Defining the Digital Supply Chain as a Driver of Competitive Advantage: *A Case Study of Pharmaceutical Industrial Institutions in Palestine*[1]

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ABSTRACT

The sole objective of this research paper is to find out the impact of supply-chain digitization pillars namely: sustainability, agility, predictability and traceability on the competitive advantage dimensions (reliability, quality, innovation, time and cost) in Pharmaceutical industrial institutions in the Palestinian territories. The research study is categorized as a cross-sectional quantitative explanatory study. The researcher has employed a survey strategy thorough a self-administrated questionnaire as the main tool for data collection. The study population consisted of managers, supervisors and production line officials in pharmaceutical companies in Palestine (West Bank), which numbered (5) companies. The data collection tool was distributed to the total sample number of 268. This research paper has many managerial implications. Most importantly, adopting the pillars of the supply chain (sustainability, Predictability, agility, and traceability) in (PIIs) can reduce the costs of the pharmaceutical manufacturing processes, enhance quality assurance, improve delivery dependability and time to market within the pharmaceutical industry. Given the general observation that digitalization of supply chain will provide pharmaceutical institutions a revolutionary extent of responsiveness and resiliency enabling them to enhance their competitive advantage, build a sustainable value through providing wholesalers, retailers and final consumers with the utmost transparent, effective and efficient service provision.

Keywords: *Digital supply-chain, Digitalization Competitive advantage, pharmaceutical industry.*

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1. INTRODUCTION

In globalizing world circumscribed by a dynamic, perplexing and aggressive environment and a conflicting, hostile and competitive corporate business industries, digitalization has turned as a unprecedented phenomenon that impacted various business sectors around the globe. More than 90% of internet users have already made online purchases and about 40% of companies has used sophisticated tools for big data analytics (Hung, 2017). Supply-chain (SC) operations have equally been tremendously impacted by digitalization. And it is evident that the transformation from an unprogressive traditionalistic supply-chain to a progressive, modernistic digital supply-chain (DSC) emerge as a competitive advantage constructing a demonstrable value-added for organizations. Supply-chain processes contain a series of substantially siloed, discrete steps extracted from manufacturing activities, product development, distribution processes, marketing and eventually into the hand of the final consumer. Digital Supply Chain processes bring down those walls, (Berttram and Schrauf, 2016) and the chain becomes a completely integrated ecosystem that is fully transparent to all the players involved — from the suppliers of raw materials, components, and parts, to the transporters of those supplies and finished goods, and finally to the customers demanding fulfillment. This system relies upon on several technological techniques: advanced analytics, autonomous logistics, logistics visibility, spare parts management, smart warehousing and procurement, and integrated execution and planning systems. The outcome enables organizations to resolve interruptions and perturbations in the supply-chain, and even prognosticate them by creating "what-if" scenarios, fully modeling the network, and adjusting the supply chain in real time as conditions change (Berttram and Schrauf, 2016).

During the last decade, various organizations around the world have embarked digital transformational strategies for their supply chain (SC) processes (Cap Gemini 2016; EY, 2016). Digital Supply Chain processes can be defined as the development of information systems and the adoption of innovative technologies strengthening the integration and the agility of the supply chain

and thus improving customer service and sustainable performance of the organization (Bentahar and Angappa, 2020)

Digital-transformation (DT) turned out to be significant for Pharmaceutical Industrial Institutions (PIIs) in Palestine and around the world. As a consequence of COVID 19 pandemic, pharmaceutical organization's ability to adapt quickly to online processes, remote work, more flexible drug development, declining supplies, and rapidly changing patients' expectations has become critical. If (PIIs) remain and endure as an essential component of this transformation, and not vanish from the stage, it is indispensable that they transform comprehensively (Bentahar and Ika, 2019) Digitalization of supply chain will provide pharmaceutical institutions a revolutionary extent of responsiveness and resiliency enabling them to enhance their competitive advantage, build a sustainable value through providing wholesalers, retailers and final consumers with the most transparent, effective and efficient service delivery.

1.1 Problem Statement

Previous literature has proposed a significant influence of digital supply-chain transformation on competitive advantage on various manufacturing and industrial firms. Ahmed, Asim & Manzoor (2020); Muthaher (2017) However, none have tackled the influence of digital supply-chain within the Pharmaceutical industrial institutions' ecosystem. According to the examination of considerable competitive advantage dimensions in numerous literatures, the elements of competitive - advantage that may be utilized from supply-chain digitalization practices are innovation, reliability, cost, quality, and time-to-market. Therefore, this research paper sole objective is to find out the impact of supply-chain digitization pillars namely: sustainability, agility, predictability and traceability on the competitive - advantage dimensions: innovation, reliability, cost, quality, and time-to-market of Pharmaceutical industrial institutions in the Palestinian territories.

