأردن

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Thesis Submitted as Partial Fulfillment of the Requirements for master's degree in E-Business.

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Authorization

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This thesis of the student Sara Mahmoud Issa which study "The Prospects of Blockchain Technology on the Counterfeit Drugs in Jordan: Qualitative Study" has defined, accepted and approved on 21 / 01 / 2020.

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I would like to thank ALLAH. For the help and blessings, he gives to me through this journey.

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Many thanks to all organizations and associations for their help in completing this work.

Sara Mahmoud Issa

Dedication

I dedicate this dissertation to my beloved family for the support through all these years, to my Dad, the reason for what I have been now, and for sure my Mom blessings all day and night.

I would like to thank my friends who are being there always for me, to coffee, and my four years old daughter Zeina without whom this would have been an easier job.

Sara Mahmoud Issa

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The Prospects of Blockchain Technology on the Counterfeit Drugs in Jordan: Qualitative Study

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Abstract

Purpose: Blockchain Technology has emerged as a key tool for controlling Counterfeit drugs, which attempt visualizing and control level of Counterfeit drugs index in Jordan (legislation and Cooperation between stakeholders). Therefore, this study aims to develop a model with a distinctive feature of Blockchain Technology, and test the model to investigate the impact of Blockchain distinctive features on Counterfeit drug index in Jordan.

Design/Methodology/Approach: To actualize this study, the data was collected in the first stage (qualitative) from subject matter experts in counterfeit drugs and information technology in structured interviews, and the output was then used as an input into the development of a model that relates Blockchain distinctive features to counterfeit drugs, subject to statistical tests (quantitative). In the second stage (quantitative), for testing the model, a questionnaire was used to collect data collection entailing the participation of 120 managers and supervisors of the Ministry of Health and Jordan Food and Drug Administration. After confirming the normality, validity and reliability of the tool, descriptive analysis was carried out, and correlation between variables checked. Finally, the impact was tested by multiple regressions.

Recommendations: The current study was conducted of a limited time of university semester, and the domain of the research was restricted specifically to the Jordanian pharmaceutical sector. Therefore, it is only reasonable to recommend that future researches to collect more data over a longer time to check the current model validity and measuring instrument, and to consider carrying out similar studies on other industries in Jordan and/or same industry outside Jordan to test its results generalizability.

Originality/Value: This study may be considered as one of the pioneer studies to tackle the issue of controlling the level of counterfeit drugs in Jordan and investigate the impact of Blockchain distinctive features on the drugs counterfeiting.

Keywords: Blockchain Technology, Decentralization, Transparency, Traceability, Counterfeit Drugs, Legislation, Cooperation between stakeholders.

الأثر المتوقع لتكنولوجيا سلسلة الكتل على السيطرة على تزوير الأدوية في الأردن: دراسة نوعية

إعداد:

سارة محمود عيسى

إشراف:

الدكتور فايز البدري

الملخص

الهدف: تعد تكنولوجيا سلسلة الكتل أداة رئيسية للسيطرة على الأدوية المزورة، والتي تسعى لضبط مستوى الأدوية المزورة ومراقبته في الأردن. .لذلك، تهدف هذه الدراسة إلى تطوير انموذج بخصائص تكنولوجيا سلسلة الكتل، واختبار هذا الانموذج لمعرفة تأثير الخصائص المميزة لسلسلة الكتل على مستوى الأدوية المزورة في الأردن.

التصميم / الإجراءات: لإنجاز هذه الدراسة، تم جمع البيانات في المرحلة الأولى (النوعية) من خبراء في موضوعي الأدوية المزيفة وتكنولوجيا المعلومات في مقابلات منظمة ومن خلال تنظيم ورش عمل متخصصة، وتم تحليل نتائج هذه المقابلات والورش واستخدام الناتج كمدخلات في تطوير أنموذج يربط السمات المميزة لسلسة الكتل بالأدوية المزيفة، ويخضع للاختبارات الإحصائية (الكمية). في المرحلة الثانية (الكمية)، لاختبار الأنموذج إحصائيا، تم استخدام استبانة لجمع البيانات التي تنطوي على مشاركة 120 من المديرين والمشرفين من وزارة الصحة وإدارة الغذاء والدواء الأردنية. وبعد التأكد من التوزيع الطبيعي وصدق مثبتات الأداة، تم إجراء التحليل الوصفي، والتحقق من العلاقة (الارتباط) بين المتغيرات. وأخيرًا، تم اختبار الأثر بواسطة الانحدار المتعدد.

التوصيات: أجريت الدراسة الحالية في فترة زمنية محدودة للفصل الجامعي، وكان مجال البحث مقصورًا بشكل خاص على قطاع الأدوية الأردني .لذلك، يكون من التوصية بأن تقوم الأبحاث المستقبلية بجمع المزيد من البيانات على مدى فترة زمنية أطول للتحقق من صلاحية النموذج الحالي وأداة القياس، والنظر في إجراء دراسات مماثلة على صناعات أخرى في الأردن و / أو نفس الصناعة خارج الأردن لاختبار تعميم نتائجها.

الأصالة/القيمة: يمكن اعتبار هذه الدراسة واحده من الدراسات الرائدة االمعنية بفهم ومعالجة قضية السيطرة على مستوى تزوير الأدوية في الأردن واستطلاع أثر خصائص تكنولوجيا سلسلة الكتل على مشكلة التزوير.

الكلمات المفتاحية: تكنولوجيا سلسلة الكتل، الشفافية، التتبع، اللامركزية، الأدوية المزورة، التشريعات.

Chapter One: Introduction

1.1 Background

The pharmaceutical industry in Jordan has steadily developed during the past decades, and the number of pharmaceutical firms has grown to 20 in 2014. However, the merger of some of these companies and the restructuring of others have led to the reduction of the number of companies to 17 in 2015 (Jordanian Association of Pharmaceutical Manufacturers, 2014). Jordanian manufactured medicines and pharmaceutical products are distributed worldwide in more than 60 countries, attributable to the blend of high quality, excellent notoriety and sensible costs, which are seen as basic achievement indicators to the internationalization procedures of different Jordanian pharmaceutical organizations. This remarkable exhibition by Jordanian pharmaceutical industry is supported by exportation figures, with 81% of the Jordanian produced medicines is sent out to remote markets, and 90% of it is going to Middle Eastern markets. What's more, a portion of the Jordanian pharmaceutical organizations has joint endeavors and auxiliary branches in eight Middle Eastern nations. (JAPM, 2014).

Counterfeit drugs persist as one of the most important problems to deal with, in both global and local markets. In 2007, the Organization for Economic Cooperation and Development (OECD) announced that the counterfeiting in international trade has amounted to about 250$ billion. (OECD, 2008). It is also thought that this rapid increase of counterfeiting is due to the rapid development of e-commerce, warranting the urgent need to develop anti-counterfeits systems. (Toyoda, et.al. 2017).

For more than two decades, the International Pharmaceutical Federation (FIP) has been fighting against fake medications. (FIP, 2018). Since 2013, the World Health Organization (WHO) has gotten 1500 reports of instances of fake products (WHO, 2017). In fact, WHO (2017) suggests that an expected 1 of every 10 medicinal items circling in low-

and center salary nations is duplicated. Furthermore, JFDA, (2013) indicated that the value of fake medications in Jordan market in 2013 was in excess of 3 million Jordanian dinars.

The scale and extent of the counterfeit drugs issue dictates the need of the pharmaceutical industry sector for a new technology-based supply chain system, and thus the new Blockchain technology with its distinctive features seems to be a good choice to consider as a base for the solution.

Blockchain is a disseminated record of exchanges among the members associated with the system with a decentralized server. It reserves each exchange that happens in the system with a timestamp. Each platform on the system keeps up a neighborhood duplicate of the record, and any little change in the nearby record is imitated to the public structure, and each platform refreshes their neighborhood record. (Haq and Esuka, 2018). A Blockchain is also described as a chain of squares verified by cryptographic strategies. Information added to the Blockchain can't be altered or replaced; and in this way, an irrefutable and right record of information can be made. (Bell, et.al. 2018).

Then again, in the pharmaceutical industry, Blockchain can help by controlling the levels of fake medicines. Like a framework following, it is plausible to decide smart contracts for drugs and to perceive tranquilize holders, with implanted Global Positioning System (GPS) and chain of security logging. (Buchanan, 2018).

A prime motivation to utilize Blockchain innovatively in such a framework like the pharmaceutical production network is its “security” features. Blockchain is an excellent alternative to support digital security, mainly through its prevention mechanism of any unauthorized changing of information and exchanges, which can contribute to building the trust and help to wipe out the issues found in conventional store network frameworks. (Haq and Esuka, 2018).

1.2 Study Purpose

The objective of this study is to explore and gauge the effect of Blockchain Technology on the pharmaceutical industry in Jordan, and its ability to reduce the levels of counterfeit drugs within an integrated system, benefiting from and utilizing the distinctive features of the new Blockchain technology to improve the management and control in the pharmaceutical industries, and to increase its efficiency, leading to the reduction of drug counterfeiting levels.

This study also advocates moving from multiple drugs information sources that are difficult to track and control, to a single source that allows stakeholders to identify the exact location of the drug.

1.3 Study Significance

The importance of the study is stemmed from the fact that it is a pioneer study of a new disruptive technology (Blockchain) that many observers view as a new major technology wave, with far-reaching potential impact on individuals and businesses alike. The study will enlighten the pharmaceutical sector of the potential Blockchain applications that are promising of major gains, specifically in relation to controlling levels of counterfeit drugs.

The results may also be appropriate to other industries that have similarities with this; also, it can be a base for other studies in the future.

1.4 Problem Statement

The topic of "Counterfeit drugs" persists as one of the most important, due to its high risk and dangerous nature that the world may face, because of its severity and serious effects on human life, health, and well-being, including fatalities.

Due to the criticality of the issue, an international task force against counterfeit medical products was established in 2006, with main objective to engage a range of stakeholders in collaborative efforts to protect people from purchasing and using counterfeit drugs, in order to prevent the manufacture and distribution of drugs (WHO, 2006).

In fact, JFDA has raided an integrated factory for the manufacture of counterfeit drugs in Amman and control 74 thousand tablets of fake drugs, and more than one pharmacist was caught selling fake drugs and expired medicine in 2016 (JFDA, 2016).

Given the importance and criticality of the issue of counterfeit drugs in Jordan, and the evident inadequacy of existing technologies to resolve or control this problem, the current study is dedicated to answering the following main questions, "Will Blockchain technology distinctive features have an impact on the control of counterfeit drugs levels in Jordan".

1.5 Operational Definitions

- **Blockchain:** Growing list of linked blocks by cryptography, each block contains a cryptographic hash of the previous one, a timestamp and transaction data.
- **Decentralization:** Transfer of decision-making power and assignment of accountability and responsibility for results.

- **Transparency:** The lack of hidden documents accompanied by the availability of full information required for collaboration (Restricted access to affordable, quality, safe and effective medicinal products).
- **Traceability:** Ability to trace the location of drug or activity by means of records data.
- **Counterfeit Drugs:** Drugs that are fraudulently mislabeled with respect to their identity and/or source. Counterfeit medicines may include products with correct ingredients, with wrong ingredients, without active ingredients, with incorrect amounts of active ingredients or with fake packaging.
- **Legislation:** Appropriate regulations to help in preventing of counterfeit products.
- **Cooperation between stakeholders:** Intersectoral cooperation between national drug regulatory authorities and official parts concern about counterfeiting products (ministry of health, Jordan food and drug association, Jordanian pharmacy association).

1.6 Study Limitations and Delimitations

- **Human Limitation**

  This study involved the creation of a focus group, composed of selected Blockchain technology experts and pharmaceutical subject matter experts (SMEs).

- **Place Limitation**

  The study was carried out in Jordan.

- **Time Limitation**

  This study was carried out during second semester of 2019.

- **Study Delimitation**

  As with any research, it is not possible to generalize the results of this study to other sectors, since this study was limited to the pharmaceutical sector in Jordan.

Chapter Two: Conceptual and Theoretical Framework and Previous Studies

2.1 Introduction

This chapter includes variables definitions, the relationship between variables, previous studies and what differentiate this study from previous studies.

2.2 Theoretical and Conceptual Framework

The importance of the study is come from the fact that it is a pioneering study of a new disruptive technology (Blockchain) that many observers view as a new major technology with far-reaching impact on individuals and businesses alike. The study aims to enlighten the pharmaceutical sector of the potential Blockchain applications that are promising of major gains, specifically about controlling levels of counterfeit drugs.

The results may also be appropriate to other industries that have similarities with this; also, it can be a base for other studies in the future. The topic of “Counterfeit drugs” persists as one of the most important, due to its high risk and dangerous nature that the world may face, because of its severity and serious effects on human life, health, and well-being, including fatalities.

