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Digital Platforms and Supply Chain Traceability for Robust Information and Effective Inventory Management: The Mediating Role of Transparency

Muhammad Khan [1,*], Amal Nasser Alshahrani [2] and Julija Jacquemod [3]

[1] Institute of Business Studies and Leadership, Abdul Wali Khan University Mardan, Mardan 23200, KP, Pakistan
[2] Ministry of Education, School 239, Riyadh 11153, Saudi Arabia
[3] Department of Business, RISEBA University, LV-1048 Riga, Latvia
* Correspondence: muhammadkhan@awkum.edu.pk

Abstract: *Background:* This article's main goal is to examine how digital platforms and supply chain traceability (SCT) might contribute to robust information and efficient inventory management (EIM); *Methods:* SmartPLS3 software was used in conjunction with the partial least squares structural equation modeling (PSL-SEM) technique. Using the snowball sampling method, the software was used to collect data from Pakistani supply chain (SC) specialists; *Results:* According to this study's conclusions, robust information and inventory management using digital platforms and SC traceability depend greatly on transparency; *Conclusions:* Even though investing in digital platforms is a complex process including multiple internal and external parties, this study will be helpful for the decision-makers who make such decisions. The paper identifies research gaps and presents the potential for more research while also increasing awareness of digital platforms, traceability, and transparency in the SC system. There is a shortage of empirical evidence on how digital platforms and SCT lead to robust information and EIM through the mediation association of transparency, notwithstanding the abundance of research conducted on SCT and transparency.

Keywords: digital platforms; supply chain; traceability; transparency; robust information; effective inventory management

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1. Introduction

The current global financial turmoil is having a profound impact on how the world economy is growing, posing hitherto unheardof challenges. It is important and urgent to set up a fully transparent and trustworthy SC platform free from the influence of organizations or people. The conventional SC mode no longer adjusts to society's rapid progress due to lack of confidence between parties [1]. Similarly to this, both scholars and practitioners have afforded SC transparency, robust information, and inventory management a lot of attention. Businesses are put under pressure to be transparent due to the mix of cutting-edge technology and dynamic surroundings. This transparency can only be achieved by implementing digital platforms and SCT [2,3]. Due to the present digital and knowledge-based economy, classical SCs may evolve into modern SCs [4–6]. Organizational survival is difficult, though, due to the complexity brought on by e-commerce growth and technological dynamism [5]. Because of their significant influence on SC's high-performing organizations, strong information and the EIM cannot be ignored even in such difficult conditions [7]. As a result, maintaining accurate information and managing inventories pose real difficulties for all businesses, particularly those in SCs [8]. Although business model changes offer excellent chances for the development of digital platforms and the success of robust information by utilizing their existing e-commerce resources [7,9], they also pose certain risks.

SC transparency is always developing with the wave of internet technology. Because of the need tomaintain these conventional paper trading records for transparency, robust information and EIM incur a tremendous waste of time and resources [1]. The effort and difficulty of activities will be reduced, however, and this will further support the realization of procedural management and cost control [1,10,11]. Participants in the SC (such as producers, suppliers, transporters, warehouse buyers, terminal purchasers, funding sources, etc.) have had little peer-to-peer interaction with their issues in a conventional environment [12]. The concept of "trust" is among the major barriers to information communication. On the other hand, openness is a means of building trust in businesses [13]. Moreover, there are significant dangers of fraud when dealing with warehouse receipts, contracts, and debit notes. In reality, tampering with a record is simple in a centralized information system [14]. Moreover, efficient custody is expensive and it might be challenging to confirm the legitimacy of an invoice or receivable [1]. Digital platforms, on the other hand, provide safe verification of the circulation of logistics and information within a SC network and promise sincerity [15,16]. Applications for them in SC sectors are fast developing as a result of the development of digital platforms [16]. In order to provide shareholder transparency, provide reliable information, enable enterprise information management, and ultimately lower organizational finance costs, this article builds a digital platform-driven SC [1].

For both organizations and customers, complete transparency with full information is essential. As an example, undesired contamination of the cold chain, such as the poisoning of food, has the potential to harm consumers' short- and long-term health. To protect service quality, brand reputation, and consumer confidence early on in the cold chain, it is crucial to identify and recall possibly contaminated products. On these topics, the SCT literature has mostly remained unrestricted. The SC does not, however, have a plan for putting in place digital platforms that would make the SC transparent and provide reliable data as well as efficiency in inventory management.

