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The Role of Digital Collaboration Network on Pharmaceutical Supply Chain Sustainability in Aswan

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Abstract- The pharmaceutical industry in low-income countries like Egypt is facing challenges due to large inventories of expired medications and improper quantity ordering strategies, which lead to stagnant medications. The convergence of computing and communications has facilitated networking and collaboration, making digital collaboration networking crucial for improving the sustainability of the pharmaceutical supply chain. A study aimed to investigate the role of digital collaboration network on pharmaceutical supply chain sustainability in Aswan, proposing the use of digital communication networks to enhance electronic information sharing. The research findings provide practical implications for installing and activating the digital communication network to improve sustainability by lowering transportation and CO2 emissions, increasing the volume of recycled materials, and reducing pharmaceutical waste returns. The study accepts the statistical hypothesis that there is a positive relationship between the digital collaboration network and pharmaceutical supply chain sustainability and recommends setting regulations to commit pharmacies to place all medicines on the ERP system to prevent commercial fraud and harm to the environment and society.

Keywords- Digital Networking, E-Collaboration, Collaboration Network, Sustainability, Waste, expiry medicine.

I. INTRODUCTION

The World Health Organization (WHO) defines pharmaceutical waste as including drugs, vaccines, and sera that are not needed and should be disposed of properly, as well as outdated, unused, spilled, and infectious pharmaceutical items. The increase in the number of patients and prescriptions has led to a rise in pharmaceutical waste. Misplaced, expired, and unused medications contribute to the issue and lead to shortages and increased disposal expenses. This is a growing global problem that requires a comprehensive solution **Alshemari et al, (2020).** A lack of cooperation between the national supply system and development partners, or specific programs that offer pharmaceuticals as a source, can all hinder efficient stocking and lead to inaccurate projections of future demand also lead to the accumulation of pharmaceutical stocks **Nakyanzi et al, (2010).** Data integration has evolved into a support function to guarantee improved use of digital technology in the healthcare industry. Digitalization surely enhanced the entire process; digital technology aids in tracking the supply of drugs **Paul et al, (2023). Camarinha & Boucher, (2010)** Given that the necessary adjustments transcend the capacity and capabilities of individual players, it is evident that sustainability challenges demand broader collaboration. The multi-stakeholder collaborative approach that needs to be adopted right now undoubtedly benefits greatly from the discipline of collaborative networks. **El Moussaoui et al, (2024)** Digitization and digitalization have significantly changed the distribution process by guaranteeing information accessibility everywhere and at any time. It promotes sustainability by improving the flow of commodities, reducing lead times, and cutting costs. Establishing a digitally-powered distribution network would significantly improve responsiveness. Digital network construction can provide pharmaceutical supply chains a competitive edge by allowing businesses to observe changes in the market more quickly, analyze decisions quickly, take adaptable action, guarantee a secure supply, and use the collaborative power of inter-organizational networks to respond to demand and modify supply chain structure, speed, capacity, delivery, and sustainable development **Ma, J. Y., Shi, L., & Kang, T. W. (2022).** The aim of the study is investigating the role of digital network on pharmaceutical supply chain sustainability in Aswan, to decrease the overstocking drugs generated from unsold or returning with coordination with different parties to mitigate the

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negative environmental damages, aligning with all of new trends in field of healthcare which calls for digitalize this industry to quick walk for sustainability, The last climate conference, COP 27, did not neglect the healthcare sector. Rather, it was among its activities to discuss the outputs of the goals that were set by the Sustainable Market Initiative, The goals stipulated, **(I)** Healthcare supply chain less environmental negative impact, **(II)** digitalization of health care, **(III)** Health care provided to the patient. The 17 SDGs set in the third goals "Ensure Healthy lives and promote well-being for all at all ages which aim to ensure universal access to healthcare for all. Paper will provide insights into how digital collaboration networks can help reducing waste, improve inventory management, and enhance overall sustainability in the pharmaceutical supply chain. The research framework comprises a literature review aimed at elucidating the gap and significance of digital collaboration networks in addressing identified gaps. Subsequently, the study delineates its research objectives, followed by an exposition on the significance of the research endeavor. This is succeeded by an explication of the research methodology, encompassing its approach and procedural intricacies. Finally, the paper culminates in the presentation and discussion of the obtained results.