Due to the importance or the issue, World Health Organization has established an international task force against counterfeit medical products in 2006, with main objective to engage a range of stakeholders in collaborative efforts to protect people from purchasing and using counterfeit drugs, in order to prevent the manufacture and distribution of drugs (WHO, 2006).

Although the official announced figures of counterfeit drugs in Jordan is 3.7 million dinars, observers believe that the problem is much bigger than that and this is evident by the recent confiscation of huge amounts of fake pills. In fact, JFDA has raided a plant for the manufacture of counterfeit drugs in Amman, and confiscated a seventy-four thousand tablets

of fake drugs, and more than one pharmacist was caught selling fake drugs and expired medicine in 2016 (JFDA, 2016).

Given the importance and criticality of the issue of counterfeit drugs in Jordan, and the evident inadequacy of existing technologies to resolve or control this problem, the current study is dedicated to answering the following main question, “Will Blockchain technology distinctive features have an impact on the control of counterfeit drugs levels in Jordan?”.

A Blockchain is basically a dispersed database of records, or an open record of all automated instances that have been executed and shared among taking an interest party. Every transaction is verified in the system by the consent of a dominant part of the members. Once entered, data can never be altered or deleted. (Crosby, et.al. 2016).

According to the International Anti-Counterfeiting Coalition (IACC), counterfeiting has become one of the largest and fast-growing criminal enterprises in the world, with an estimated annual value of over US$ 600 billion. Accordingly, the pharmaceutical industry needs an effective supply chain management system and the best solution available to create a complete Supply Chain Management System (SCMS). (Shrikant, et.al. 2019).

The term "Blockchain" combing the words “Block” and “Chain” refers to how it stores transaction data in "Blocks" that are connected to form a "Chain." As the number of transactions rises, the net increases in size and complexity. Blockchain has been designed to make transactions unchangeable, (they can't be removed). Therefore, Blockchain are designed to be stable and free from interference. Information can distribute, but not copied. Almost anything can be put on a Blockchain when it comes to digital assets and transactions, and several Blockchains call for different scenarios. (Sadiku, et.al 2018).

As a chain of squares verified by cryptographic methods, one of the distinctive features of one the Blockchain is information permanence; once information is added to the

Blockchain would be virtually impossible to have it changed; and the right record of information can be made. (Bell, Et.al. 2018).

Additionally, Blockchain can help in the counteractive action of debasement, as it implies that once a square has been acknowledged in the framework it morally sounds to change and by that, it makes it difficult for individuals to change the narrative of what occurred. A Blockchain master remarks on the potential progress that Blockchain can have on fake items and defilement. (Chaudhuri, 2018).

Supply Chain security is one point of view that has been lately considered when the Drug Supply Chain Security Act (DSCSA) has been executed in the U.S. The Demonstration has been executed in addition to other things, to battle the fake medication issue. Fake medicines are drugs that don't contain the active ingredient they should have and thusly can hurt patients.

According to the World Health Organization, fake medicines amounted to around $75 billion at 2010, representing 90% increase in five years. The manufacturing and trading of fake medicine is inspired by the conceivably enormous benefits (WHO, 2010). The general loss of life owing to fake medicines is obscure, yet the expenses to general wellbeing are colossal since separated from death fakes can make opposition meds (WHO, 2010).

The pharmaceutical production network is one of the verticals most conspicuously thought about when creating innovation-driven arrangements. Be that as it may, the worldwide market for unsatisfactory, fake, and dark market medications represents up to $200 billion every year. Studies have revealed a large group of pharmaceutical items, restorative gadgets, and biologics that have been liable to falsifying in Low Countries, and high-pay nations showing that the whole medication store network is vulnerable to this transnational type of pharmaceutical wrongdoing. (Clauson, et.al. 2018).

According to WHO, 1999. A variety of factors contribute to counterfeit drug production. These should be accurately identified to enable governments to detect problems with counterfeiting and to enforce effective programs in national drug distribution channels to eliminate counterfeit drugs. Nevertheless, Countries need appropriate legislation to help with counterfeiting elimination. If there is little or no regulation to properly control drug production and distribution, counterfeiting will escape punishment. Although, if intersectoral cooperation between national DRAs, government, regulations, and the judiciary is ineffective in fighting drug counterfeiting, counterfeiters will avoid the law, arrest, and punishment. It is necessary to define clearly the roles and responsibilities of each sector. Retailers reporting drug counterfeiting to the national DRA could stop national authorities from taking effective counterfeiting actions.

Considering the scale of problems such as the counterfeit medicines as indicated above, a disruptive technology such as Blockchain has the potential not only to transform conventional business with its key features of decentralization, transparency, confidentiality and audit ability but also to be the basis of innovative business solutions. Blockchain no longer requires third parties, as it has the potential to be used in the distributed network to maintain data consistency. (Shaik, et.al. 2019)

The Pharmaceutical Safety Institute (PSI) is an organization created around the world to track fake and illegal medicines production. It reports that 1,378 people were arrested last year, which means that arrests during the period 2016–2017 the number of arrests has been raised by 10 percent. The study also showed the number of arrests per stage of the supply chain (production, distribution, transportation, and sales). (PSI, 2017)

PSI (2017) has also indicated that globally, from 2016 to 2017, drug-related incidents have increase by 11 percent, and has attributed these incidents to prescription

counterfeit drugs, which may cause the end-user to obtain an illegal or mislabeled drug that is believed to be genuine.

As such, Blockchain could be an open-gate stage to build trust and straightforwardness, with clients having the option to track pharmaceutical items all through the inventory network. The bundling of a medication could be examined by a standardized identification, whenever the medication changes possession. The record is conveyed on the Blockchain progressively. The end client can check the standardized identification and see history. Ideally, the stage guarantees sedate recognizable proof, following, confirmation and warning if an ill-conceived medication is found. (Schoner, et.al. 2017).

According to Huang (2018), a drug traceability system should generally be able to track or trace the drug transaction flow through various stakeholders along the drug supply chain. It should provide investors and patients with reliable information on the flow, that of drug production origin for anti-counterfeit purposes. This will enable consumers of pharmaceutical medicines now to track the supply chain information of purchasing or buying the pharmaceutical products, and it can be easy to know that they are legitimate because of the originality and reliability of the product information, due to the fact that Blockchain does not allow data to be removed by a party, leaving no room for mistakes. (Muniandy and Ern, 2019).

Additionally, the ‘Transparency’ feature of the Blockchain helps one to understand the effects and implications of a product decision, and fosters knowledge of environmental circumstances. Nevertheless, it can be a very difficult task to handle knowledge and monitor clear exchanges about the supply chain of each product; therefore, to allow a flow of trustworthy information between parties, it requires accurate data collection and secure data storage. Currently, by centralized information depositories, this obligation is assumed by non-profit, governmental entities or other third parties. (Abayrante and Monfared, 2016).

It could at least be used to link the responsibility for drug safety to the appropriate government regulatory stakeholders. Furthermore, it is necessary to protect as much as possible the privacy of traceability data in the system, especially that of statistical information on drugs that have gone past the stakeholder (Huang 2018).

2.3 Previous Studies

Jackson, Et.al (2012) study titled "***Assessing the problem of counterfeit medications in the United Kingdom,****"* suggested that fake medicines represent a consistently expanding risk to the general wellbeing and confirmed that the exact and effective tracing of unlawful fake professionally prescribed medication movement is troublesome. Accessible information shows that the emphasis has been on a wide range of medications. Due to the use of fake drugs, adverse effects on well-being, including death, have occurred; buyers who self-sedate without proper communications with the medicinal services framework infrequently get enough human services. The Internet gives an enormous, helpful course for forgers to arrive at potential purchasers with unregulated, regularly hazardous, items. Most of the medications acquired by means of unsubstantiated Internet destinations are fake. Regularly, these items do not have the implied medication compound or have variable centralizations of dynamic fixings and here and there contain hazardous poisons. Albeit numerous buyers recognize some level of hazard with acquiring drugs by means of the Internet, speed, accommodation, and cost frequently brief these buys. Additionally, fake drugs have been identified in the genuine supplychain; however, they relate to a significantly less than those obtained through the Internet. Critical Europe regulations, including more grounded punishments for duplicating, is being developed. In the United Kingdom, the Medicines and Human services Products Regulatory Agency (MHRA) propelled an activity against fake

medicine. Social insurance experts should report associated cases with fake prescription to the MHRA, be aware of dangers to the drug supply, also, give commonsense counsel to patients about requesting drugs internet, including keeping away from unregulated Internet drug stores, and being suspicious of destinations advertising considerable limits and remedy just drug without a solution.

Rabah (2017) study titled *"**Challenges & Opportunities for Blockchain-Powered Healthcare Systems**"* proposed that Blockchain acts as an intermediate between providers, payers, and patients in the healthcare industry as well as increasing the security, privacy, and interoperability of healthcare data by placing the patient at the center of the healthcare ecosystems. Blockchain provides a new model of health information exchanges (HIE). Blockchain solves issues related to the EHR distribution of data and nationwide interoperability. Nonetheless, Blockchain technology's core offerings that make it a no-brainer for supply chains across industries is its immutable, time-stamped, tamper-proof ledger, accessible by its all or pre-approved participants.

Shconer, et.al. (2017) study titled *"**Blockchain Technology in the Pharmaceutical Industry***" suggested that Blockchain is the solution to enhance pharmaceutical supply chain security, because supply chain security is one of the important subjects that acquired the attention of researchers recently, prompting the United States to implement the Drug Supply Chain Security Act to fight the counterfeit drug problem.

Karafiloski's (2017) study titled *"**Blockchain Solutions for Big Data Challenges**"* aimed to show that Blockchain technology is rapidly gaining huge popularity and extent of application and innovative business solutions in different areas although it is new. Blockchain advocates decentralization, data ownership, identity, trust, and data-driven decisions. Also, Blockchain technology gives many important inputs to store and organize big data, and provide solutions are built around decentralized management of private data,

public institutions' reforms and IoT communication, digital property resolution which influence how Big Data can evolve. This study gives the novel solutions by the empowered Blockchain technology that is related to big data areas.

Zhang, et.al. (2017) study titled *"**Applying Software Patterns to Address Interoperability in Blockchain-based Healthcare Apps**"* aimed to explain Blockchain features such as decentralization, immutability, and transparency which contribute to make Blockchain more suited for business application through a trustless exchange, operational models beyond cryptocurrency, and records of the incorruptible transaction. Besides, it addresses interoperability issues in the healthcare sector as interactions between medical applications and user's ineffective way, promoting the workflow of the medical practice, and delivering the data of patient securely. This study gives steps to fill the gap about the little information for applying Blockchain to healthcare applications:

1- The challenges of implementation in interoperability of healthcare.

2- Comprehensive case study of developing a healthcare application by Blockchain.

3- The way of applying foundational software patterns of the Blockchain based healthcare apps to address interoperability challenges.

Toyoda. et.al (2017) study titled *"**A Novel Blockchain-Based Product Ownership Management System (POMS) for Anti-Counterfeits in the Post Supply Chain**,"* stated that for over 10 years, Radio Recurrence Identification (RFID) innovation has been very compelling in giving enemies of fakes measures in the production network. Be that as it may, the validity of RFID labels can't be ensured in the post inventory network, since these labels can be somewhat effectively cloned in the general population space. In this paper, they propose a novel item proprietorship the board framework (POMS) of RFID-appended items for enemies of fakes that can be utilized in the postproduction network. For this reason, they influence Bitcoin's Blockchain's probability that anyone can verify the balance

equity verification. With the proposed POMS, a client can dismiss the acquisition of fakes even with authentic RFID label data, if the merchant doesn't have their own. An idea has been executed of exploratory framework utilizing a Blockchain based decentralized application stage, Ethereum, and assessed its cost exhibition.

Radanovic and Likic (2018) study titled *"**Opportunities for Use of Blockchain Technology in Medicine**"*, highlighted the importance of Blockchain in many sectors of our life, specifically in the healthcare field, and that some pharmaceutical companies have started implementing Blockchain applications in the management of supply chain in counterfeit drugs. The study also estimated that faked drugs cost about 44% of sales every year in the European Union.