In the prevailing discussion, two questions are raised: where does this study fit and what does this study add value to the current literature on digital platforms and traceability? In response to both inquiries, (i) this study builds on those studies, aiming to displaythe application of trackability as a means of gaining a competitive edge; and (ii) we investigate robust information and EIM and Pakistan, which, to our knowledge, has not been examined in the traceability literature. This knowledge gap suggests the following study question: how can a transparency process based on digital platforms and traceability lead to robust information and ineffective inventory management in the SC? This research aims to explore digital platforms and traceability to augment the transparency of SC processes for robust information and inventory management. The study objectives are: (1) exploring how digital platforms and traceability affect SC transparency;(2) studying the effect of transparency on robust information and inventory management; and (3) setting up the proposed framework of digital platforms of transparency and assessingthe potential effects of this framework on robust information and inventory management. To achieve these objectives, SmartPLS3 software was applied for PLS-SEM. Using surveys from Pakistani firms, this study develops hypotheses and statistically assesses the conceptual framework. Theoretical, practical, and societal ramifications are highlighted in this work. This paper's structure is as follows:First, a theoretical model and hypotheses development is offered. Following this, the methodology and their analyses are developed. A discussion section then proposes the possible implications arising from the research. Finally, conclusions are drawn from the modeling analysis and the discussion.

2. Theoretical Model and Hypotheses Development

Supply chain (SC) inventory management optimizes the flow of raw materials to finished products [17,18]. Product SC involves manufacturers, vendues, wholesalers, importers, exporters, retailers, specialist outlets, and service providers. Handling, conditioned storage, packaging, shipping, and trade are the primary procedures, with the original product's essential properties remaining unchanged. SC processing begins with raw mate-

rials, ultimately resulting in higher-value processed consumer items [19]. A high level of communication is essential because a large number of different stakeholders need to work together in order to achieve the common goal of added value [20]. This is in addition to the physical flow of resources that is required for activities such as production, distribution, and transportation. Due to of the rise of process automation, business procedures have evolved away from relying on manual communication and instead make use of electronic platforms [21].

Digital platforms are essential for businesses to stay solvent in the face of technological and environmental challenges [22]. Digital platforms are technologies that are used by companies to enable them to control, deliver, and manage data on a scale that was previously unattainable [23]. Digital platforms help change the way that companies achieve a competitive edge [24]. Digital platforms help organizations come up with new ways to perform tasks by affording them access to useful information [25]. This makes it possible for new ideas to improve a company's products or services by aligning its goods and services strategically with the core of what it does [26]. Many effects of digital platforms have been emphasized in the literature, including corporate economic output [27], the capacity of the network [22], customer value generation [28], as well as the capacity for improvising, and the readiness of the organization [29].

However, the most thrillingresult of digital platforms in relationshipsbetween traceability and transparency has been ignoreduntil now [29]. This study seeks to quantify digital platforms as a valuable asset that facilitates a company to achieve tremendous success in the SC process, as transparency is facilitated by the free flow of information [2]. Despite increasedinvestigation on transparency, the term has yet to be completelyexplained.Transparency, according to Park and Blenkinsopp [30], is the external dissemination of genuine, inside organizational information. Similarly, Parris et al. [31] remarked that transparency is important for acquiring improvements as well as displaying a company's positive characteristics. This suggests that maintaining, improving, and creating distributed communications and stakeholder interactions are all part of transparency. According to a previous study [32], the greatest hurdle to coordination across HL parties is a lack of clear and reliable information among stakeholders. Transparency is defined as providing useful information in a timely manner that is devoid of discrimination, expense, or delay [3]. Traceability can be used to achieve transparency in the SC [4].

Traceability refers to the ability to track a product's progress throughout the SC [33]. The definition comprises three importantcomponents: product tracing (forwardand backward follow-up), product record, data associated with producing motion in the SC, andaftersales service (backward and forward). The information shows how many production sections and where incorrect materials introduced into the SC at any one movement affect production. Technologies for recall management and tracking can make global SC more valuable and safe [33]. According to previous research [34], construction's advantages might be impacted by a well-managed SC. The SC is a significant factor in the world economy [35], providing enormous benefits [36] and immense advantages to peoplefrom all backgrounds [37].

The majority of the studies already conducted have focused on either technological or SC transparency-related issues. Only a few studies [21,38] have examined digitalization and transparency combined with the humanitarian logistics field. Nevertheless, no study is found in the SC context for the implementation of digital platforms for transparency and EIM. In light of the particularelementsdiscussed, five digital platform variables [7,39], SCT, robust information, EIM [21], and supply chain transparency [38,40] areassessed as performing an essential role in the field of SCs (Figure 1). These five variables are distinguishedand important in the SCfield. In order to encourage their practitioners to embrace these practices, academics and practitioners must develop their policies about acts aimed at advancing these concepts. Similarly, ourinvestigation aims to draw a framework to discover the effect of digital platforms on SC traceability and transparency. Thisresearchevaluates the mediating impact of transparency on the linking of digital platforms and robust infor-

mation and inventory management. The presentresearch also assesses the direct impact of digital platforms and SC traceability on robust information and EIM.