From the previous, the main research questions

Q1. How much stagnant medicine is in the pharmacies in Aswan**?**
Q2. How can digital collaboration network help pharmaceutical supply chain sustainability in Aswan?

II. RESEARCH METHODOLOGY

The researcher conducted an exploratory study to investigate the drug stagnation problem that could face the pharmaceutical supply chain in Aswan. The researcher designed a survey to extract the reality of this problem. The results prove that the percentage of expired medicine ranges from 1 to 3% annually, before retrieving the permitted part for companies. Descriptive analysis methodology applied in this paper to test the research hypothesis and explain the correlation and regression between network and pharmaceutical supply chain sustainability.

III. DATA COLLECTION

1. Primary data

Researcher designed a questionnaire include 14 statements classified into 5 statements for independent variable & 9 statements for dependent variable with 5-point Likert scale distributed via google forum to 300 pharmacies as a random sample for analyzing output data to conclude the relation between variables.

2. Secondary data

Secondary data in research represented in the literature of the previous studies which support the research objectives and uncover the relations between variables from a positivism point of view.

IV. RESEARCH ANALYSIS

In this section, we will explain the statistical measures used to investigate the impact of digital collaboration networks on pharmaceutical supply chain sustainability in Aswan. It's divided into two main phases: an exploratory study to understand the drug stagnation problem through a survey, and a descriptive analysis focusing on reliability, validity, internal consistency, demographic variables, and correlation between digital collaboration networks and pharmaceutical supply chain sustainability.

Print ISSN 2682-3993
Online ISSN 2682-4000

1. Exploratory Study

1.1 Exploratory study procedures

1.1.1 Literature review related to the research gap (Identifying problem)

Researcher reviewed the previous studies that were carried out by the researchers that have a close relationship with the research problem that have been referred previously in literature related to gap.

1.1.2 Reviewing/Consultation

At this phase of the exploratory study, the opinions of the experts were taken, which classified into (managers of current and former companies and pharmacists) both with a good reputation in addition to a professor in the field of scientific research to judge the questionnaire.

1.1.3 Analysis

A researcher conducted an exploratory study to investigate the issue of expired medicine in pharmacies in Aswan. The study involved collecting data from a questionnaire, with 30 samples, to analyze the extent of the problem. The results indicated that there is a percentage of expired medicine ranging from 1 to 3% annually before retrieval of the permitted part for companies.

2 Statistical Analysis using SPSS

2.1 A statement of the numbers of survey lists distributed and received for the study sample

Table (1) explain the number of distributed questionnaires and the number of valid was obtained which indicates for correct roll response rate.

Lists	The number
Number of distributed questionnaires	300
The obtained lists are valid for analysis	275
The number of incorrect listings	25
Correct roll response rate	92%
non-response rate	8%
Total	100%

2.2 Reliability and Validity

The researcher used to check the reliability coefficient Cronbach Alpha, to measure the stability of the content variables of the study and the results are as the follows:

Table (2) Reliability and Validity

Nu	Variable	Reliability	Validity
#	Digital collaboration network	. 864	. 929

Table (3) Internal consistency by used the coefficient of correlation Pearson

For Statements independent variable (*Digital Collaboration Network*)

#	Digital Collaboration Network	.926**	Less than 0.01

Print ISSN 2682-3993
Online ISSN 2682-4000

Table (4) Internal consistency by used the coefficient of correlation Pearson

For Statements dependent variable (Pharmaceutical Supply chain sustainability)

N	Statements	Pearson Correlation	Sig.
1	Pharmaceutical supply chain sustainability reduces the number of pharmaceutical waste returns.	.519*	Less than 0.05
2	Pharmaceutical supply chain sustainability reduces number of transportation and reduces CO2 emissions.	.726**	Less than 0.01
3	Pharmaceutical supply chain sustainability reduces stagnant stocks that are not delivered to customers.	.818**	Less than 0.01
4	Reverse logistics increases the volume of recycled materials in the pharmaceutical supply chain instead of disposing them**.**	.853**	Less than 0.01
5	Pharmaceutical supply chain sustainability raise the level of customer service provided by the company by solving the problems of "reducing" stagnant inventory.	.617**	Less than 0.01
6	Pharmaceutical supply chain sustainability makes it easier to trace recalls of drugs with safety concerns.	.538*	Less than 0.05
7	Pharmaceutical supply chain sustainability reduces unfulfilled customer demand.	.842**	Less than 0.01
8	Pharmaceutical supply chain sustainability reduces the cost of production losses and stabilize the level of production	.619**	Less than 0.01
9	Reverse logistics helps pharmaceutical companies improve their competitive position	.733**	Less than 0.01