Plotnikov and Kuznestsova (2018) study titled *"**The Prospects for the Use of Digital Technology (Blockchain) in the Pharmaceutical Market**,"* articulated that the advancement of data innovation in the cutting-edge economy is one of the drivers of financial development. Computerized innovations are being created at a quickening pace. Digitalization invigorates not just financial, but also in addition social and mechanical advancement. The effect of advanced innovation in various enterprises isn't the equivalent. The writers of the article consider such encouraging present-day innovation as Blockchain. Its bit of leeway is that the data is shielded from unapproved adjustment. This changes the arrangement of monetary relations. The degree of trust increments. The deft conduct of members in legally binding relations is blocked. Thus, financial productivity improves. These beneficial outcomes are investigated on account of the pharmaceutical business. The presentation of Blockchain advancements into pharmaceuticals enables you to follow all stages of the generation of medications and the assurance of their quality. Blockchain innovation enables you to affirm the credibility of plans and the medications with the assistance of extraordinarily advanced gadgets. The outcome of this is a decrease in the

number of fakes tranquilizes available, just as improving the quality of medicinal consideration for the public.

Haq and Esuka (2018) study titled *"**Blockchain Technology in the Pharmaceutical Industry to Prevent Counterfeit Drugs**"* aimed to explain that counterfeit drugs are increasing in developing countries and the world through production and distribution. Pharmaceutical counterfeiting takes billions of dollars annually from the market value because of the imperfect supply chain system in the pharmaceutical industry whereas ownership of drugs is change from manufacturers to wholesalers, distributors, and pharmacists than to the customer. This study explains how Blockchain technology adds traceability, visibility, and security to the drug supply system where drugs can be tracked through the supply chain in the pharmaceutical industry, and the effect of drugs on patients will record in their database for future statistics.

Bell, et.al. (2018) study titled *"**Applications of Blockchain within Healthcare**"* proposed that Blockchain technology can improve many areas of healthcare, including drug tracking and tracing, health insurance, and clinical trials. This technology can improve the safety of the patient and enhance the efficiency savings.

Jochumsen and Chaudhuri, (2018) study titled *"**Blockchain's impact on the supply chain of a pharmaceutical company**"* examined the Impact of Blockchain technology on the pharmaceutical supply chain, with the main objective being to identify the most potential areas where the case company will take the advantage of Blockchain. The main findings show that the areas of the pharmaceutical supply chain which be affected by Blockchain are tracking, smart contract and avoiding counterfeiting.

Sylim, et.al (2018) study titled *"**Blockchain Technology for Detecting Falsified and Substandard Drugs in Distribution: Pharmaceutical Supply Chain Intervention**,"* proclaimed that drug counterfeiting is a worldwide issue with huge dangers

to buyers and the overall population. In the Philippines, 30% of investigated medication stores in 2003 were found with unsatisfactory/deceptive/dishonestly marked/adulterated/fake drugs. The Philippine Nourishment and Medication Organization encourage the general population to check the testaments of item enlistment and report any cases of falsifying. The National Police of the Philippines reacts to such reports through a unique team. Be that as it may, no writing on its effect on the dissemination of such medications was found. Blockchain innovation is a cryptographic record that is supposedly permanent through rehashed consecutive hashing and issues tolerant through an agreement calculation. This undertaking will create and test a pharmacy surveillance Blockchain framework that will bolster data sharing along the official medication conveyance arrange.

Alzahrani and Bulusu (2018) study titled *"**Block-Supply Chain: A New Anti-Counterfeiting Supply Chain Using NFC and Blockchain**,"* announced that current hostility to forging supply chains depend on a brought together position to battle fake items. This design results in issues, for example, single point handling, stockpiling, and disappointment. Blockchain innovation has developed to give a promising answer to such issues. In this paper, it is proposed that the square supply chain, another decentralized inventory network that identifies falsifying assaults utilizing Blockchain. Square inventory network replaces the concentrated stock chain plan and uses another proposed agreement convention that is, in contrast to existing conventions, completely decentralized and balances between efficiency and security. The reproductions show that the proposed convention others noteworthy execution with an agreeable level of security contrasted with the cutting-edge accord convention tender mint.

Chavali, Et, al (2018) study titled *"**The Emergence of Blockchain Technology and its Impact in Biotechnology, Pharmacy, and Life Sciences**,"* said that the rise of Blockchain innovation is viewed as fourth mechanical upheaval i.e., the combination of

digital-physical frameworks since the approach of Internet with extensive applications in Banking, Insurance, and Government, may affect different areas particularly life sciences. The fourth upset is described by the combination of advancements that are obscuring the lines between the physical, computerized, and natural circles. Along these lines, it is imperative to comprehend the chances and dangers of embracing this innovation in life science/ pharmaceutical inquire about. The exclusive databases of the present organizations communicate with some type of interface either human or something else. Incorporating Blockchain with life science/ pharmaceutical applications will decentralize the interface just as the information trade, coming about in high productivity, more noteworthy paces, low minor cost, and vast versatility.

Clark and Burstall (2018) study titled *"**Blockchain, IP and the pharma industry—how distributed ledger technologies (DLT) can help secure the pharma supply chain**,"* said that Blockchain innovation can be characterized as an open record of data that is dispersed and confirmed over a distributed organization, instead of through one focal server. At the end of the day, it is a modernized open record that can apply to nearly anything you may as a rule spare to a spreadsheet or database. Every exchange or square is transmitted to the entirety of the members in the system also, must be confirmed by every member hub tackling a complex numerical issue. When a square is approved, it can't be adjusted without transforming it over the entire arranges. Disseminated records are innately harder to assault because rather than a solitary database, there are numerous mutual duplicates of the equivalent database. As no single individual, establishment or organization has or controls the data, the putting away of the data on the Blockchain is seen as (about) unhackable. Various kinds of information can be added to a Blockchain, from exchange data to photographs, recordings and configuration reports and the innovation is creating further with new sorts of circulated record innovations. While the customary idea of Blockchain is

an open and unknown system, there are additionally 'private' Blockchain's, for the most part, important to the monetary and protection businesses, which pre-screen who is permitted to regulate the record.

Montecchi, et.al (2018) study titled *"**It's real, trust me! Establishing supply chain provenance using Blockchain**"* discussed that in a worldwide commercial center, clients are regularly unconscious of the precise sources of the items they buy and expend. To address this absence of mindfulness, Blockchain innovation can be executed in supply chains to build clients' information on items' provenance. Provenance learning — data about professional pipes' origin, production, changes, and custody– empowers clients to be guaranteed of their obtaining choices. This confirmation originates from data on the birthplace, legitimacy, care, and respectability of the item that lessens chance observations. We build up a provenance information structure and show how its application can upgrade confirmations and lessen apparent dangers utilizing the use of Blockchain. We present a guide on the best way to actualize Blockchain to build up provenance learning what's more, close with a benevolent notice on the significance of exhibiting the estimation of Blockchain to clients.

Post, et.al (2018) study titled *"**Evaluating Feasibility of Blockchain Application for DSCSA Compliance**,"* said that they assessed the practicality of utilizing Blockchain innovation to make a discernibility answer for pharmaceutical medicates that would advance consistency with late enactment. Fake and other ill-conceived pharmaceutical medications undermine persistent wellbeing; tranquilize adequacy and patient trust. The motivation behind the Drug Store network Security Act (DSCSA) is to extraordinarily lessen the appropriation of ill-conceived medicates by requiring all pharmaceuticals to be serialized and discernible from the producer through the inventory network to the container. A product application to serialize and follow pharmaceuticals must beat various impediments.

Specifically, the arrangement must give a high level of trust while likewise ensuring protection for producers, merchants, and patients. This research will recommend that a Blockchain-empowered application will unravel for some of the most testing requirements for this arrangement.

Wu's (2019) study titled *"**An Empirical Study of Blockchain-based Decentralized Applications**,"* concluded that a decentralized application (dapp for short) alludes to an application that is executed by various clients over a decentralized system. In ongoing years, the quantity of dapp keeps quickly developing, for the most part, due to the prominence of Blockchain innovation. Regardless of the expanding significance of dapp as a normal application type that is accepted to advance the selection of Blockchain, little is known on what, how, what's more, how well dapp are utilized practically speaking. Furthermore, the wise information on whether and how a conventional application can be changed to a dapp is yet absent. To connect the information hole, this paper shows an extensive observational examination on the abroad dataset of 734 dapp that is gathered from three well known open dapp commercial centers, i.e., Ethereum, condition of the dapp, and dapp Radar. We break down the fame of dapp and outline the examples of how brilliant agreements are sorted out in a dapp. Considering the discoveries, we attract a few ramifications to help dapp designers furthermore; clients better comprehend and send dapp.

Norfeldt, et.al (2019) study titled *"**Crypto pharmaceuticals: Increasing the Safety of Medication by a Blockchain of Pharmaceutical Products**,"* said that the future human services framework will contain a consistently extending number of computerized components. The information put away both at a unified social insurance level and at a nearby, tolerant level (e.g., on a cell phone) will be center components when choosing treatment techniques in a social insurance situation with Web of things-based components. The present method for assembling pharmaceutical items and related existing calculated

arrangements isn't prepared for such an upset. One of the key difficulties is cybersecurity and related strong open key framework arrangement. This work presents one component of a potential arrangement at a model level: the idea of crypto pharmaceuticals where pharmaceutical items are associated in a patient explicit Blockchain of individual measurement units. This innovation depends on the idea where each created measurement unit has an exceptional data-rich design. A proof-of-idea cell phone application was applied to exhibit the perception of this Blockchain at various levels. This incorporates the assembling of the individualized measurement unit, the patient view for his/her Blockchain, and coordination of these items into a wellbeing Web of things framework. This unbreakable Blockchain of individual drug history will give intends to maintain a strategic distance from fake items and to empower inventive strategic arrangements.

Li, et.al (2019) study titled *"**DMMS: A Decentralized Blockchain Ledger for the Management of Medication Histories**"* discussed access to accurate and complete prescription records through medical facilities enhances effective consideration of patients. Until then, accounts around medical services organizations depend on centralized systems for sharing medical information. Nonetheless, there is no effective system for ensuring that medicinal anthology is correct from one organization to another, secure, and reliable. In this article, DMMS is presented to a board framework that uses the benefits of Blockchain to oversee medicine narratives. DMMS is acknowledged as a decentralized system under the hyper ledger texture system. Given the system, they structured engineering, inside which each prescriber can make solutions for every patient and perform questions about recorded remedies as needs are. At last, they broke down the preferences of DMMS over concentrated frameworks in the wording of exactness, security, dependability, and security.

Kumar and Tripathi (2019) study titled *"**Traceability of counterfeit medicine supply chain through Blockchain**,"* said that the primary issues with sedate security in the fake medication store network, are to do with how the medications are at first made. The detectability of right and dynamic pharmaceutical fixings during real assembling is a troublesome process, so identifying medications that don't contain the proposed dynamic fixings can at last lead to end-consumer patient hurt or even demise. Blockchain's progressed highlights make it fit for giving a premise to finish detectability of medications, from producer to end customer, furthermore, the capacity to recognize fake medication. This paper points to address the issue of medication wellbeing utilizing Blockchain and scrambled QR (quick reaction) code security.

Khezr, et.al (2019) study titled *"**Blockchain Technology in Healthcare: A Comprehensive Review and Directions for Future Research**"* articulated that one of the most significant disclosures and inventive advancements is playing a fundamental job in the expert present reality is Blockchain innovation, as it moves in the course of relentless transformation and change. It is a chain of hinders that spreads data, what's more, keeps up trust between people regardless of how far they are. Over the most recent few years, the upsurge in Blockchain innovation has obliged researchers and authorities to examine new ways to apply Blockchain innovation with a wide scope of spaces. The sensational increment in Blockchain innovation has given numerous new application openings, including human services applications. This study gives a thorough audit of developing Blockchain-based medicinal services and related applications. The open research matters in this quickly developing field are pointed out, clarifying them under certain subtleties. Likewise, Blockchain innovation capability is shown in changing the social insurance industry.

Kumar, et.al (2019) study titled *"**Combating Counterfeit Drugs: A quantitative analysis on cracking down the fake drug industry by using Blockchain technology**"* articulated that India, being a worldwide innovator in assembling and the biggest provider of financially savvy nonexclusive medications around the globe, particularly to the African nations under the Unified Countries help, is confronting a broad phony medication pestilence. One of the significant reasons behind this is the unregulated and complex medication production network. At the point when a medication committal changes proprietorship from maker to merchant and afterward to the distributer, no data is traded between the gatherings. What is needed is a satisfactory and straightforwardness of the first wellspring of medications. Outcomes incorporate fake sedate issues, wasteful review procedures of the medications and absence of trust. By putting the whole medication production network of India on Blockchain, it is proposed to play out a quantitative investigation on utilizing exceptional Blockchain properties like credibility, responsibility, and capacity to deal with delicate data to tackle India's fake medications issue for all time. It will reinforce the production network and will present the truly necessary straightforwardness of exchanges and quality affirmation by following a medication through its whole lifecycle from the extraction of crude materials to the patient taking the medication. Along with this, keen agreements can be conveyed which will give mechanization, trust, and security to the framework. Keen agreements are advanced conventions that can be customized to play out an assignment when a specific objective is come to with no intercession of a third party and can encourage administrations like programmed installments, quality control, and trust between partners.