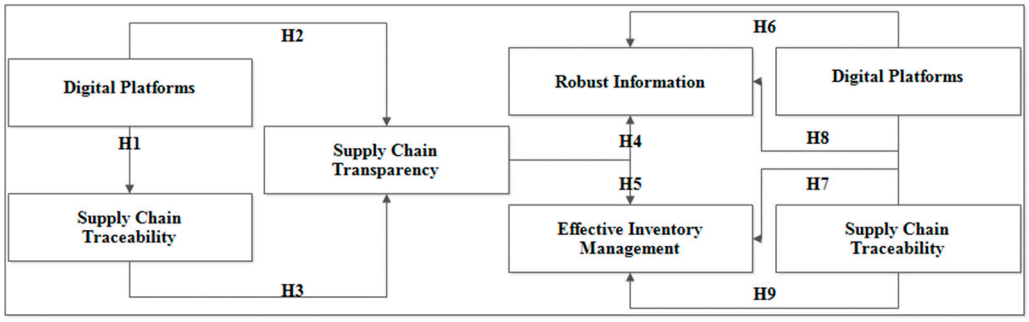

Figure 1. The study's framework. Note: H = Hypothesis.

2.1. Digital Platforms and Supply Chain Traceability

One of the most important elements to consider while developing a distribution network is the degree of order visibility. Using a digitally based traceability system, end consumers can view the entire history of the product. Reference [41] developed and implemented a technology-based traceability solution to manage the agri-food SC. The International Business Machines Corporation and Walmart recently worked together to investigate the outcomes of technology-based traceability. A technology-based traceability solution based on Hyperledger Fabric was able to determine the origin of mangoes in just 2.2 s, which is a significant improvement over the standard requirement of seven days [42]. References [43,44] suggested a new methodology for judging the authenticity of wine.

Live broadcasting using digital platforms is a new method of trade that allows for rapid product sales and customer interaction [45]. Similar to physical platforms, digital platforms address a range of concerns, including composition, service discovery [46], connectivity, and monitoring and controlling object behavior [47]. Similar to this, greater levels of business transparency and traceability make new income sources available, revolutionizing the SC through the use of digital platforms [48]. Conventional tracking techniques, consisting ofrecurring barcode scanning and checkpoints, merely offer segmented information that is inadequate. Digital platforms haveoffered SCT thoroughknowledge that was not possible with outdated technology.

A system that is centralized across digital platforms, on the other hand, lacks transparency and trust [49]. The centralized traceability system was characterized in a previous stuy [50] as a strong, asymmetric, and dominant information system. This may lead to issues such as information fraud and corruption. Moreover, problems such as single points of failure can suddenly make it impossible for centralized systems to function. In opposition, authors of [44] stated that the major purpose of the suggested digital platform traceability solutions for product SC is to prevent dangers. Simply put, digital platform traceability solutions can improve SC efficiency, robustness, and sustainability. Hence, digital platforms can be understood as a collection of public records that is unchangeable, permanent, and searchable in its entirety. Because of SCT's distinctiveness, no systematic or theoretical framework incorporates these perspectives. We are motivated to research this matter. Thus, we hypothesize—H1.

Hypothesis (H1). *Digital platforms and SCT have a positive relationship.*

2.2. Digital Platforms and Supply Chain Transparency

Many game-changing technologies are transforming how SC operations are carried out daily, increasing productivity and improving corporate success [51]. Platforms can be seen as gradually displacing traditional SCs in favor of modern ones [52]. Social media, mobile networks, and e-commerce help consumers make more informed purchases. Fortunately,

these same cutting-edge technologies are also transforming traditional SC networks into digital systems that improve transparency, collaboration, efficiency, and reaction times [48].

Transparency technologies are essential for SC stakeholder information coordination and sharing [53]. Several platform features are necessary for rapid information flow during SC [54], for example, by putting in place a warehouse management system and a radio frequency identification system, monitoring the status of orders, and developing an efficient distribution mechanism [55]. The SC relies on good communication between decision-makers and operational reaction teams/field workers [56]. Reference [57], says that systemic information vulnerabilities are caused by irregular internet connectivity, poor tools, a lack of skilled people, and a lack of SC-capable software. Reference [58] contends that a dearth of appropriate digital platform systems forces partners to exert more effort than is necessary and communicate information ineffectively. Inadequate digital platform systems can lead to costly errors and ineffective time management, which can also hinder customer–management relations [58,59].

Information interchange plays a crucial role in SC performance in the present big data era [60]. The procedure has been improved by modern technologies [61], and the internet reveals the extent of transparency in any institution [62]. All SC processes may easily be monitored and controlled because the IoT makes information available online [63]. Sharing information during the SC process improves performance thanks to IT [64]. Blockchain technology has been embraced by businesses and government organizations recently, making the logistics system impenetrable and incredibly transparent [65]. We propose the following hypothesis because one could argue that the increased access to information provided by digital platforms increases transparency [40]—H2.