2.3 Descriptive analysis for demographic variables

1- Pharmacy Location: (Kom Ombo/ Edfu/ Aswan)

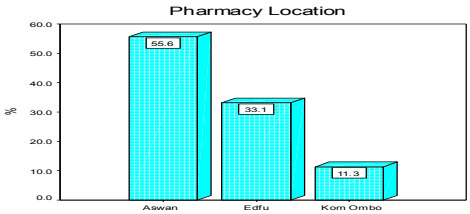

Fig (1) Frequency distribution for pharmacy location

2- Experience years: (less than 5 year/ from 5 less 10 year/ from 10 year +)

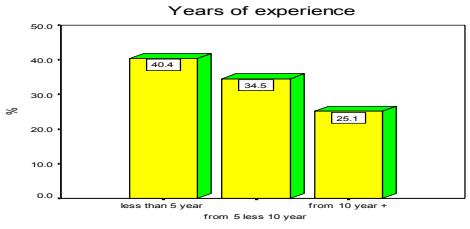

Fig (2) Frequency distribution for experience years

3- Establishment: (year or less /below/from 1 year to 3/ from 3 years to above/more)

Print ISSN 2682-3993
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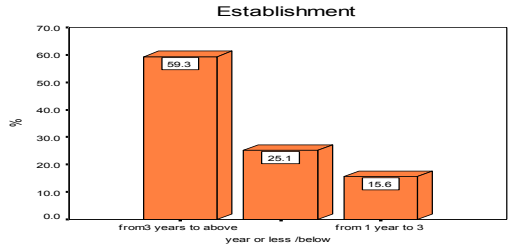

Fig (3) Frequency distribution for establishment

2.4 Descriptive analysis for research variables

Table (5) Descriptive Statistical (Mean, Std. Deviation, Relative importance and rank (Digital collaboration network)

Statements	Mean	Std. Deviation	Relative importance	Rank
1-Digital collaboration network help in transparency to provide high quality services.	3.60	1.12	72	4
2- Digital collaboration network linkage with software, help the participating parties to easily access the required information.	3.77	1.09	75.40	2
3- Digital collaboration network help by exchanging information electronically by transferring unified data between units and branches.	3.66	1.0	73.20	3
4- Digital collaboration network through the electronic exchange of information help to expand the knowledge database of pharmaceutical companies and pharmacies	3.95	1.03	79	1
5-An internal internet network (Intranet) is available within the pharmacy that distributes data to the internal units/departments of the pharmacy.	2.62	1.42	52.40	5
6-An external internet network (Extranet) is available to communicate and distribute information with the parties involved in the pharmaceutical supply chain.	2.04	1.26	40.80	6
Mean Average	**3.54**	**0.84**	**70.80%**	**-**

Table (6) Descriptive Statistical (Mean, Std. Deviation, Relative importance and rank) about the axis (Pharmaceutical supply chain sustainability)

Statements	Mean	Std. Deviation	Relative importance	Rank
7-Pharmaceutical supply chain sustainability reduces the number of pharmaceutical waste returns.	3.66	0.85	73.20	3
8-Pharmaceutical supply chain sustainability reduces number of transportation and reduces CO2 emissions.	3.73	1.33	74.60	1
9-Pharmaceutical supply chain sustainability reduces stagnant stocks that are not delivered to customers.	3.60	1.39	72	4
10-Reverse logistics increases the volume of recycled materials in the pharmaceutical supply chain instead of disposing them**.**	3.72	1.41	47.40	2
11-Pharmaceutical supply chain sustainability raise the level of customer service provided by the company by solving the problems of "reducing" stagnant inventory.	3.55	1.21	71	5
12-Pharmaceutical supply chain sustainability makes it easier to trace	3.17	0.95	63.40	7

Print ISSN 2682-3993
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recalls of drugs with safety concerns.				
13-Pharmaceutical supply chain sustainability reduces unfulfilled customer demand.	3.43	1.16	68.60	6
14-Pharmaceutical supply chain sustainability reduces the cost of production losses and stabilize the level of production	3.05	1.23	61	8
15-Reverse logistics helps pharmaceutical companies improve their competitive position	2.42	1.26	48.40	9
Total: Pharmaceutical supply chain sustainability	**3.37**	**0.69**	**67.42%**	**-**