2.4 What Differentiates the Current Study from Previous Studies

This current study is differentiated from previous studies in several aspects, including:

- The current study is a pioneer in exploring the trends pertaining to new disruptive technology (Blockchain)
- The current study is unique in exploring the selected subject in the context of Jordan.
- The findings of the research associated with the current study have major industry implications.
- The current study adopts a mixed research in two stages; stage 1, Qualitative and 2. Quantitative; the qualitative research includes the composition of a Blockchain technology workshop and focus group, which will help in the development of the model, and the quantitative research is concerned with statistically testing the model.

Chapter Three: Study Methodology (Methods and Procedures)

3.1 Introduction

This chapter includes the study design, population and sampling, data collection methods, data collection analysis, study tool and validity and reliability tests. In addition, to the respondent demographic description.

3.2 Study Design

The current study is considered as a mixed methodology that combines a qualitative research study for the first stage, and quantitative research for the second stage.

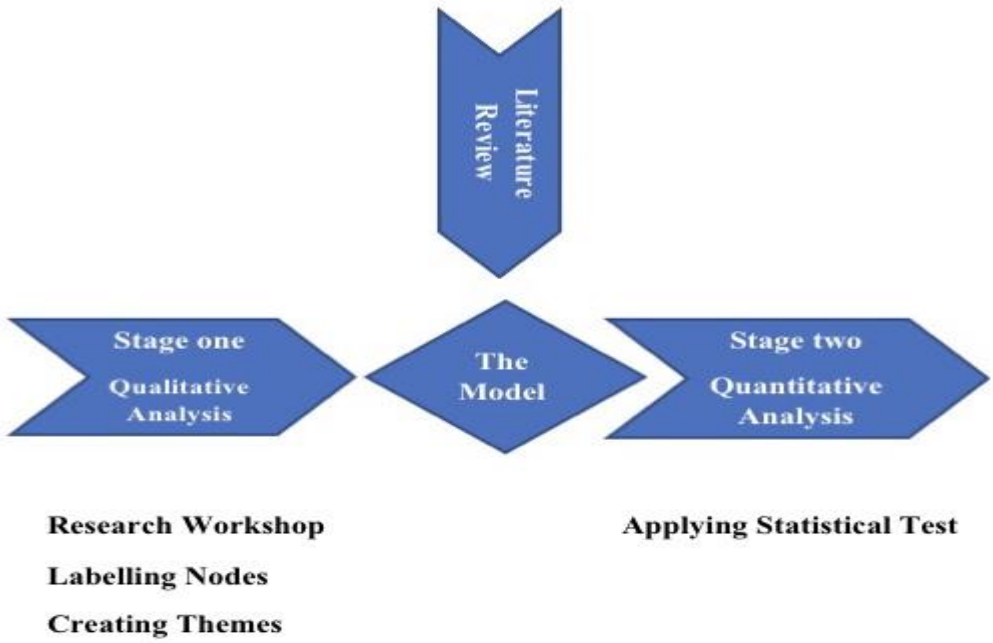

Figure (1) Study Design

It aims to develop a model for linking Blockchain technology's distinctive features and the levels of counterfeit drugs in Jordan by doing a workshop for specialists in pharmacy and information technology people. It starts with a literature review to identify the relevant attributes that are discussed in the focus group. The output of the focus group discussion would be entered into a software to classify and arrange the selected model attributes into a

model structure. Then a panel of judges used to improve the measurement tool i.e., questionnaire. Then, the questionnaire was developed, and the data collected from managers and specialists working in the Ministry of Health, Jordan Food and Drug Association, and Jordan Pharmacists Association. This was followed by coding the data and the testing in SPSS 23. Upon checking the normality, validity, and reliability of the data, descriptive analysis was carried out, and correlation among variables checked. Finally, the impact tested by multiple regressions.

3.2.1 Qualitative data collection

The population of the qualitative research study will include the selected Blockchain pharmaceutical and technology experts, making the focus study advisory group and the pharmaceutical subject matter experts of senior and middle management, who will be taking part in the workshop and structured interviews.

3.2.2 Qualitative data Analysis

Different focus groups will be prepared to be used for the workshop participants to investigate the related model attributes in both Blockchain technology and drug counterfeit measuring the dependent and independent variables.

The output of the focus group discussion entered software to classify the model attributes of the output.

3.2.3 Qualitative data results

Section (A): Demographic:

The demographic analysis presented in the sections below is based on the characteristics of the valid respondent (i.e. the frequency and the percentage) of the participants such as gender, education, experience, and position.

Gender: Table (1) shows that most respondents are males, and their count was 24 (68.6 %), and the number of females was only 11 (31.4 %). This is justified and expected since the female's proportion is low within the managerial positions and higher in operation and HR positions.

Table (1): Respondents Gender

		Frequency	Percent
Gender	**Male**	24	68.6
	Female	11	31.4
	Total	**35**	**100.0**

Education Level: Table (2) shows that the majority of the respondents holds postgraduate certificates, and this came from the nature of managerial positions, which requires having higher education levels, where the majority 23 (65.7 %) have a post graduate degree, after that 12 (34.3 %) have a bachelor degree.

Table (2): Respondents Education Level

		Frequency	Percent
Education Level	**Bachelor's degree**	12	34.3
	Postgraduate	23	65.7
	Total	**35**	**100.0**

Experience: Table (3) shows that the majority of the respondents have experience between (16-20 years) 13 (37.1%) which matches the study sample who hold managerial` levels, then respondents experience between (11-15 years) 12 (34.3%), followed by those with experience more than 20 years 6 (17.1%). Finally, respondents with limited experience (5-10) were very few 4 (11.4%).

Table (3): Respondents Professional Experience

		Frequency	Percent
Professional Experience	**>20 years**	6	17.1
	16-20 years	13	37.1
	11-15 years	12	34.3
	5-10 years	4	11.4
	Total	**35**	**100.0**

Position: Table (4) shows that the majority of respondents are general managers 7 (20.0 %) out of the total respondents of 35, followed by 6 (17.1%) for those who are working in research and development positions. The third includes categories are equally for senior managers and operation managers 3 (8.6%). The fourth includes Supervisors, Marketing & Sales Managers, Regulatory Affairs Manager, having similar frequencies of 2 (5.7%) out of the total respondents. Nine other positions have equally a frequency of 1 (2.9%).

Table (4): Respondents Position

		Frequency	Percent
Position	General Manager	7	20.0
	Supervisor	2	5.7
	Marketing and sales manager	2	5.7
	Sales operation and logistic manger	1	2.9
	Research and development	6	17.1
	Senior Manager	3	8.6
	Purchasing manager	1	2.9
	Operation Manager	3	8.6
	Regulatory affairs manager	2	5.7
	Quality assurance manager	1	2.9
	Technical Manager	1	2.9
	Logistic manager	1	2.9
	Sales Manager	1	2.9
	Clinical research associate	1	2.9
	Research executive	1	2.9
	Quality control manager	1	2.9
	Quality assurance	1	2.9
	Total	**35**	**100.0**

Section (B): Knowledge awareness of Information Technology, Blockchain and Counterfeit Drug.

Awareness: Table (5) shows that the majority of respondents have medium awareness of information technology 19 (54.3%) while 16 (45.7%) of the respondents have a high awareness. The table also shows that most of the respondents have a low awareness about Blockchain technology 21 (60.0%), while 6 (17.1%) have medium awareness. Finally, 8 (22.9 %) of the respondents have no knowledge of Blockchain technology. Finally, the table illustrates that 18 (51.4%) of the respondents have a high awareness of Counterfeit

Drugs, while 11 (31.4 %) are experts, and 6 (17.1%) of the respondents have a medium awareness of Counterfeit Drugs.

Table (5) Respondents awareness

Information Technology awareness			
		Frequency	**Percent**
Information Technology	**Expert**	0	0
	High	16	45.7
	Medium	19	54.3
	Low	0	0
	No	0	0
	Total	**35**	**100.0**
Blockchain Technology awareness			
		Frequency	**Percent**
Blockchain Technology	**Expert**	0	0
	High	0	0
	Medium	6	17.1
	Low	21	60.0
	No	8	22.9
	Total	**35**	**100.0**
Counterfeit Drugs awareness			
		Frequency	**Percent**
Counterfeit Drugs	**Expert**	11	31.4
	High	18	51.4
	Medium	6	17.1
	Low	0	0
	No	0	0
	Total	**35**	**100.0**

Section (C): Blockchain Impact on counterfeit dimensions

Table (6) illustrates the respondents' reaction on the statement "The most important potential impact of Blockchain on the issue of "Lack of regulation" pertaining to counterfeit medicine". Most of the respondents agree that Blockchain features maintain the records of drugs codification and the certificates and licenses of drugs and maintains authentic records of manufacturing and distribution processes 17 (20.7%). As well as, provides audit trail functions over drug (life cycle) 14 (17.1%), promotes accountability in association with transparency 8 (9.8 %), maintains authentic records of packaging and medication leaflets 7

(8.5%), and allows easy access to relevant product information and potential use Hazards and Threats 6 (7.3%). Finally, respondents stated that Blockchain features allow to adopt governance model characterized by transparency and openness of products quality and safety 5 (6.1%) and maintains authentic records of row material sources 4 (4.9%).

Table (6): Respondents reaction on the statement "The most important potential impact on the issue of "Lack of regulation" pertaining to counterfeit medicine".

		Node	Frequency	Percent
Lack of Regulation	Maintain the records of drugs codification and the certificates and licenses of drugs.	Transparency	17	20.7
	Allows easy access to relevant product information and potential use Hazards and Threats.	Transparency	6	7.3
	Provides audit trail functions over drug (life cycle).	Transparency	14	17.1
	Promotes accountability in association with transparency.	Transparency	8	9.8
	Maintains authentic records of manufacturing and distribution processes	Authenticity	17	20.7
	Maintains authentic records of row material sources.	Authenticity	4	4.9
	Maintains authentic records of packaging and medication leaflets.	Authenticity	7	8.5
	Adopts governance model characterized by transparency and openness of products quality and safety.	Transparency	5	6.1
	Provides measures to reduce possibilities of corruption.	Transparency	4	4.9
	Total		**82**	

Table (7) illustrates the respondents' reaction on the statement "The most important potential impact on the issue of "having many transaction intermediaries" pertaining to counterfeit medicine". Most of the respondents agree that Blockchain features allows functionality to trace drug pre & post manufacturing 15 (18.3%), allows functionality to trace drug supply chain inbound and outbound 12 (14.6%), automates pertinent functional and

cross-functional processes and allows functionality to track drug sources 10 (12.2%). In addition, Blockchain features promote reliability and availability as quality indicators 9 (11.0%). Finally, 5 (6.1%) of the responses indicate that Blockchain features allow functionality to track marketing mechanisms, allows functionality to trace fraudulent mislabeling, provides drug ingredients records (right / wrong), Integrates disparate pertinent functions, and provides drug ingredients (active /inactive).

Table (7): Respondents reaction on the statement "The most important potential impact on the issue of "having many transaction intermediaries" pertaining to counterfeit medicine"

		Node	Frequency	Percent
Having many transaction intermediaries	Allows functionality to trace drug pre & post manufacturing	Traceability	15	18.3
	Allows functionality to track marketing mechanisms	Traceability	5	6.1
	Automates pertinent functional and cross-functional processes	Integrity	10	12.2
	Promotes reliability and availability as quality indicators	Integrity	1	1.2
	Allows functionality to trace fraudulent mislabeling	Traceability	5	6.1
	Allows functionality to trace drug supply chain inbound and outbound	Traceability	12	14.6
	Provides drug ingredients records (right / wrong)	Integrity	5	6.1
	Promotes reliability and availability as quality indicators	Integrity	9	11.0
	Allows functionality to track drug sources	Traceability	10	12.2
	Integrates disparate pertinent functions	Integrity	5	6.1
	Provides drug ingredients (active /inactive)	Integrity	5	6.1
	Total		**82**	

Table (8) illustrate the respondents' reaction on the statement "The most important potential impact on the issue of "Corruption" pertaining to counterfeit medicine". Most of the respondents 14 (17.1%) agree that clock chain features adopt decentralized/ distributed governance model and applies distributed monitoring and control, and applies empowerment,

authorizations and delegation 13 (15.9%). Respondents agree that Blockchain features ensure vigilance and advocacy by the healthcare providers 12 (14.6%), ensure high standards of management and good ethical practices in health care facilities 10 (12.2%), allows flexibility in re-organization 9 (11.0%), and ensure that the political will is there to tackle drug counterfeit problem 8 (9.8%).