1.2 Research Questions:

- Do the digital supply chain pillars (sustainability, agility, predictability, and traceability) positively impact cost reduction efforts in Process and Industrial Industries (PIIs)?
- Do the digital supply chain pillars (sustainability, agility, predictability, and traceability) positively impact quality assurance measures in Process and Industrial Industries (PIIs)?
- Do the digital supply chain pillars (sustainability, agility, predictability, and traceability) positively impact delivery dependability in Process and Industrial Industries (PIIs)?
- Do the digital supply chain pillars (sustainability, agility, predictability, and traceability) positively impact time to market in Process and Industrial Industries (PIIs)?

1.3 Research Significance

The significance of this research lies in its potential to address critical challenges and unlock opportunities for pharmaceutical industrial institutions in the Palestinian territories. As the global market becomes increasingly competitive, the adoption of digital supply chain practices is no longer optional but essential for achieving sustained growth and efficiency. By defining the digital supply chain as a driver of competitive advantage, this study provides a framework for understanding how key elements—such as sustainability, agility, predictability, and traceability—can optimize operations and enhance resilience in a region marked by economic and logistical complexities. Furthermore, it highlights the strategic role of digital transformation in improving cost-efficiency, ensuring timely delivery of pharmaceutical products, and meeting stringent quality assurance standards. This research also offers valuable insights for policymakers and industry leaders seeking to bridge technological gaps, thereby contributing to the broader economic development of the Palestinian territories.

2. THEORETICAL FRAMEWORK AND HYPOTHESES DEVELOPMENT

The digitalization of supply chain and related competitive advantage perspective lay foundation for this research paper. Recent supply-chain researches proposed that digitalization establish exceptional outcome which then transformed into competitive-advantage (Sanders, Autry & Gligor, 2011). The previous literature indicates the critical importance of digital supply chains to industrial and commercial companies, but does not pay equal attention to pharmaceutical companies. The literature also indicated organizations strive to achieve efficiency and effectiveness in performance, and to develop appropriate strategies to respond to the organization's current and future fluctuated consumers' needs. The digital transfiguration of supply-chain caused by the concept of "Industry 4.0" is an issue that has been frequently considered theoretically in recent years as mentioned in the following sections.

2.1 Pillars of digital supply-chain

The dramatic increase of operational evolutions and innovations such as "Industry 4.0" are signaling a fundamental new era supply-chain digitalization. A well architected supply-chain model is anchored in four key pillars: sustainability, agility, predictability and traceability, which serve as critical enablers that more and more organizations are striving for as they reinvent their ecosystems. (Bentahar & Angappa, 2020)

Pharmaceutical industrial institutions (PIIs) around the globe have turned their attentions to digitalization because of the substantial advantages it brings to their competitive advantages (Büyüközkan & Göçer, 2018). (PIIs) realized the unlimited benefits of utilizing the four pillars of digital supply-chains processes (Büyüközkan & Göçer, 2018)., namely efficient predictability of consumers purchasing patterns through analytics, and system downtimes through smart-energy management, agility of Pharmaceutical managerial roles and manufacturing processes, sustainability of raw-materials quality, continuity and cost reduction, and finally tractability of provenience of raw-materials, data and ownerships through the value chain and organizational ecosystem. In other words, Pillars of digital supply-chain aim to correlate all supply-chain personnel to collaborate in the organization to enhance efficiency in the supply-chain and

deliver added-value for all associated stakeholders (Susanto, Saribanon, Pahala, Liana, & Purwoko, 2024)