2.5 Regression & Correlation

Table (7) Effect the digital collaboration network on the Pharmaceutical supply chain sustainability by using simple Liner Regression

Independent variables	β	t. test		F. test		R^2
		Value	Sig.	Value	Sig.	
constant	0.964	12.777	.01**	1086.03	.01*	79.9%
digital collaboration network	0.894	32.955	.01**			

** significant level 0.01

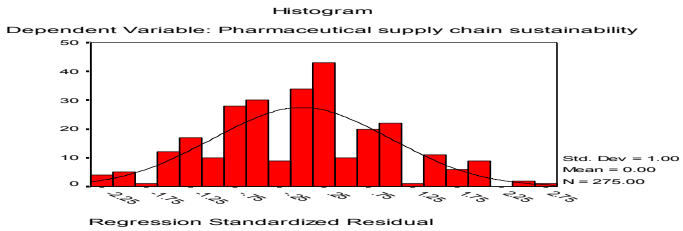

Figure (4) Histogram (Digital collaboration network on the Pharmaceutical supply chain sustainability by using simple Liner Regression)

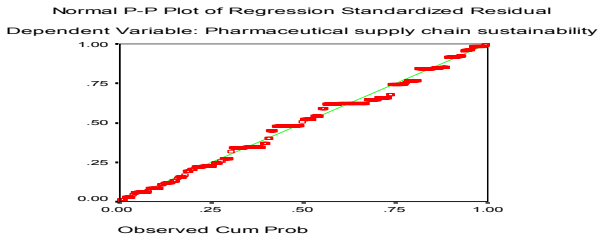

Fig (5) P-Plot (Digital collaboration network on the pharmaceutical supply chain sustainability by using simple Liner Regression)

V. RESULTS OF STATISTICAL ANALYSIS

Referring to the previous statistical analysis we will find the following, **table (4)** shows that the (Digital collaboration network) has a strong stability of the content, with reliability (0.864), validity (.926) which is more than 70% based on alpha Cronbach rule, with person's correlation coefficients less than 0.05 illustrated in **table (5)**. **Table (6)** explained that the (Pharmaceutical supply chain sustainability) statements is strong and moderate, with a person's correlation coefficients ranging from (0.519 to 0.842), at less than 0.05. **Fig (1), (2)& (3)** represented the distribution of demographic variables, There are pharmacies spaced out throughout Kom Ombo, Edfu, and Aswan, as seen by the frequency distribution of pharmacy locations, which shows a balanced spread. Pharmacists' years of experience are primarily classified as "less than 5 years" and "from 5 to less than 10 years," indicating that they are a relatively young workforce with some seasoned experts. According to the establishment data, a considerable proportion of pharmacies have been in operation for "one year or less" and "between one and three years," suggesting a recent trend of