Table (8): Respondents reaction on the statement "The most important potential impact on the issue of "Corruption" pertaining to counterfeit medicine".

		Node	Frequency	Percent
Corruption	Adopts decentralized/ distributed governance model	Decentralization	14	17.1
	Applies; empowerment, authorizations and delegation	Decentralization	13	15.9
	Applies distributed monitoring and control	Decentralization	14	17.1
	Allows flexibility in re-organization	Decentralization	9	11.0
	Ensuring high standards of management and good ethical practices in health care facilities	Legal Perspective	10	12.2
	Ensuring vigilance and advocacy by the healthcare providers	Legal Perspective	12	14.6
	Providing a global repository (database) of drugs	Technology Perspective	1	1.2
	Ensuring the political will is there to tackle drug counterfeit problem	Legal Perspective	8	9.8
	Maintain record of involved Human Resources	People Perspective	1	1.2
	Total		**82**	

Table (9) shows the respondents' reaction on the statement "The potential impact on the issue of "Conflict of Interest" pertaining to counterfeit medicine". Most of the respondents agree that Blockchain features ensure effective regulations and ensure effective processes and policies 17 (20.7%) and Maintain record of relevant training and human development 16 (19.5 %). Respondents agree that Blockchain features ensure health public and private sector organizations adoption of business best practices and supporting collaboration of relevant stakeholders 9 (11.0%) and protect the identity and appropriate labeling of genuine drugs 5 (6.1%). Finally, some of the respondents 3 (3.7%) agree that Blockchain features support the drug life cycle (supply chain / value chain), provide easy to use reporting and analytics tools, and endure secure systems and technology application.

Table (9): Respondents reaction on the statement "The potential impact on the issue of "Conflict of Interest" pertaining to counterfeit medicine".

		Node	Frequency	Percent
Conflict of Interest	Ensure effective regulations	Organization Perspective	17	20.7
	Ensure effective processes and policies	Organization Perspective	17	20.7
	Maintain record of relevant training and human development	People Perspective	16	19.5
	Supporting the drug life cycle (supply chain / value chain)	Technology Perspective	3	3.7
	Protecting the identity and appropriate labeling of genuine drugs	Technology Perspective	5	6.1
	Ensure health public and private sector organizations adoption of business best practices	Legal Perspective	9	11.0
	Supporting collaboration of relevant stakeholders	Technology Perspective	9	11.0
	Providing easy to use reporting and analytics tools	Technology Perspective	3	3.7
	Ensuring secure systems and technology application	Technology Perspective	3	3.7
	Total		**82**	

Figure (2) shows the recurrence of the different nodes (Blockchain features) as a result of the qualitative study. It is clear that the most recurrent nodes (Blockchain features) which are expected to have potential impact on the level of counterfeit medicines in Jordan are: Decentralization (15.2%), Traceability (14.3%) and Transparency (13.7%).

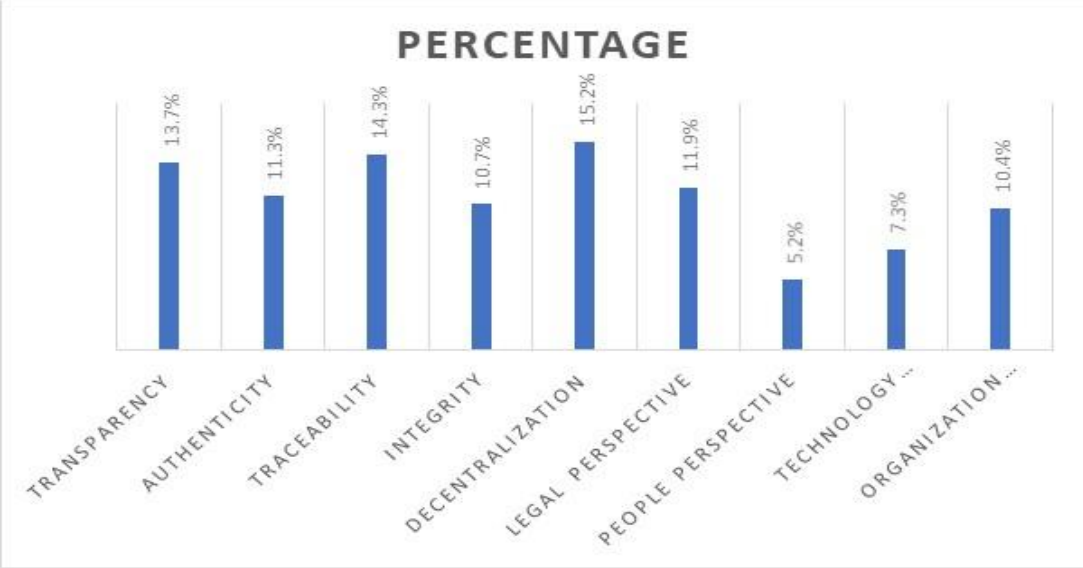

Figure (2) Blockchain Features

3.2.4 Develop the Model

The second stage of the study is dedicated to answer the following main question:

1. Do Blockchain distinctive features (Decentralization, traceability and transparency) affect the level of counterfeit drug index in Jordan?

Based on Blockchain distinctive features, the main question is divided into the following sub-questions:

1.1 Does “Decentralization” affect the control of the level of counterfeit drugs in Jordan?

1.2 Does “Traceability” affect the control of the level of counterfeit drugs in Jordan?

1.3. Does “Transparency” affect the control of the level of counterfeit drugs in Jordan?

Based on the output of the focus groups of the qualitative data analysis, and its questions the following model has been developed to study the effect of Blockchain distinguished features on counterfeit drugs in Jordan, as shown in model (1).

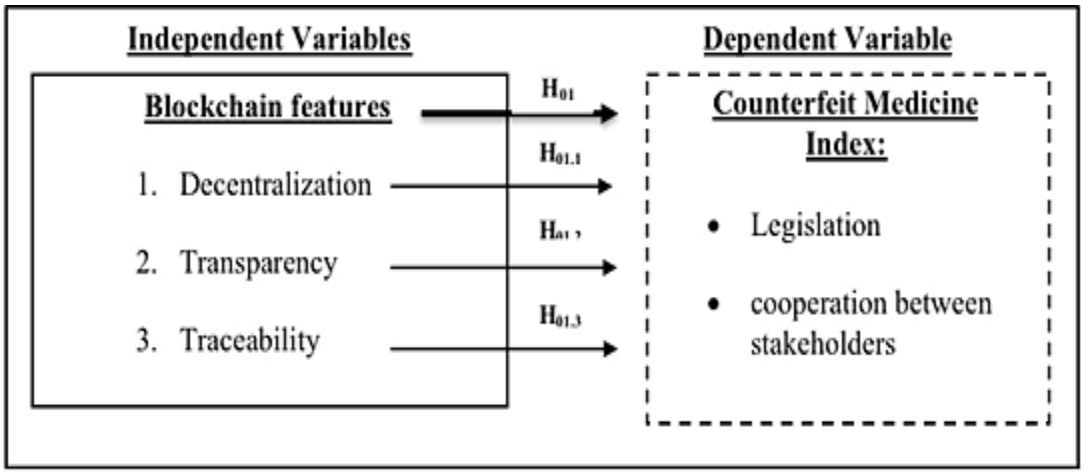

Figure (3) Study Model

Sources: This model developed based on the following: **Independent Variables**: The outcome results from the qualitative analysis. **Dependent Variable**: World Health Organization, (1999). Guideline for the development of measures to combat counterfeit drugs, Switzerland.

3.2.5 Study Hypothesis:

The above questions will be answered through testing the following hypothesis:

Main Hypothesis:

H_{01}: Blockchain distinctive features (Decentralization, traceability and transparency) don't affect the level of counterfeit drug index in Jordan, at ($\alpha \leq 0.05$).

Based on Blockchain features the main hypothesis can be divided into the following sub-hypothesis :

$H_{01.1}$: Decentralization does not affect the level of counterfeit drugs in Jordan, at ($\alpha \leq 0.05$).

$H_{01.2}$: Traceability does not affect the control of the level of counterfeit drugs in Jordan, at ($\alpha \leq 0.05$).

$H_{01.3}$: Transparency does not affect the control of the level of counterfeit drugs in Jordan, at ($\alpha \leq 0.05$).

3.2.6 Quantitative Data Collection

3.2.6.1 The Questionnaire :

To actualize this study, the questionnaire was used as a main tool, which contains two parts, as follows:

First part contains the demographic dimensions related to gender, age, experience, education, position, division. Second part includes both independent and dependent variables as follows:

Independent Variable (Blockchain): contains the following sub-variables (dimensions) Decentralization, Traceability and Transparency. Five items were used to measure each sub-variable.

Dependent Variable (Counterfeit medicine): contains the following dimensions: Legislation and Cooperation between stakeholders. Four items were used to measure each dimension.

All items measured by five-point Likert-type scale to rate respondent's actual perceptions regarding each item as follows: 1 (strongly disagree) to 5 (strongly agree).

3.2.6.2 Data Collection and Analysis

One hundred and twenty (120) questionnaires were collected out of 135 questionnaires distributed to supervisors and managers. The data was collected from the Ministry of Health, Jordan Food and Drug Association and Jordan Pharmacists Association. From September to December 2019.

All collected questionnaires were complete and suitable and coded against SPSS 23.

3.2.6.3 Validity Test

Table (10) shows that the loading factor of **Decentralization** items scored between 0.730 and 0.883, which assume the construct validity. KMO has rated 62.1%, which indicates good adequacy, and the Chi^2 is 153.417, which indicates the fitness of the model. Moreover, variance percentage is 71.713, so it can explain 71.71% of variation. Finally, the significance of Bartlett's Sphericity is less than 0.05, which indicates the factor analysis is useful.

Table (10): Principal Component Analysis Decentralization

No.	Item	F1	KMO	Chi^2	BTS	Var%	Sig.
01	Decentralization distributes monitoring and control	0.823	0.621	153.417	10	71.713	0.000
02	Decentralization allows flexibility in re-organization	0.730					
03	Decentralization allows retrieving information by third party	0.824					
04	Decentralization reduces individual power	0.856					
05	Decentralization facilitates cooperation between all parties	0.883					

Table (11) shows that the loading factor of **Traceability** items scored between 0.664 and 0.867, which assume the construct validity. KMO has rated 83.3%, which indicates good adequacy, and the Chi^2 is 272.136, which indicates the fitness of the model. Moreover, variance percentage is 64.294, so it can explain 64.29% of variation. Finally, the significance of Bartlett's Sphericity is less than 0.05, which indicates the factor analysis is useful.

Table (11): Principal Component Analysis Traceability

No.	Item	F1	KMO	Chi^2	BTS	Var%	Sig.
01	Traceability allows counterfeit product tracking	0.867	0.833	272.136	10	64.296	0.000
02	Traceability allows defining the counterfeit product source	0.858					
03	Traceability discover counterfeit product before and after manufacturing	0.783					
04	Traceability traces counterfeit product through supply chain	0.821					
05	Traceability can monitor and track transportation	0.664					

Table (12) shows that the loading factor of **Transparency** items scored between 0.734 and 0.871, which assume the construct validity. KMO has rated 80.6%, which indicates good adequacy, and the Chi^2 is 255.823, which indicates the fitness of the model. Moreover, variance percentage is 63.104, so it can explain 63.10% of variation. Finally, the significance of Bartlett's Sphericity is less than 0.05, which indicates the factor analysis is useful.

Table (12): Principal Component Analysis Transparency

No.	Item	F1	KMO	Chi²	BTS	Var%	Sig.
01	Transparency provides full information about counterfeit product	0.811	0.806	255.823	10	63.014	0.000
02	Transparency allows participant to add information about counterfeit product	0.871					
03	Transparency informs the concern bodies about the current state of counterfeit product	0.806					
04	Transparency provides measures to reduce possibilities of counterfeit product corruption	0.743					
05	Transparency Increases the flexibility in the use of information technology	0.734					

Table (13) shows that the loading factor of **Legislation** items scored between 0.709 and 0.882, which assume the construct validity. KMO has rated 71.6%, which indicates good adequacy, and the Chi^2 is 168.925, which indicates the fitness of the model. Moreover, variance percentage is 59.285%. Finally, the significance of Bartlett's Sphericity is less than 0.05, which indicates the factor analysis is useful.