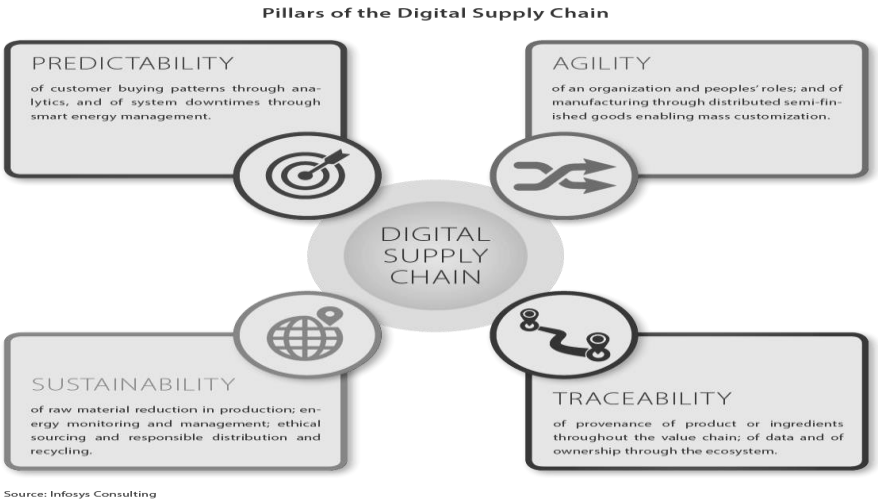

Figure 1: Digital supply chain pillars

Source: Infosys Consulting

2.2 Competitive advantage

Competitive-advantage could be described as anything that a firm is capable of considerably better than its competing rivals, Arsawan, Koval, Rajiani, Rustiarini, Supartha, & Suryantini (2020) defines competitive-advantage (CA) as something that an organization does exceptionally significant in comparison to competitor organizations. Another definition of competitive-advantage, is the organization's capability to manufacture merchandises that fulfill customers' needs at competitive prices and competitive quality compared to rival firms in the market place (Famiyeh, Kwarteng, Asante & Dadzie, 2018). Meanwhile, according to (Sutanto et al., 2024), competitive-advantage is an indication of an organization ability to generate revenues. Organizations that possess a competitive -advantage attempt to own the competences to recognize variations in market environment and select the most efficient marketing strategy. As a consequence, Supply-chain managerial patterns have a direct relation in establishing an Organization's competitive-advantage (Famiyeh et al., 2018).

2.3 Digital supply chain ⟶ Competitive Advantage (Cost)

Digital supply-chain ultimate objective is to enhance the organizations' performance in order to magnify the needed outcome, and deliver the needed value at the minimal feasible cost. (Sutanto & Kodrat, 2020). Many studies have concluded that digital supply chain practices will tremendously reduce cost without affecting the added value and products' quality requirements (Afraza, Bhattia, Ferraris, & Couturier, 2021) and this includes overhead costs, added-value costs. Other studies (Arsawan et al,. 2020) (Chang et al,. 2021) concluded that digital supply chain practices may play a vital role in reducing all costs associated with production and this include all direct and indirect costs, all fixed and variable costs. It is worth noting that some previous studies also confirmed that cost reduction didn't negatively impact product quality (Afraza et al., 2021) (Arsawan et al., 2020) (Chang & Lai, 2021) (Sharabati, 2021) (Sutanto & Kodrat, 2020) (Sutanto et al., 2024) suggests three different types of quality costs, appraisal costs, prevention costs and failure costs. Pharmaceutical industrial institutions (PIIs) pursuit to minimize costs shouldn't -under no circumstances- negatively impact the quality of the pharmaceutical products. Traditionally, organizations elect to minimize costs in a variety of manners such as: minimizing employees compensation rate, using either mass production or just-in-time techniques, stress control on raw materials, minimizing fixed cost or using forward or backward integration strategies, (Arsawan et al., 2020) (Chang & Lai, 2021) (Sharabati, 2021). In this present technological juncture, where digitalization has turned as a unprecedented phenomenon that impacted various business sectors around the globe, digital supply chain (DSC) practices and its four pillars (sustainability, agility, predictability, traceability) are considered an efficient approach used to maximize incorporation between producers, suppliers, warehousing and storing activities, so that manufacturing and distributing of products can be executed in the appropriate quantity, appropriate location, appropriate time , minimized cost, and most importantly guaranteeing service-satisfaction to customers (Sutanto et al., 2024). Consequently, the following hypothesis is constructed:

H1: Digital supply chain pillars (sustainability, agility, predictability, traceability) positively impact cost reduction efforts in (PIIs)

2.4 Digital supply chain ⟶ Competitive advantage (Quality assurance)

Quality assurance is an imperative competitive advantage component to the Pharmaceutical industrial institutions (PIIs) in Palestine and elsewhere. (Sharabati, 2021) described quality as "Fitness for use" where fitness is about the goods and services that satisfy the customers' needs. Attar, Homayounfar & Gilaninia (2016) contend that in order to achieve quality, organization should add distinctive features and attributes to product or services to enhance their competitive position and add value to customers. Few studies have investigated the impact digital supply chain practices on achieving competitive advantage related to quality assurance measures (Famiyeh et al., 2018) Generally, digital supply chain practices enhance quality, delivery, and cost (Tan, Zailani & Shaharudin, 2016). Tan et al. came to a firm conclusion that (DSC) enhances product added value and quality features, and reduces costs. Other authors Waqas, Honggang & Ahmad (2021); Sutanto et al. (2024) concluded that (DSC) improves not only products quality, but also delivery quality, reliability and flexibility qualities, besides reducing production costs. However, other studies concluded that (DSC) practices enhances quality of products, time to market, delivery dependability, and overall operational performance but doesn't minimize the production costs (Famiyeh et al., 2018) (Tan et al., 2019) (Waqas et al., 2021). (Porter, 2019) argues that firms which compete on quality can adopt a differentiation strategy and position their products based on several attributes to satisfy customer needs which might lead to the ability of charging premium price. Apparently, there is a controversy argument about the impact of (DSC) on competitive advantage dimensions. Therefore, the following hypothesis is developed:

H2: Digital supply chain pillars (sustainability, agility, predictability, traceability) positively impact Quality assurance measures in (PIIs)