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pharmacy openings. The dynamism and expansion of the pharmacy industry in these areas is demonstrated by the data. All things considered, it points to a developing field with a mix of recent and somewhat seasoned practitioners. **Table (7)** explain the general trend of the study sample for independent variable (Digital collaboration network), indicates that it is towards the (neutral and agreement), with mean of (3.54), and the Std. Deviation (.84), with Relative importance (70.80%). The arithmetic mean ranged from (2.04 to 3.95), the relative importance ranged from (40.80 % to 79%). The most important statements are (Digital collaboration network through the electronic exchange of information help to expand the knowledge database of pharmaceutical companies and pharmacies) with relative importance (79%), the second important statement (Digital collaboration network linkage with software, help the participating parties to easily access the required information) with relative importance (75.40%), The least important statements are (An internal internet network (Intranet) is available within the pharmacy that distributes data to the internal units/departments of the pharmacy) with relative importance (52.40%), (An external internet network (Extranet) is available to communicate and distribute information with the parties involved in the pharmaceutical supply chain) with relative importance (40.80%). **Table (8)** shows the general trend of the study sample in dependent variable (Pharmaceutical supply chain sustainability), indicates that it is towards the (neutral and agreement), with mean of (3.37), and the Std. Deviation (.69), with Relative importance (67.42%). The arithmetic mean ranged from (2.42 to 3.73), The relative importance ranged from (48.40 % to 74.60%). The most important statements are (Pharmaceutical supply chain sustainability reduces number of transportation and reduces CO2 emissions) with relative importance (74.60%), the second important statement is (Reverse logistics increases the volume of recycled materials in the pharmaceutical supply chain instead of disposing them) with relative importance (74.40%), third statement (Pharmaceutical supply chain sustainability reduces the number of pharmaceutical waste returns) with relative importance (73.20%), fourth statement (Pharmaceutical supply chain sustainability reduces stagnant stocks that are not delivered to customers), with relative importance (72 %). The least important statement is (Reverse logistics helps pharmaceutical companies improve their competitive position) with relative importance (48.40%). The dependent variable obtained an overall average total of (3.37) and a significance score of (67.42%), this means neutrality or approval.**Table (9)** illustrate the result of correlation coefficient (r) that there is significant positive relationship between (digital collaboration network) and (Pharmaceutical supply chain sustainability), where the value of correlation coefficient (0.894) at a significant level less than (0.05). Coefficient of determination (R^2) explain that the independent variable (digital collaboration network) explains (79.9%) of the total change in the dependent variable (Pharmaceutical supply chain sustainability), which have a significant significance. Test significant independent variable (t. test) results of the previous table confirmed the existence of a statistically significant impact of (digital collaboration network) on the (Pharmaceutical supply chain sustainability), where the value of (t) equal to (32.955), with a level of significance less than 0.05 . Testing significance of the quality of regression model (F. test) to test significance of the quality of the fit of the model as a whole, was used test (F-test), whereas the value of the F test is (1086.030), which is significant at a level less than (0.05), which indicates the quality of the impact of the regression model on (Pharmaceutical supply chain sustainability), The equation of the regression model is Pharmaceutical supply chain sustainability = .964 + .894 digital collaboration network. Finally we can accept the statistical hypothesis there is relationship between the digital collaboration network and pharmaceutical supply chain sustainability

H1. Digital network can affect pharmaceutical supply chain sustainability in Aswan

The research sample responses respond on the second question of the research **"How can digital collaboration network help pharmaceutical supply chain sustainability in Aswan?** according to the previous results of **table (7)** digital collaboration network can help pharmaceutical supply chain sustainability in field of exchanging and sharing of information, in addition to linkage of digital network with software; help the participating parties to easily access the required information but suffering of infrastructure represented in statements 5 and 6 explained that the connections of internet lead to weak utilization of intranet and extranet reached to hinders communication internally and externally. Results of **table (8)** demonstrating the major advantages for the environment and operations. The top-ranked statement, which shows that sustainability lowers transportation and CO2 emissions, indicates that stakeholders are highly aware of the impact sustainability has on the environment. Reverse logistics' increase in recycled materials shows that the industry is moving toward more environmentally friendly practices, which supports the idea that sustainability initiatives are successfully reducing waste. The decrease in idle inventory also suggests better inventory control, guaranteeing effective product delivery to customers. The research aim was achieved by investigating the role of digital collaboration network on pharmaceutical supply chain sustainability in Aswan, the previous results explained the statistical relation with positive strong relationship with total effect (79.9%) on dependent variable , results also shed the light on the ability if digital collaboration network to exchanging and sharing of information, in addition to linkage of digital network with software will help in participating parties to easily access the required

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Online ISSN 2682-4000

information, and the barriers of implementing digital network represented in lack of internet connections & infrastructure which make a difficulty in activate intranet and extranet to share information to enhance sustainability.