Table (13): Principal Component Analysais Legislation

No.	Item	F1	KMO	Chi²	BTS	Var%	Sig.
01	Jordanian legislation provides clear information about counterfeit products	0.840	0.716	168.925	6	59.285	0.000
02	Jordanian legislation prevents counterfeit product manufacturing	0.807					

No.	Item	F1	KMO	Chi^2	BTS	Var%	Sig.
	by suitable penalties						
03	Jordanian legislation prevents counterfeit products distribution	0.882					
04	Jordanian legislation prevents distribution of counterfeit products by suitable punishments	0.706					

Table (14) shows that the loading factor of **Cooperation between stakeholders'** items scored between 0.603 and 0.871, which assume the construct validity. KMO has rated 74.5%, which indicates good adequacy, and the Chi^2 is 151.292, which indicates the fitness of the model. Moreover, variance percentage is 61.305%. Finally, the significance of Bartlett's Sphericity is less than 0.05, which indicates the factor analysis is useful.

Table (14): Principal Component Analysis Cooperation between stakeholders

No.	Item	F1	KMO	Chi^2	BTS	Var%	Sig.
01	Cooperation between different stakeholders is efficient.	0.871	0.745	151.292	6	61.305	0.000
02	Pharmaceutical industry agents exchange information in real time	0.790					
03	Police and custom services cooperation in counterfeiting products is effective	0.840					
04	Judiciary is responsive to threats of counterfeit products	0.603					

Table (15) shows that the loading factor of **Blockchain Technology items** scored between 0.506 and 0.872. Therefore, the construct validity is assumed. KMO has rated 69.1%, which indicates good adequacy, and the Chi^2 is 64.97, which indicates the fitness of model.

Moreover, variance percentage is 58.389 % of variation. Finally, the significance of Bartlett's Sphericity is less than 0.05, which indicates the factor analysis is useful.

Table (15): Principal Component Analysis Blockchain Technology

No.	Item	F1	KMO	Chi^2	BTS	Var%	Sig.
01	Decentralization	0.872	0.553	64.97	10	58.389	0.000
02	Traceability	0.858					
03	Transparency	0.506					

Table (16) shows that the loading factor of **Counterfeit Drugs** items scored between 0.831 and 0.838. Therefore, the construct validity is assumed. KMO has rated 50 %, which indicates good adequacy, and the Chi^2 is 213.913, which indicates the fitness of model. Moreover, variance percentage is 69.071% of variation. Finally, the significance of Bartlett's Sphericity is less than 0.05, which indicates the factor analysis is useful.

Table (16): Principal Component Analysis Counterfeit Drugs

No.	Item	F1	KMO	Chi^2	BTS	Var%	Sig.
01	Legislation	0.831	0.500	18.47	10	69.071	0.000
02	Cooperation between stockholders	0.838					

3.2.6.4 Reliability Test

The data reliability examined through Cronbach's alpha, the reliable tools have a Cronbach's alpha above 0.70, and accepted if it is exceeding 0.60 (Hair, et. al. 2014). Table (17) shows that reliability coefficient for Blockchain Technology sub-variables ranges between 0.786 and 0.859, and for the Counterfeit Drugs dimensions is between 0.750 and 0.785.

Table (17): Reliability Test for All Variables

Variable	Item/Sub-Variable	*Cronbach's Alpha*
Decentralization	5	0.70
Traceability	5	0.859

Variable	Item/Sub-Variable	*Cronbach's Alpha*
Transparency	5	0.853
Blockchain Technology	**3 Sub-Variables**	**0.803**
Legislation	4	0.750
Cooperation between stockholders	4	0.785
Counterfeit Drugs	**2 Dimensions**	**0.792**

3.2.6.5 Demographic Analysis

The demographic analysis is presented in the following sections based on the characteristics of the valid responses i.e. frequency and percentage of the participants such as gender, age, experience, education, position, and division.

Gender: Table (18) shows that most respondents are females 66 (55.0%), and 54(45.2%) are males.

Table (18): Respondents Gender

		Frequency	Percent
Gender	**Male**	54	45.0
	Female	66	55.0
	Total	**120**	**100.0**

Age: Table (19) shows that the majority of respondents ages are less than 40 years 53 (44.2%) out of the total sample, then those ages less than 30 years 38 (31.7%), after that the respondents less than 50 years 20 (16.7%), finally those older than 50 years 9 (7.5%).

Table (19): Respondents Age (Years)

		Frequency	Percent
Age (Years)	**Less than 30**	38	31.7
	Less than 40	53	44.2
	Less than 50	20	16.7
	More than 50	9	7.5
	Total	**120**	**100.0**

Experience: Table (20) shows that the majority of respondents are having experience less than 10 years are (50.0%), then respondents experience between (10-20 years) are (30.0%),

followed by those with experience between (21-30 years) are (12.5%). Finally, respondents more than 30 years' experience are (7.5%).

Table (20): Respondents Experience

		Frequency	Percent
Experience	**Less than 10**	60	50.0
	between 10-20	36	30.0
	between 21-30	15	12.5
	more than 30	9	7.5
	Total	**120**	**100.0**

Education: Table (21) shows that the majority of respondents holds Bachelor's degree 68 (56.7%), then Master degree holders are 39 (32.5%), the PhD degree have (7.5%), and finally (3.3%) have Diploma degree.

Table (21): Respondents Education

		Frequency	Percent
Education	Diploma	4	3.3
	Bachelor	68	56.7
	Master	39	32.5
	PhD	9	7.5
	Total	**120**	**100.0**

Position: Table (22) shows that the majority of respondents are working in other position than the listed 56 (46.7%) out of the total respondents, after that 26 (21.7%) are supervisors, then general managers 20 (16.7%), finally the senior manager position 18 (15.0%) out of total respondents.

Table (22): Respondents Position

		Frequency	Percent
Position	**Supervisor**	26	21.7
	Other	56	46.7
	Senior Manager	18	15.0
	General Manager	20	16.7
	Total	120	100.0

Chapter Four: Data Analysis

4.1 Introduction

This chapter includes data descriptive statistical analysis of respondents' perception, Pearson Bivariate Correlation matrix to test the relationships among Supply Chain Control Tower sub-variables with each other, Competitive Advantages dimensions with each other; and between Supply Chain Control Tower variable and sub-variables with Competitive Advantages dimensions. Finally, multiple regressions to check hypothesis: the impact of Supply Chain Control Tower on Competitive Advantages.

4.2 Descriptive Statistical Analysis

The mean, standard deviation, t-value, ranking and implementation level are used to describe the respondents' perception and the degree of implementing of each variable, dimension and items. The implementation level is divided into three categories based on the following formula:

5-1 / 3=1.33.

Therefore, the implementation to be considered high if it is within the range 3.67-5.00 and medium if it is between 2.34 and 3.66 and low implementation is between 1.00 and 2.33.

1-2.33 - Low - 2.33-3.67 - Medium - 3.67-5 High

Independent Blockchain Technology

Table (23) shows that the means of Blockchain Technology sub-variables ranges from 3.56 to 3.67 with standard deviation between 0.63 and 0.81. This indicates that respondents agree on a medium implementation of Blockchain Technology sub-variables that is supported by a high t-value compared to T-tabulated. The average mean is 3.56 with standard deviation of 0.55, indicates that the respondents highly aware and concern about Decentralization, where t-value is 11.02>T-tabulated = 1.960.

Table (23): Mean, Standard Deviation, t-value, Ranking and Implementation Level of Blockchain Technology

No.		M.	S.D.	t	Sig.	Rank	Impl.
1	**Decentralization**	3.56	0.63	6.69	0.00	3	Medium
2	**Traceability**	3.62	0.81	8.39	0.00	2	Medium
3	**Transparency**	3.67	0.78	9.30	0.00	1	High
	Blockchain Technology	**3.56**	**0.55**	**11.02**	**00**		**Medium**

Table (24) shows that the means of Decentralization items ranges from 3.35. to 3.92 with standard deviation between 1.07 and 1.23. This indicates that respondents agree on medium implementation of Decentralization items that is supported by high t-value compared to T-tabulated. The average mean is 3.56 with standard deviation of 0.92, indicates that the respondents highly aware and concern about Decentralization, where t-value is 24.23>T-tabulated = 1.960.

Table (24): Mean, Standard Deviation, t-value, Ranking and Implementation Level of Decentralization

No.		M.	S.D.	t	Sig.	Rank	Impl.
1	Decentralization distributes monitoring and control	3.38	1.02	14.74	0.00	3	Medium
2	Decentralization allows flexibility in re-organization	3.62	0.98	18.06	0.00	2	Medium
3	Decentralization allows retrieving information by third party	3.30	0.975	14.60	0.00	4	Medium
4	Decentralization reduces individual power	3.08	1.23	9.61	0.00	5	Medium
5	Decentralization facilitates cooperation between all parties	3.62	1.07	16.42	0.00	1	Medium
	Decentralization	**3.56**	**0.92**	**24.23**	**0.00**		**Medium**

Table (25) shows that the means of Traceability items ranges from 3.41 to 3.74 with standard deviation between 0.99 and 1.06. This indicates that respondents agree on medium implementation of Traceability items that is supported by medium t-value compared to T-tabulated. The average mean is 3.62 with standard deviation of 0.81, indicates that the respondents highly aware and concern about Traceability, where t-value is 21.81>T-tabulated = 1.960.

Table (25): Mean, Standard Deviation, t-value, Ranking and Implementation Level of Traceability

No.		M.	S.D.	t	Sig.	Rank	Impl.
1	Traceability allows counterfeit product tracking	3.74	1.06	17.91	0.00	1	High
2	Traceability allows defining the counterfeit product source	3.71	0.99	18.73	0.00	2	High
3	Traceability discover counterfeit product before and after manufacturing	3.41	1.01	15.17	0.00	5	Medium
4	Traceability traces counterfeit product through supply chain	3.60	1.00	17.39	0.00	4	Medium
5	Traceability can monitor and track transportation	3.67	1.01	17.98	0.00	3	High
	Traceability	**3.62**	**0.81**	**21.81**	**0.00**		**Medium**

Table (26) shows that the means of Transparency items ranges from 3.57 to 3.71 with standard deviation between 0.92 and 1.04. This indicates that respondents agree on a high implementation of Transparency items that is supported by high t-value compared to T-tabulated. The average mean is 3.67 with standard deviation of 0.68, indicates that the respondents highly aware and concern about Transparency, where t-value is 23.26>T-tabulated = 1.960.

Table (26): Mean, Standard Deviation, t-value, Ranking and Implementation Level of Transparency

No.		M.	S.D.	t	Sig.	Rank	Impl.
1	Transparency provides full information about counterfeit product	3.67	1.04	17.42	0.00	4	High
2	Transparency allows participant to add information about counterfeit product	3.57	1.02	16.71	0.00	5	Medium
3	Transparency informs the concern bodies about the current state of counterfeit product	3.71	0.97	19.22	0.00	1	High
4	Transparency provides measures to reduce possibilities of counterfeit product corruption	3.70	0.92	20.19	0.00	2	High
5	Transparency Increases the flexibility in the use of information technology	3.69	0.968	19.13	0.00	3	High
	Transparency	**3.67**	**0.68**	**23.26**	**0.00**		High

Dependent Variable (Counterfeit drugs):

Which includes the following dimensions: Legislation and Cooperation between stakeholders.

Table (27) shows that the means of Counterfeit drugs variables ranges from 3.00 to 3.28 with standard deviation between 0.76 and 0.79. This indicates that respondents agree on medium implementation of Counterfeit drugs sub-variables that is supported by high t-value compared to T-tabulated. The average mean is 3.14 with standard deviation of 0.64, indicates that the respondent's awareness is medium and concern about Competitive Advantages, where t-value is 19.42>T-tabulated = 1.960.

Table (27): Mean, Standard Deviation, t-value, Ranking and Implementation Level of Counterfeit drugs

No.		M.	S.D.	t	Sig.	Rank	Impl.
1	Legislation	3.00	0.76	14.40	0.00	2	Medium
2	Cooperation between stakeholders	3.28	0.79	17.80	0.00	1	Medium
	Counterfeit drugs	**3.14**	**0.64**	**19.42**	**0.00**		**Medium**

Table (28) shows that the means of Legislation items ranges from 2.91 to 3.07 with standard deviation between 0.79 and 1.11. This indicates that respondents agree on medium implementation of Legislation items that is supported by medium t-value compared to T-tabulated. The average mean is 3.00 with standard deviation of 0.76, indicates that the respondents highly aware and concern about Legislation, where t-value 14.09 > T-tabulated = 1.960.