2.5 Digital supply chain →Competitive advantage (Delivery dependability)

As Pharmaceutical products are being developed, manufactured and produced for and distributed in the Palestinian territories, their raw materials and component parts are increasingly outsourced from international suppliers. Afraza, Bhattia, Ferraris & Couturier (2021); Famiyeh et al. (2018); Tan et al. (2019); Waqas et al. (2021) have argued that (SCD) substantially enhanced communication, transportation and information technology systems. Consequently, Pharmaceutical industrial institutions (PIIs) today can leverage delivery dependability and reliability from suppliers and to distributors anywhere in the world. However, according to (Majeed & Rupasinghe, 2017) these far-flung resources can raise risks and uncertainties in the form of supply chain interruptions from political unrest, natural disasters and even military operations. Predicting and planning for these issues requires local insights enabled by global data and communications networks (Majeed & Rupasinghe, 2017). The authors of this research paper argue that digital supply chain (DSC) practices and its four pillars (sustainability, agility, predictability, traceability) are considered an efficient approach used to optimize integration raw material suppliers, producers and distributors of finished products. Therefore, the following hypothesis is constructed:

H3: Digital supply chain pillars (sustainability, agility, predictability, traceability) positively impact Delivery Dependability in (PIIs)

2.6 Pillars of digital supply chain →Competitive Advantage (Time to market)

Time to market flexibility can be defined as the ability of the processes to switch from one product to another or from one customer to another as soon as feasible at the least cost or impact (Tan et al., 2019). Market flexibility could be defined as the ability to adapt to a changing market environment easily (Sutanto et al., 2020). The competition for marketplace competitive advantage is turning out to be continually aggressive. Many organizations – specifically those in working in Pharmaceutical industrial institutions (PIIs) and other electronic, software and

other technological sectors– are attempting to gain competitive advantage by compacting products renewal-cycles, and shortening products time to market. This is placing greater demand for more proactive forecasting and planning in the supply chain by applying prescriptive and predictive analytics that increase accuracy amidst this rapid change. Tan et al. (2019) The authors of this research paper argue that digital supply chain (DSC) practices and its four pillars (sustainability, agility, predictability, and traceability) are considered an efficient approach used to optimize pharmaceutical products time to market. Consequently, the following hypothesis is constructed:

H4: Digital supply chain pillars (sustainability, agility, predictability, and traceability) positively impact Time to market in (PIIs)

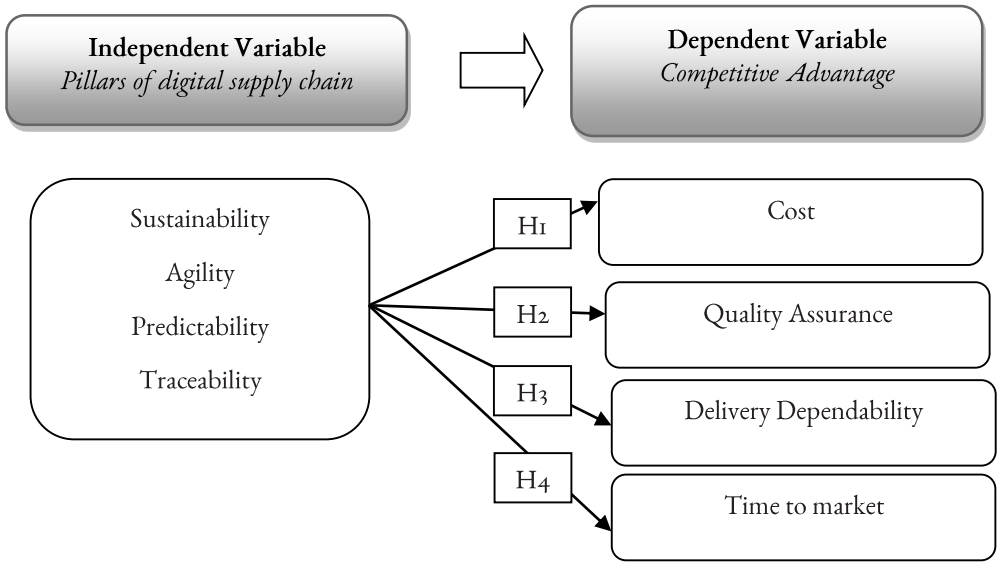

Figure 2: Research Model

3. RESEARCH METHODOLOGY

The research study is considered as a cross-sectional quantitative explanatory study aims to examine the influential relationship between digital supply chain pillars (sustainability, agility, predictability, traceability) and competitive advantage components (cost, Quality assurance, Delivery Dependability, and time to market) in pharmaceutical industrial institutions (PIIs) in Palestine.

Furthermore, it seeks to explore the degree of awareness and perception of digital supply chain's role in achieving competitive advantage in the targeted pharmaceutical industrial institutions (PIIs) in Palestine. A survey strategy was applied thorough a self-administrated questionnaire as the data collection method. The study population consisted of managers, supervisors and production line officials in pharmaceutical companies in Palestine (West Bank), which numbered (5) companies. The data collection tool was distributed to the total sample number of 268. All of them were recovered at 100% survey return rate.