VI. DISCUSSION

A. Similarity

The previous results explained that (Digital collaboration network through the electronic exchange of information help to expand the knowledge database of pharmaceutical companies and pharmacies) which align with **Mehdikhani & Valmohammadi, (2019)** findings that external knowledge sharing has high importance in pharmaceutical supply chain. (Digital collaboration network linkage with software, help the participating parties to easily access the required information) ensured **Rizzi et al, (2013)** in the nine factors of sustainability in collaborative networks especially in element (6) "The more decentralized the nodes of the structure, the greater the net benefit of openness to collaboration" and element (8) "The more embedded the IT in EPR-oriented organizations, the greater the net benefit of high levels of openness to collaboration". (An internal internet network (Intranet) is available within the pharmacy that distributes data to the internal units/departments of the pharmacy) , (An external internet network (Extranet) is available to communicate and distribute information with the parties involved in the pharmaceutical supply chain) support **Hai & Thi Tuyet, (2021)** point of view in digital network is still limited at low level of online processing and we must build a digital network infrastructure to go towards digital transformation. (Pharmaceutical supply chain sustainability reduces number of transportation and reduces CO2 emissions result totally correspondence with **El Moussaoui & El Andaloussi, (2024)** conclusion that electronic exchange practices should aid in confirming the effects of these practices on the environment (transport reduction). (Reverse logistics increases the volume of recycled materials in the pharmaceutical supply chain instead of disposing them) result somewhat similar with **Tat & Heydari, (2021)** that coordination and collaboration can utilize the stagnant instead of disposing with supply it in secondary market. (Pharmaceutical supply chain sustainability reduces the number of pharmaceutical waste returns) and (Pharmaceutical supply chain sustainability reduces stagnant stocks that are not delivered totally similar to **Nematollahi & Hosseini-Motlagh, (2022)** in decentralized collaborative model outcomes support the ability to returned the unsold drugs or not necessarily which effect on environmental and economic aspects. The dependent variable obtained an average total of (3.37) and a significance score of (67.42%). This means neutrality or approval. The reason is sustainability for the pharmaceutical sector in Egypt, specifically in Upper Egypt is a new matter. Current research discuss **Camarinha-Matos & Boucher, (2010)** recommendation about "collaborative network can support solving problem for sustainability issues, to enhance sustainability in pharmaceutical industry in upper egypt. Results also similar to a graph represented in **Ma, J. Y & Kang, (2022)** research which explain that Middle east and Africa is the lowest Healthcare spending.

B. Contrasting

(Reverse logistics helps pharmaceutical companies improve their competitive position) result contrasted with **Alsaad & AlJedaiah, (2018)** in conclusion of information sharing can help pharmaceutical companies in Jordan achieve their competitive priorities. (Digital collaboration network through the electronic exchange of information help to expand the knowledge database of pharmaceutical companies and pharmacies) with high importance and Digital collaboration network help in transparency to provide high quality services moderate importance contrasted with **Ma, J. Y & Kang, (2022), Alsaad & AlJedaiah, (2018)** ***(El Moussaoui & El Andaloussi, 2024; Nematollahi & Lucas, 2018).*** in un significance of information sharing and significance of transparency.

VII. LIMITATIONS

1. Location**:** Pharmacies located in Aswan
2. Time horizon: Study will be from May 2024 to May 2025.
3. Language fluency: Survey translated into Arabic to meet the nature of study location in upper Egypt and also the non-specialization of pharmacies with supply chain and sustainability terminologies may be affect the accuracy and consistency of data.

Print ISSN 2682-3993
Online ISSN 2682-4000

VIII. CONCLUSION

According to exploratory study, the results ensured the gap that was mentioned in literature related to gap ***Alkhouri, M. (2024), Papalexi & Breen, (2020) Abbas & Farooquie, (2018), Kamba et al, (2017)*** and answered the first research question **"How much stagnant medicine is in the pharmacies in Aswan?.** Descriptive analysis approach by using survey can answer the second research question **"How can digital collaboration network help pharmaceutical supply chain sustainability in Aswan?"** explained that digital collaboration network with electronic exchange of information which help in expanding the knowledge database of pharmaceutical companies and pharmacies, helping the participating parties to easily access the required information can lead pharmaceutical supply chain in Aswan to sustainability by reducing number of transportation and reduces CO2 emissions, increasing the volume of recycled materials in the pharmaceutical supply chain instead of disposing them, and reducing the number of pharmaceutical waste returns. Finally, we accept the statistical hypothesis there is a positive relationship between the digital collaboration network and pharmaceutical supply chain sustainability. The significance of conclusion represented in, by addressing these problems, the pharmaceutical supply chain's costs can be decreased, the environment can be improved, and patient care can be improved by optimizing stock levels, cutting waste, and ensuring timely medicine availability. Safer pharmaceutical practices can be ensured by implementing efficient waste management procedures and reevaluating outdated prescriptions. These actions can reduce environmental concerns and stop the spread of counterfeit drugs. Improving stakeholder coordination and communication can increase visibility, expedite procedures, and help with improved decision-making, resulting in a pharmaceutical supply chain that is more dependable and efficient. Reverse logistics systems that are well-built can decrease waste, maximize the use of resources, and boost customer satisfaction and confidence.

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