Table (28): Mean, Standard Deviation, t-value, Ranking and Implementation Level of Legislation

No.		M.	S.D.	t	Sig.	Rank	Impl.
1	Jordanian legislation provides clear information about counterfeit products	2.91	1.07	9.24	0.00	4	Medium
2	Jordanian legislation prevents counterfeit product manufacturing by suitable penalties	3.07	1.09	11.47	0.00	1	Medium
3	Jordanian legislation prevents distribution of counterfeit products by suitable punishments	3.03	1.11	10.10	0.00	2	Medium
4	Jordanian legislation leads to horrid situation	3.01	0.79	13.91	0.00	3	Medium
	Legislation	**3.00**	**0.76**	**14.09**	0.00		**Medium**

Table (29) shows that the means of Cooperation between stakeholders' items ranges from 3.03 to 3.30 with standard deviation between 0.89 and 1.17. This indicates that respondents agree on medium implementation of Cooperation between stakeholders' items that is supported by high t-value compared to T-tabulated. The average mean is 3.28 with standard deviation of 0.79, indicates that the respondent's awareness is medium and concern about Cooperation between stakeholders, where t-value is 17.08 > T-tabulated = 1.960.

Table (29): Mean, Standard Deviation, t-value, Ranking and Implementation Level of Cooperation between stakeholders

No.		M.	S.D.	t	Sig.	Rank	Impl.
1	Cooperation between different stakeholders is efficient.	3.30	1.17	12.16	0.00	1	Medium
2	Pharmaceutical industry agents exchange information in real time	3.03	0.95	11.88	0.00	4	Medium
3	Police and custom services cooperation in counterfeiting products is effective	3.12	0.89	12.37	0.00	2	Medium
4	Judiciary is responsive to threats of counterfeit products	3.17	0.93	19.94	0.00	2	Medium
	Cooperation between stakeholders	**3.28**	**0.79**	**17.08**	**0.00**		**Medium**

Relationship between Independent and Dependent Variables:

Bivariate Pearson Correlation Test has been used to check the relationship between variables. Table (30) shows that the relationships among Blockchain sub-variables with Counterfeit Drugs is negative where r ranges from -0.087 – 0.005. Moreover, the relationships among the dimensions of Blockchain technology are strong, where the ranges are between 0.655 and 0.851.

Table (30): Relationship between Independent and Dependent Variables Correlation

		Decentralization	Traceability	Transparency	Blockchain Technology	Legislation	Cooperation between Stakeholders	Counterfeit drugs
Decentralization	Pearson Correlation	1						
	Sig. (2-tailed)							
Traceability	Pearson Correlation	.623**	1					
	Sig. (2-tailed)	.000						
Transparency	Pearson Correlation	.239*	.201*	1				
	Sig. (2-tailed)	.009	.028					
Blockchain Technology	Pearson Correlation	.791**	.815**	.655**	1			
	Sig. (2-tailed)	.000	.000	.000				
Legislation	Pearson Correlation	-.030	-.068	-.151	-.115	1		
	Sig. (2-tailed)	.748	.458	.099	.211			
Cooperation between Stakeholders	Pearson Correlation	.036	-.105	.013	-.031	.381**	1	
	Sig. (2-tailed)	.695	.252	.886	.733	.000		
Counterfeit Drugs	Pearson Correlation	.005	-.105	-.081	-.087	.823**	.839**	1
	Sig. (2-tailed)	.959	.254	.379	.344	.000	.000	

****. Correlation is significant at the 0.01 level (2-tailed). Correlation is significant at the 0.05 level (2-tailed).**

4.3 Hypothesis Testing

After confirming validity, reliability and the correlation between independent and dependent variables, the following tests should be carried out to ensure the validity of regression analysis. (Sekaran, 2003):

Normality: Figure (4) illustrates that the shape follows the normal distribution, so the model does not violate this assumption.

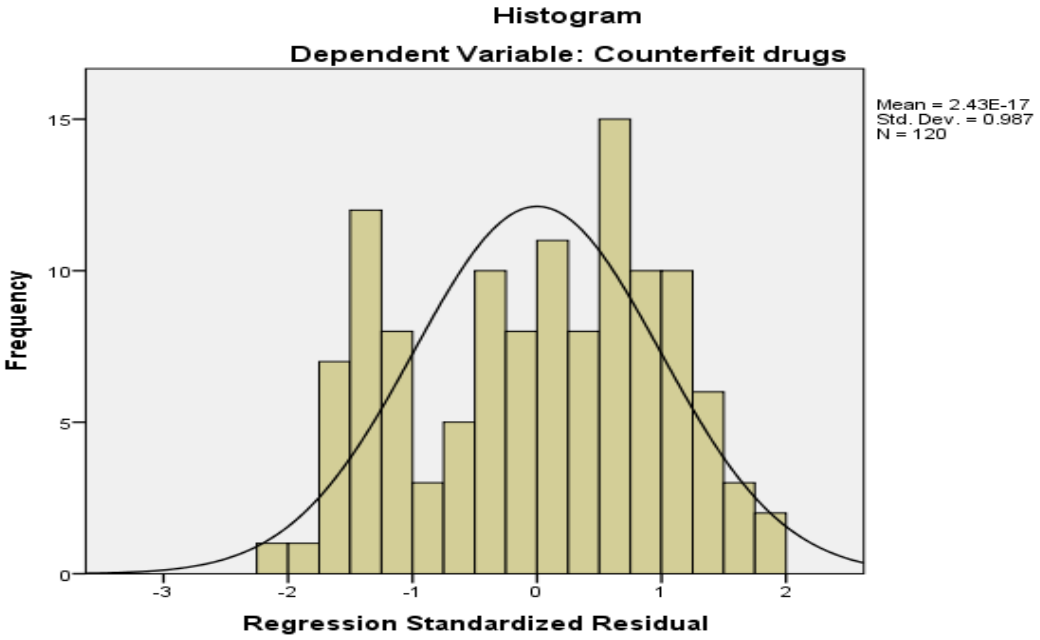

Figure (4): Normality Test

Linearity test: figure (5) shows that there is a linear relationship between independent and dependent variables. In such case, the model does not violate this assumption

Figure (5): Linearity test

Multi-Collinearity: the VIF (Variance Inflation Factor) value is less than 10, and tolerance is more than 10%, in such case the Collinearity model does not violate this assumption.

Table (31): Durbin-Watson value and Variance Inflation Factor

Collinearity Statistics		
	Tolerance	**VIF**
Decentralization	0.598	1.671
Traceability	0.609	1.642
Transparency	0.939	1.065

Main Hypothesis:

H_{01}: Blockchain distinctive features (Decentralization, Traceability and Transparency) have no effect the level of counterfeit medicine index in Jordan, at ($\alpha \leq 0.05$).

Table (32) shows that when regressing the three sub-variables of Blockchain distinctive features against the total of counterfeit medicine, the model shows that Blockchain

distinctive features has a small impact and can be explained where (R^2= - 0.001, f=0.98, Sig.=0.405). Therefore, we accept the null hypothesis and reject the alternative hypothesis, which states that Blockchain distinctive features sub-variables (**Decentralization, Traceability and Transparency**) affect counterfeit medicine **index in Jordan at (α≤0.05) because the sig. is less than 0.05.**

Table (32): Multiple Regressions of Blockchain Distinctive Features Sub-variables on counterfeit medicine.

Model	r	R^2	Adjusted R^2	f	Sig.
1	0.157[a]	0.025	-0.001	0.980	0.405[b]

a. Predictors: (Constant), Transparency, Traceability, Decentralization. b, Dependent Variable: Counterfeit drugs.

Based on the components of Blockchain distinctive features, table (33) shows the impact of each sub-variable on counterfeit medicine. Blockchain technology features have impact as following: the highest impact is for Decentralization (0.129) Transparency (-0.078), and Traceability (-0.170). while all of these dimensions have small impact and the sig. is >0.05.

Table (33): Multiple Regressions of Blockchain distinctive features sub-variables on counterfeit medicine (ANOVA).

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.420	0.390		8.759	0.000
	Decentralization	0.132	0.121	0.129	1.088	0.279
	Traceability	-0.134	0.903	-0.170	-1.444	0.151
	Transparency	-0.064	0.078	-0.078	-0.821	0.413

a. Dependent Variable: Counterfeit drugs, -tabulated=1.960, Predictors: (Constant), Transparency, Traceability, Decentralization.

$H_{01.1}$: Decentralization has no effect the level of counterfeit medicine in Jordan, at (α≤0.05).

Table (34) shows that when regressing Decentralization on counterfeit medicine, the model shows that Decentralization has a small impact on counterfeit medicine (R^2= -0.08, f=0.003,

Sig=0.959). Therefore, we accept the null hypothesis and reject the alternative hypothesis, which states that **Decentralization** affect counterfeit medicine **index in Jordan at (α≤0.05) because the sig. is <0.05.**

Table (34): Multiple Regressions of Decentralization on Counterfeit Drug.

Model	r	R^2	Adjusted R^2	f	Sig.
1	0.005[a]	0.000	-0.08	0.003	0.959[b]

a. Predictors: (Constant), Decentralization, b Dependent Variable: Dependent Variable: Counterfeit drugs

Based on the elements of Decentralization, table (35) shows that decentralization has a small impact on Counterfeit drugs because the significance is >0.05.

Table (35): Multiple Regressions of Decentralization on Counterfeit Drugs (ANOVA).

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	0.792	0.300		2.637	0.009
2	Decentralization	0.05	0.094	0.005	0.051	0.959

a. Dependent Variable: Counterfeit drugs, tabulated=1.960.

$H_{01.2:}$ Traceability has no effect the control of the level of counterfeit medicine in Jordan, at (α≤0.05).

Table (36) shows that when regressing **Traceability on counterfeit medicine**, the model shows that **Traceability** has a small impact on counterfeit medicine because Sig. > 0.05. Therefore, we accept the null hypothesis and reject the alternative hypothesis, which states that **Traceability** affect counterfeit medicine **index in Jordan at (α≤0.05) because the sig. is <0.05.**

Table (36): Multiple Regressions of Traceability on counterfeit medicine.

Model	r	R^2	Adjusted R^2	f	Sig.
1	0.105[a]	0.011	0.003	1.315	0.254[b]

a. Predictors: (Constant), Traceability, b Dependent Variable: Counterfeit Medicine.

Based on the components of Traceability items, table (37) shows the impact of Traceability items on Counterfeit medicine dimensions. These items have a small impact with – 10.5%, while sign. is > 0.05.

Table (37): Multiple Regressions of Traceability on Counterfeit Medicine (ANOVA).

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.447	0.269		12.799	0.00
	Traceability	-0.083	0.072	-0.105	-1.147	0.254

a. Dependent Variable: Counterfeit Medicine, tabulated=1.960.

$H_{01.3}$: Transparency has no effect the control of the level of counterfeit medicine in Jordan, at (α≤0.05).

Table (38) shows that when regressing Transparency elements against Counterfeit Medicine, the model shows that Transparency has a small impact and can explain – 0.2% of the variation of Counterfeit Medicine, where (R^2=0.007, f=78.00, Sig.=0.379). Therefore, the $H_{01.3}$ hypothesis is accepted, and the alternative hypothesis is rejected, which states that **Transparency has no effect the control of the level of counterfeit medicine in Jordan, at (α≤0.05).**

Table (38): Multiple Regressions of Transparency on Counterfeit Medicine.

Model	r	R^2	Adjusted R^2	f	Sig.
1	0.081[a]	0.007	-0.002	0.780	0.379[b]

a. Predictors: (Constant), Transparency, b Dependent Variable: Counterfeit drugs.

Table (39) shows the impact of Transparency on Counterfeit medicine. **Transparency has a small impact on Counterfeit Medicine** where can explain – 0.081% of the variation of Counterfeit Medicine, and the sig. >0.05.

Table (39): Multiple Regressions of Transparency on Counterfeit Medicine (ANOVA).

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.391	0.283		11.971	0.000
2	Transparency	-0.067	0.076	-0.081	-0.833	0.379

a. Dependent Variable: Counterfeit drugs, tabulated=1.960

Chapter Five: Findings and Discussion

5.1 Results Discussion

The study results indicate a negative relationship between the Blockchain sub-variables and counterfeit drugs. Transparency has the highest implementation rate among the sub-variables, then Traceability, and finally Decentralization. Decentralization and traceability have medium rates, while Transparency has a significant impact. Second, the findings showed a high implementation of Blockchain Dimensions on counterfeit drugs. The highest implementation is for Transparency, then traceability, and finally Decentralization.

Table (40): Summary of Multiple Regressions of Blockhain on Counterfeit Drugs sub-variables (Legislation and Cooperation between stakeholders) (ANOVA)

	Counterfeit Drugs	
Blockchain	+	
Decentralization	+	
Traceability	+	
Transparency	+	

+ There is an impact

1. Blockchain has a negative impact on the total counterfeit drugs, and this is supported by the study of (Shrikant, et.al. 2019) that talked about Blockchain is useful in keeping track of the whole production chain of the drug. Any new transaction applied to a chain is unchangeable and time dated, making sure the records can't be manipulated. Organizations can have either a Blockchain for themselves or the public. The businesses can have a distributed ledger on these Blockchains owned by the manufacturing stakeholders
2. Decentralization has a negative small impact on the total counterfeit drugs, and this is supported by the study of (Alzahrani and Bulusu, 2018) that said Blockchain technology has emerged to provide a promising solution for Counterfeiting. this study proposes a new decentralized Blockchain that detects counterfeiting attacks using Blockchain.