The primary data were collected by questionnaires, which were developed based on previous studies and tailored according to the pharmaceutical industry. All Palestinian pharmaceutical industrial institutions (PIIs) were targeted. Data were collected from different manager levels, and then answers were checked, coded, and registered against SPSS. Two types of data were used to develop the research concept, model, hypothesis, and questionnaire. Secondary data were collected from journal papers, information collected through censuses, scientific research papers, theses, dissertations, and internet searches. Primary data were collected through a self-administrated questionnaire, which was developed based on previous literature with all required adaptations and adjustments to fit the purposes of this research, its dependent and independent variables, and the pharmaceutical industry in Palestine. The questionnaire included three sections: demographic information, independent variables (sustainability, agility, predictability, traceability), and dependent variables (cost, quality assurance, delivery dependability, and time to market).

3.1 Validity and reliability

Multiple validity tests were utilized to check the goodness of the research tool. Content validity was acknowledged with various sources of related literature, while face-validity was demonstrated through a group of two academics and two pharmaceutical industry professionals. Lastly, construct-validity was established by using Cronbach's alpha statistical test as shown in the following tables (1) (2).

Table 1: Cronbach's Alpha: Independent variables

Cronbach's Alpha	Number of Items	Constructs
0.912	7	sustainability
0.895	7	agility
0.924	7	predictability
0.883	7	traceability
0.911	**28**	**Overall**

Table 2: Cronbach's Alpha: dependent variables

Cronbach's Alpha	Number of Items	Constructs
0.924	8	cost reduction
0.873	7	quality assurance
0.916	7	delivery dependability
0.925	8	time to market
0.924	**30**	**Overall**

4. STATISTICAL RESULTS

4.1 HYPOTHESES TESTING

H1: Digital supply chain pillars (sustainability, agility, predictability, traceability) positively impact cost reduction efforts in (PIIs)

Table 3: Multiple Linear Regression for Testing the Impact of Digital Supply Chain on Cost Reduction Efforts in (PIIs)

Sig (t)	t	β Coefficients		Ind. Variables
		Standardized (Beta)	Unstandardized (B)	
.000	12.814	-------	1.593	(Constant)
.000	9.313	.524	.323	Sustainability
.033	2.140	.135	.086	Agility
.131	1.515	.102	.077	Predictability
.016	2.414	.114	.098	Traceability
			.754	R
			.569	R-square
			.562	Adjusted R-square
			86.682	Cal. F
			.000	Sig. (f)

Table (3) indicates the results of multiple linear regressions for testing the impact of digital supply chain pillars on cost reduction efforts in (PIIs). The calculated (Cal.) f value is (86.682) and the adjusted R-square is (0.569) and (Sig. f = 0.000) is ≤ 0.05. This result suggests a statistical impact of digital supply chain pillars

(sustainability, agility, predictability, traceability) on cost reduction efforts as the first dimension of competitive advantage in (PIIs). Based on the results included in the table above, the value of Adjusted R-square expresses the percentage of variation in the dependent variable (cost reduction efforts) that could be referred to the independent variables (sustainability, agility, predictability, traceability). Accordingly, the digital supply chain pillars explain a percentage of 56.9 %.

The (t) statistics tests the linearity significance of each digital supply chain constructs in connection with the dependent variable. Sustainability, agility and traceability indicated a significant linearity in the prediction model. The magnitude of impact of these constructs on the dependent variable demonstrated from Beta(β) coefficient as (0.524), (0.135), and (0.114) respectively, are statistically significant since the related probability values Sig (t) are ≤ 0.05 excluding (Predictability) construct with Sig (t) (0.131) were insignificant. Consequently, the null hypothesis is rejected and the alternative hypothesis is accepted. This demonstrates that " there is a significant impact of digital supply chain pillars (sustainability, agility, traceability) on cost reduction efforts as the first dimension of competitive advantage in (PIIs) at level ($\alpha \leq 0.05$).

H2: *Digital supply chain pillars (sustainability, agility, predictability, traceability) positively impact quality assurance measures in (PIIs)*

Table 4: Multiple Linear Regression for Testing the Impact of Digital Supply Chain on Quality Assurance Measures in (PIIs)

Sig (t)	t	β Coefficients		Ind. Variables
		Standardized (Beta)	Unstandardized (B)	
.000	12.247	-------	1.571	(Constant)
.000	9.393	.529	.336	Sustainability
.114	1.585	.100	.066	Agility
.039	2.075	.140	.109	Predictability
.040	2.066	.098	.086	Traceability
			.753	R
			.568	R-square
			.561	Adjusted R-square
			86.326	Cal. F
			.000	Sig. (f)

Table (4) indicates the results of multiple linear regressions for testing the impact of digital supply chain pillars on quality assurance measures in (PIIs). The calculated (Cal.) f value is (86.326) and the adjusted R-square is (0.561) and (Sig. f = 0.000) is ≤ 0.05. This result suggests a statistical impact of digital supply chain pillars (sustainability, agility, predictability, traceability) on quality assurance measures as the second dimension of competitive advantage in (PIIs). Based on the results included in the table above, the value of adjusted R-square expresses the percentage of variation in the dependent variable (quality assurance) that could be referred to the independent variables (sustainability, agility, predictability, traceability). Accordingly, the digital supply chain pillars explain a percentage of 56.1 %.

The (t) statistics tests the linearity significance of each digital supply chain constructs in connection with the dependent variable. Sustainability, predictability and traceability indicated a significant linearity in the prediction model. The magnitude of impact of these constructs on the dependent variable demonstrated from Beta (β) coefficient as (0.529), (0.140) and (0.098) respectively, are statistically significant since the related probability values Sig (t) are ≤ 0.05 excluding (agility) construct with Sig (t) (0.114) were insignificant. Consequently, the null hypothesis is rejected and the alternative hypothesis is accepted. This demonstrates that " there is a significant impact of digital supply chain pillars (sustainability, agility, traceability) on quality assurance measures as the second dimension of competitive advantage in (PIIs) at level (α ≤ 0.05).

H3: *Digital supply chain pillars (sustainability, agility, predictability, traceability) positively impact Delivery Dependability in (PIIs)*

Table 5: Multiple Linear Regression for Testing the Impact of Digital Supply Chain on Delivery Dependability in (PIIs)

Sig (t)	t	β Coefficients		Ind. Variables
		Standardized (Beta)	Unstandardized (B)	
.000	11.568	-------	1.479	(Constant)
.000	8.382	.476	.299	Sustainability
.015	2.457	.156	.102	Agility
.085	1.726	.118	.091	Predictability
.005	2.825	.134	.118	Traceability

Sig (t)	t	β Coefficients		Ind. Variables
		Standardized (Beta)	Unstandardized (B)	
			.749	R
			.561	R-square
			.555	Adjusted R-square
			84.122	Cal. F
			.000	Sig. (f)

Table (5) indicates the results of multiple linear regressions for testing the impact of digital supply chain pillars on delivery dependability in (PIIs). The calculated (Cal.) f value is (84.122) and the adjusted R-square is (0.561) and (Sig. f = 0.000) is ≤ 0.05. This result suggests a statistical impact of digital supply chain pillars (sustainability, agility, predictability, traceability) on delivery dependability as the first dimension of competitive advantage in (PIIs). Based on the results included in the table above, the value of Adjusted R-square expresses the percentage of variation in the dependent variable (delivery dependability) that could be referred to the independent variables (sustainability, agility, predictability, traceability). Accordingly, the digital supply chain pillars explain a percentage of 56.1%.

The (t) statistics tests the linearity significance of each digital supply chain constructs in connection with the dependent variable. Sustainability, agility and traceability indicated a significant linearity in the prediction model. The magnitude of impact of these constructs on the dependent variable demonstrated from Beta (β) coefficient as (0.476), (0.156), and (0.134) respectively, are statistically significant since the related probability values Sig (t) are ≤ 0.05 excluding (Predictability) construct with Sig (t) (0.085) were insignificant. Consequently, the null hypothesis is rejected and the alternative hypothesis is accepted. This demonstrates that "there is a significant impact of digital supply chain pillars (sustainability, agility, traceability) on delivery dependability as the third dimension of competitive advantage in (PIIs) at level (α ≤ 0.05).

H4: *Digital supply chain pillars (sustainability, agility, predictability, traceability) positively impact time to market in (PIIs)*

Table 6: Multiple Linear Regression for Testing the Impact of Digital Supply Chain On time to market in (PIIs)

Sig (t)	t	β Coefficients		Ind. Variables
		Standardized (Beta)	Unstandardized (B)	
.000	13.794	-------	1.772	(Constant)
.000	9.073	.536	.325	Sustainability
.346	.943	.062	.039	Agility
.046	2.005	.142	.106	Predictability
.101	1.646	.081	.069	Traceability
			.724	R
			.525	R-square
			.517	Adjusted R-square
			72.551	Cal. F
			.000	Sig. (f)

Table (6) indicates the results of multiple linear regressions for testing the impact of digital supply chain pillars time to market in (PIIs). The calculated (Cal.) f value is (72.551) and the adjusted R-square is (0.517) and (Sig. f = 0.000) is ≤ 0.05. This result suggests a statistical impact of digital supply chain pillars (sustainability, agility, predictability, traceability) on time to market as the fourth dimension of competitive advantage in (PIIs). Based on the results included in the table above, the value of Adjusted R-square expresses the percentage of variation in the dependent variable (time to market) that could be referred to the independent variables (sustainability, agility, predictability, traceability). Accordingly, the digital supply chain pillars explain a percentage of 51.7 %.