3. Traceability has a negative small impact on the total counterfeit drugs, and this is supported by the study (Shrikant, et.al. 2019) that discussed the current Blockchain system, and manufacturers don't know what happened to their products, drug regulators have no system visibility, recalls are complicated and expensive, and companies are unable to monitor patients. So, the study explains how to use Blockchain technology to add traceability, visibility, and security in the pharmaceutical Blockchain.
4. Transparency has a negative small impact on the total counterfeit drugs, and this is supported by the study (Francisco and Swanson, 2017) that discussed the openness supply chain principle encompasses knowledge that is readily available to end-users and Blockchain firms. Specifies that the degree of exchange of Blockchain information within the Blockchain varies. For it as accountability and supply chains, intelligence needs to be provided transparently to all stakeholders, standardizing the use of information during negotiations and including more detail on the sources and processes of the components.

5.2 Conclusion

The present study aimed at investigating the impact of Blockchain sub-variables on counterfeit drugs in Jordan, and aimed to answer the main question: Does Blockchain distinctive features (Decentralization, traceability, and transparency) affect the level of counterfeit drug index in Jordan?

A model has developed on qualitative data analysis and from the previous studies, then a questionnaire was designed to collect the data. The validity and reliability of the questionnaire have been performed. To test the study hypothesis, the correlation and multiple regression were operated.

The study results revealed that Blockchain has a negative relationship with counterfeit drugs in Jordan. The study found that Transparency is the highest implementation rate among the sub-variables, then Traceability, and finally Decentralization.

5.3 Recommendations

1. The result of the study confirms the prospect and potential of Blockchain technology on counterfeit drugs in Jordan and predicts that a proper and systematic utilization of Blockchain distinguished features such as decentralization, traceability and transparency contribute to the reduction and control of counterfeit drugs in Jordan. However, the success of such a proposition is conditional to the following:

- Ensuring effective collaboration of all relevant stakeholders including governments, pharmaceutical sector (public and private), educational institutions, international partners.
- Adopting a long term strategy with a vision and strategic goals to eradicate the problem of drug counterfeiting, by identifying the roots of the problem and tackle them through a implementation of comprehensive system that uses Blockchain technology platform as the backbone, yet enforced and complemented by policies, laws and regulations, and the commitment of all stakeholders to understand their roles and their proactive contribution to the success of this ambitious and important initiative.
- Ensuring that the sough system is designed and developed based on a good understanding of the root causes of the problem following a thorough analysis of the relevant issues, incorporating best practices, leading to functional integration, business process automation and utilization of state of the art technologies such as analytics, dashboards and business intelligence.

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Appendices

Appendix (1): Panel of Referees Committee (1)

No.	Name	Qualification	Organization
1	Dr. Osama Rababa	Professor	Jordan University
2	Dr. Abdel Aziz Shrbati	Associate Prof.	Middle East University
3	Dr. Mohammad adaileh	Associate Prof.	Middle East University
4	Dr. Ahmad Sukkar	Associate Prof.	Petra University
5	Dr. Dana Qudah	Assistant Prof.	Jordan University
6	Dr. Nahla Alnazer	Assistant Prof.	Middle East University
7	Dr. Hussam Barham	Assistant Prof.	Petra University
8	Dr. Firas Omar	Assistant Prof.	Petra University
9	Dr. Fadi Qutaishat	Assistant Prof.	Princess Sumayya University
10	Dr. George Sammour	Assistant Prof.	Princess Sumayya University
11	Fares Zahran	General Manager	Pharmcure Pharmacy

Appendix (2): Letter and Research tool of Respondents

جـــامـعـــة الـــشـرق الأوسـط
MIDDLE EAST UNIVERSITY

Research Tool

The Prospects of Block-Chain Technology on the Counterfeit Drugs in Jordan; A qualitative study

الأثر المتوقع لتكنولوجيا سلسلة الكتل على السيطرة على تزوير الأدوية في الأردن: دراسة نوعيه

Prepared by:

Sara Mahmoud Issa

Supervised by:

Dr. Fayez Albadri

This survey is a research tool used for data collection to support the above study, part of the master's degree in E-business.

Management Department - Business Faculty

Middle East University

Amman - Jordan

2019

Dear Survey Participant

This survey is a research tool to collect data for the Middle East University, E-Business Master's research thesis titled "*The Prospects of Block-Chain Technology on the Counterfeit Drugs in Jordan; A qualitative study*". The research findings will support both government and pharmaceutical organizations, to consider the utilization of Block-Chain technology applications as part of their strategy to manage and control the levels of counterfeit drugs in Jordan.

Block-Chain is a new technology platform that is expected in few years to have a major impact on different aspects of business due to the nature of its architecture and distinctive features, including decentralization, traceability, integrity, transparency etc.

As an expert in your area, you are cordially invited to take part in this important study, by completing the relevant parts of the attached survey, reflecting your views based on your understanding and experience in addressing the survey questions.

Your completion of this survey is an important part of a genuine effort to tackle the persisting problem of drugs counterfeiting, and thus your participation is highly regarded.

Please be reassured that your answers are anonymous, you DO NOT need to disclose your identity on the survey and all answer will be kept confidential. Only group results will be presented or documented, not individual answers.

Please talk about the most applicable answers to the survey questions. However, for any questions, clarifications or concerns, please contact the Researcher Sara Issa (sara@gmail.com) or the Supervisor (falbadri@gmail.com)

Thank you for your time and consideration.

The Research Team

Middle East University

Section A: Demographics

Name (Optional): ……

Contact (Optional): ……...

Position: ...……

Gender:

☐ Male ☐ Female

Education Level:

☐ Diploma ☐Bachelor degree ☐ Post-graduate degree

Professional Experience (years**):**

☐ 5-10 years ☐ 11-15 years ☐ 16-20 years ☐ >20 years

Section B:

How do you rate your level of awareness and knowledge of the following?

S. No.	Subject	Expert	High	Medium	Low	No
1.	Information Technology					
2.	Blockchain Technology					
3.	Counterfeit Drugs					

Section C:

Having in mind the importance of Blockchain features of Authenticity; Transparency, Traceability, Integrity, and Decentralization, talk about the following:

The most important potential impact on the issue of "Lack of regulation" pertaining to counterfeit medicine
The most important potential impact on the issue of "having many transaction intermediaries "pertaining to counterfeit medicine
The most important potential impact on the issue of "Corruption" pertaining to counterfeit medicine.
The potential impact on the issue of "Conflict of Interest" pertaining to counterfeit medicine.

Section E:

Should you have any other ideas, comments or suggestions to support or improve this research, kindly add here:

We thank you for your invaluable time, and we shall make sure that the findings of this research are shared with you once it is completed.

Research Student:

Sara Mahmoud Issa (PhD)
Middle East University

Research Supervisor:

Fayez Albadri
Middle East University

Appendix (3): Panel of Referees Committee (2)

No.	Name	Qualification	Organization
1	Dr. Osama Rababa	Professor	Jordan University
2	Dr. Mohammad Adaileh	Associate Prof.	Middle East University
3	Dr. Abdel Aziz Shrbati	Associate Prof.	Middle East University
4	Dr. Sameer Jabali	Associate Prof.	Middle East University
5	Dr. Ahmad Sukkar	Associate Prof.	Petra University
6	Wasfi Nawafleh	General Manager	Lilium Drug Store
7	Tariq Hejazi	General Manager	Mawared Drug Store
8	Hani Alzoubi	Marketing Product Manager	MS Pharma
9	Salah Qandil	JPA Member	Jordan Pharmacist Association

Appendix (4): Letter and Questionnaire of Respondents

جامعة الشرق الأوسط
MIDDLE EAST UNIVERSITY

Questionnaire

Dear Mr./Dr. …….

I would like to request you to referee the attached questionnaire, which will be used for thesis entitled:

The Prospects of Blockchain Technology on the Counterfeit Drugs in Jordan

الأثر المتوقع لتكنولوجيا سلسلة الكتل على السيطرة على تزوير الأدوية في الأردن

You are requested to spare your precious time to fill up the questionnaire. Your views and answers are important to us, please answer all questions as we cannot use the questionnaire if it is incomplete.

Finally, the information given by you will be kept confidential and will be used for the academic purpose only.

Thank you for your support and collaboration.

Prepared by: Sara Mahmoud Issa

Supervised by: Dr. Fayez Albadri

Part I: Demographic Data

Gender: ☐ Male ☐ Female

Age (years): ☐ less than 30 ☐ less than 40 ☐ less than 50 ☐ More than 50

Experience: ☐ less than10 ☐ Bet.10-20 ☐ Bet.21-30 ☐ More than 30

Education: ☐ Diploma ☐ Bachelor ☐ Master ☐ PhD

Position: ☐ Supervisor ☐ Senior Manager ☐ General Manager ☐ Other

Part 2: The following questions test the perceptions of Jordanian pharmacists in different sectors about the perspective effect of the Blockchain features on counterfeit drug index. Evaluate each question according to actual implementation and not your belief, as follows:

1 = strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = strongly agree

No	Item	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Blockchain Technology A technology that allows individuals and companies to make instantaneous transactions on a network without any middlemen, Transactions made on Blockchain are completely secure, and, by function of Blockchain technology, are kept as a record of what happened.						
Decentralization The transfer of decision-making power and assignment of accountability and responsibility for results						
1	Decentralization distributes monitoring and control	**1**	**2**	**3**	**4**	**5**
2	Decentralization allows flexibility in re-organization	**1**	**2**	**3**	**4**	**5**
3	Decentralization allows retrieving information by third party	**1**	**2**	**3**	**4**	**5**
4	Decentralization reduces individual power	**1**	**2**	**3**	**4**	**5**
5	Decentralization facilitates cooperation between all parties	**1**	**2**	**3**	**4**	**5**
Traceability The Blockchain feature that provide the ability to follow up the location of medicine or activity by means of records data						
6	Traceability allows counterfeit product tracking	**1**	**2**	**3**	**4**	**5**
7	Traceability allows defining the counterfeit product source	**1**	**2**	**3**	**4**	**5**
8	Traceability discover counterfeit product before and after manufacturing	**1**	**2**	**3**	**4**	**5**
9	Traceability traces counterfeit product through supply chain	**1**	**2**	**3**	**4**	**5**
10	Traceability can monitor and track transportation	**1**	**2**	**3**	**4**	**5**
Transparency The Blockchain feature that entails the lack of hidden documents accompany by the availability of full information required for collaboration. (Restricted access to affordable, quality, safe and effective medicinal products)						
11	Transparency provides full information about counterfeit product	**1**	**2**	**3**	**4**	**5**
12	Transparency allows participant to add information about counterfeit product	**1**	**2**	**3**	**4**	**5**
13	Transparency informs the concern bodies about the current state of counterfeit product	**1**	**2**	**3**	**4**	**5**
14	Transparency provides measures to reduce possibilities of counterfeit product corruption	**1**	**2**	**3**	**4**	**5**
15	Transparency Increases the flexibility in the use of information technology	**1**	**2**	**3**	**4**	**5**

Counterfeit drugs Drugs that are fraudulently mislabeled with respect to their identity and/or source or use. Counterfeit medicines may include products with correct ingredients, with wrong ingredients, without active ingredients, with incorrect amounts of active ingredients or with fake packaging.						
Legislation Appropriate regulations to help in preventing of counterfeit products						
16	Jordanian legislation provides clear information about counterfeit products	**1**	**2**	**3**	**4**	**5**
17	Jordanian legislation prevents counterfeit product manufacturing by suitable penalties	**1**	**2**	**3**	**4**	**5**
18	Jordanian legislation prevents distribution of counterfeit products by suitable punishments	**1**	**2**	**3**	**4**	**5**
19	Jordanian legislation leads to horrid situation	**1**	**2**	**3**	**4**	**5**
Cooperation between stakeholders Intersectoral cooperation between national drug regulatory authorities (DRA) and official parts concern about counterfeiting products (ministry of health, Jordan food and drug association, Jordanian pharmacy association)						
20	Cooperation between different stakeholders is efficient.	**1**	**2**	**3**	**4**	**5**
21	Pharmaceutical industry agents exchange information in real time	**1**	**2**	**3**	**4**	**5**
22	Police and custom services cooperation in counterfeiting products is effective	**1**	**2**	**3**	**4**	**5**
23	Judiciary is responsive to threats of counterfeit products	**1**	**2**	**3**	**4**	**5**