The (t) statistics tests the linearity significance of each digital supply chain constructs in connection with the dependent variable. Sustainability and Predictability indicated a significant linearity in the prediction model. The magnitude of impact of these constructs on the dependent variable demonstrated from Beta (β) coefficient as (0.536) and (0.142) respectively, are statistically significant since the related probability values Sig (t) are ≤ 0.05. However, this excludes (agility and traceability) constructs with Sig (t) (0.346) and (0.101) respectively, which indicates insignificant impact on dependent variable (time to market). Irrespective of this result, the null hypothesis is rejected and the alternative hypothesis is accepted. This demonstrates that "there is a

significant impact of digital supply chain pillars of (sustainability, and Predictability) on time to market as the fourth dimension of competitive advantage in (PIIs) at level ($\alpha \leq 0.05$)

5. DISCUSSION

It is evident from the previous results that the efforts of the pharmaceutical industrial institutions (PIIs) towards improving the pillars of the supply chain (sustainability, agility, and traceability) can reduce their costs, and accordingly enhance their competitiveness in the Palestinian marketplace characterized as a price stable market. It known that pharmacies charge a fixed price for all pharmaceutical products, and thus and organization's ability to reduce its costs compared to other pharmaceutical companies is considered a competitive advantage that will enhances its competitive position in the market. The statistical results also indicated that there is a minimal impact of "predictability" in reducing cost efforts, as the value of its significance level is (0.131). This indicates that predictability is still facing difficulties in light of the environmental changes and the challenges imposed by Covid-19 pandemic. Furthermore, the pharmaceutical industry is also subject to health and legal considerations related to drug licensing and approval.

Table (4) showed that there is an impact of the digital supply chain pillars model on quality assurance measures, and this indicates that the utilization of digital supply components (sustainability, agility, predictability, traceability) leads to improve the quality of medicine and other pharmaceutical products and services for pharmaceutical companies, and enhance their competitive advantage during this period of time when quality has become a priority objective for all organizations seeking to achieve a competitive advantage. Pharmaceutical industrial institutions (PIIs) are keen to provide pharmaceutical products with a profound quality that matches pharmaceutical standards, and preserve human health. However, results also showed a minimal impact of the dimension of agility on quality assurance measures, as the value of its significance level is (0.114). This indicates that pharmaceutical products should be manufactured in accordance with medical standards set by the governmental agencies. These standards are usually characterized by rigidity, intractability and inflexibility,

particularly with regard to quality measures. This is the opposite of agility principal which indicates that the Pharmaceutical managerial roles and manufacturing processes should be flexible, adaptable and elastic.

The statistical results of table (5) have revealed a statistical impact of digital supply chain pillars (sustainability, agility, traceability) on delivery dependability. This implies that digital supply chain pillars play a central role in enhancing the level of delivery dependability of medical products. This also indicates that the digital supply chain (DSC) practices and its four pillars (sustainability, agility, predictability, and traceability) are considered an efficient approach used to optimize integration raw material suppliers, producers and distributors of finished products. Therefore, (SCD) will substantially enhanced communication, transportation and information technology systems. Consequently, Pharmaceutical industrial institutions (PIIs) in Palestine can leverage delivery dependability and reliability from suppliers and to distributors anywhere in the world. However, results have revealed a minimal impact of predictability on delivery dependability of pharmaceutical products. The reason is that delivery dependability and reliability is usually conducted on solid clear foundations, and not based on prediction or speculations. Another reason is that failure to deliver the requested raw material or finished pharmaceutical products may result in fines and other related penalties.

Table (6) indicates that there is a significant impact of the digital supply chain (DSC) model on time to market in (PIIs), which means that pharmaceutical institutions' competitiveness is subject to digital supply chain considerations, and time to market is essentially determined by the digital supply chain components (sustainability, agility, predictability, traceability). The competition for marketplace competitive advantage is turning out to be continually aggressive. Many organizations – specifically those in working in Pharmaceutical industrial institutions (PIIs) and other electronic, software and other technological sectors – are attempting to gain competitive advantage by compacting products renewal-cycles, and shortening products time to market. This is placing greater demand for more proactive forecasting and planning in the supply chain by applying prescriptive and predictive analytics that increase accuracy amidst

this rapid change. (Tan et al., 2019). As a result, that digital supply chain (DSC) practices, particularly (Sustainability and Predictability) are considered an efficient approach used to optimize pharmaceutical products time to market.

6. CONCLUSION

The study addressed empirical evidence that have not been addressed before in the literature, more especially in the Palestinian pharmaceutical industry. This research paper has many managerial implications. Firstly, adopting the pillars of the supply chain (sustainability, agility, and traceability) in (PIIs) can reduce the costs of the pharmaceutical manufacturing processes and thus reduce the total costs pharmaceutical institutions, which leads to enhance their competitive advantage.

Second; the study concluded that adopting the pillars of digital supply will improve the quality dimension of goods and services for pharmaceutical organizations, and enhances the competitive advantage. Third; there is an impact of the digital supply chain pillars model on delivery dependability and reliability of pharmaceutical product. Adopting (DSC) means enhancing consumers' confidence level, and improving trust of pharmaceutical products.

Finally; statistical results indicated that agility as one of the main components of (DSC) had a minimal impact on quality measures and time to market in (PIIs). The authors argue that this result is exclusively in the pharmaceutical industry, which are characterized by being an industry for few sellers, as well as being subject to a legal system govern drug licensing, manufacturing approvals and quality standards set by the governmental agencies. These standards are usually characterized by rigidity, intractability and inflexibility, particularly with regard to quality measures. This is the opposite of agility principal which indicates that the Pharmaceutical managerial roles and manufacturing processes should be flexible, adaptable and elastic.

7. RECOMMENDATIONS

- Pharmaceutical industrial institutions in the Palestinian territories should prioritize the adoption of advanced digital technologies, such as blockchain for traceability, AI-driven demand forecasting, and IoT for real-time inventory management. These technologies can enhance operational efficiency and reduce vulnerabilities in a region often impacted by logistical challenges.
- Institutions should invest in training and upskilling their workforce to effectively implement and manage digital supply chain systems. This includes educating employees on data analytics, digital tools, and compliance with international standards to improve overall system performance.
- Strengthen partnerships with suppliers, distributors, and healthcare institutions to foster transparency and ensure a steady flow of materials and products. Digital platforms that enable real-time communication and collaboration can mitigate risks caused by disruptions in the supply chain.
- Integrating sustainable practices into the supply chain, such as reducing waste, optimizing energy use, and ensuring eco-friendly sourcing, can improve compliance with global standards and enhance the industry's reputation in international markets.
- Institutions should align their digital supply chain practices with international pharmaceutical regulations such as GMP (Good Manufacturing Practices) and GDP (Good Distribution Practices). This alignment can enhance market access and build trust with global stakeholders.

8. RECOMMENDATIONS FOR FUTURE STUDIES

- The Role of Artificial Intelligence in Optimizing Pharmaceutical Supply Chains: Explore how AI-driven tools, such as machine learning algorithms, can enhance demand forecasting, production planning, and inventory management in pharmaceutical institutions.
- The Impact of Digital Supply Chain Transformation on Customer Satisfaction in the Pharmaceutical Industry: Examine how digital supply chain practices affect end-users, including pharmacies and healthcare providers, in terms of delivery times, reliability, and product quality.

- The Effect of Geopolitical Challenges on Digital Supply Chain Adoption in the Palestinian Territories: Study how unique regional constraints, such as political instability and limited infrastructure, influence the implementation of digital supply chains.
- The Economic Impact of Digital Supply Chain Transformation in the Palestinian Pharmaceutical Industry: Assess the cost-benefit relationship of implementing digital supply chain technologies in the Palestinian pharmaceutical sector.
- Digital Supply Chain Integration with Quality Management Systems in Pharmaceuticals: Analyze how digital technologies align with and improve pharmaceutical quality assurance measures and compliance with international standards.

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سلاسل التوريد الرقمية ودورها في تحقيق الميزة التنافسية: دراسة حالة على مؤسسات الصناعات الدوائية في فلسطين

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ملخص البحث باللغة العربية

تهدف هذه الورقة البحثية إلى التعرف على تأثير ركائز رقمنة سلسلة التوريد، وهي: الاستدامة، والمرونة، والتنبؤية، وإمكانية التتبع، على أبعاد الميزة التنافسية (الموثوقية، الجودة، الابتكار، الوقت والتكلفة) في المؤسسات الصناعية الدوائية في الأراضي الفلسطينية. تصنّف الدراسة البحثية كدراسة تفسيرية كمية مقطعية. اعتمد الباحث استراتيجية المسح باستخدام استبيان كأداة رئيسية لجمع البيانات. تكون مجتمع الدراسة من المديرين والمشرفين ومسؤولي خطوط الإنتاج في شركات الأدوية في فلسطين (الضفة الغربية)، والتي يبلغ عددها (5) شركات. وقد تم توزيع أداة جمع البيانات على العدد الإجمالي للعينة البالغ 268 فردًا.

خلُصت الورقة البحثية إلى العديد من النتائج كان من أهمها: أن تبني ركائز سلسلة التوريد (الاستدامة، التنبؤية، المرونة، وإمكانية التتبع) في المؤسسات الصناعية الدوائية يمكن أن يقلل من تكاليف عمليات التصنيع الدوائي، ويعزز ضمان الجودة، ويحسن الاعتماد على التسليم والوقت اللازم للوصول إلى السوق في إطار الصناعات الدوائية. واستنتجت الدراسة أيضاً أن رقمنة سلسلة التوريد ستوفر للمؤسسات الدوائية درجة عالية من الاستجابة والمرونة، مما يمكنها من تعزيز ميزتها التنافسية وبناء قيمة مستدامة من خلال تقديم أقصى درجات الشفافية والفعالية والكفاءة في تقديم الخدمات للموزعين وتجار التجزئة والمستهلكين النهائيين.

الكلمات الدالة: سلسلة التوريد الرقمية، رقمنة، الميزة التنافسية، صناعة الأدوية.

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