Hypothesis (H2). *The SC process is transparent if there are digital platforms.*

2.3. Supply Chain Traceability and Transparency

Traceability is the capacity of information to be tracked and traced. Traceability tracks a product's SC journey [33]. Traceability systems have been put into place all over the world as a result of governmental, societal, and economic considerations, as well as concern for the health and welfare of their consumers. Traceability is, more particularly, the what, how, where, why, and when characteristics of the underlying product along a SC [66]. The terms "traceability" and "tracking" are intimately connected [67–69]. The tracking of a product starts at the manufacturing facility and goes all the way to the retail location. Most tracing occurs on the route from the endpoint to the origin.Reference [70] explains that SC entries allow tracing. Transparency, on the other hand, is conducive to information flow [30]. To be transparent, one must provide timely, accurate, and impartial information without charge, hindrance, or discrimination [31]. Transparency is, in general, the open flow of information [30]. Traceability can be used to increase transparency in the SC [71]. Production alliances, which involve several companies at regional manufacturing facilities, require several logistical activities. Communication is needed to achieve the goal of added value and manage the flow of resources for procurement, production, distribution, and transport. The process of transparency has been improved by technology [61] and the internet displays any business' level of transparency [62]. According to Parris et al., 2016 [31], an organization that is always transparent internally shares information throughout the logistical team from the top down and bottom up to generate confidence, engage logisticians in their job, formulate and implement strategies, and increase performance.

According to authors of [44], transparency is made possible via traceability using tracking and tracing. By establishing an information trail and empowering enterprises for effective resource management through the implementation of new traceability data systems, traceability contributes to the improvement of SCM efficiency [71]. By integrating traceability, organizations can increase transparency as a critical input, which can lead to consumers feeling more satisfied since they perceive safer products [69]. As a result, it

might be stated that traceability acts as a mediator between developing technologies and SC transparency, which is the hypothesis of the current study.

Hypothesis (H3). *Transparency results from traceability.*

2.4. Transparency and Robust Information

SC topics can aid in proper participation and information exchange throughout the process, which directly affects information sharing. The bullwhip effect is a problem in SCs caused by withholding information, whereas sharing knowledge might result in SC sustainability. The SC moreover significantly affects performance and boosts economic growth [72], and information exchange can promote SC sustainability. Additionally, the SC has a substantialinfluence on performance and contributes to economic prosperity [73]. Similar to a previous study [74], this study contends that an organization's capacity for information sharing becomes crucial for performance [75]. For an organization to function well, both internal and external information is required [76]. By ensuring the sustainability of the SC process, organizations implement management strategies with the stated goal of enhancing their information capabilities in order to tackle issues brought on by an excessively uncertain environment.

Transparency solves issues such as lack of knowledge and confusion, which aids HL in making better decisions. When there is a lack of openness, bribery can be concealed more easily. Information costs increase when there is a lack of transparency [64]. Because there are so many diverse stakeholders involved in the process, information management is essential for SC sustainability [77]. Using technology promotes transparency and more reliable information. The following theory is put forth in this study:

Hypothesis (H4). *Transparency acts as a mediator in the interaction between technology and reliable SC information.*

2.5. Transparency and Effective Inventory Management

Any effective and efficient organization must have effective inventory control. The main objective of inventory management is to strike a balance between the competing economic interests of holding neither too little nor excessive stock. A "Golden equilibrium" is important in two ways: first, it prevents the organization from tying up idle capital and paying exorbitant storage, spoilage, theft, and obsolescence costs; and second, it prevents the expense of failing to satisfy client demands. A list of the products that a company keeps in stock or that are listed on its asset registry is referred to as inventory [78]. EIM improves SC efficiency. Warehouses in the SC choose the ideal location to preposition inventory. In EIM, the primary determinants—such as price, reaction time, local security, etc.—are regarded as crucial [13]. Among other things, a good storage system and prepositioned goods are taken into account to increase SC sustainability [79]. EIM is hindered by a lack of knowledge and insufficient SC integration.

A flexible and open inventory management system is necessary for an effective and efficient SC. The SC process of storing, tracking, distributing, and monitoring may be more significantly impacted by current technological advancements and the spread of information technology. The major objective of this part is to use technology in the management of inventory and other incoming logistics. Inventory transparency among the SC's actors may be made possible by usinga combination of these technologies. Because of this, introducing digital platforms into relief supplies provides the required inventory and logistic transparency, enabling improved sustainability. Thus, we suggest H5.

Hypothesis (H5). *The interaction between digital platforms and EIM is mediated by transparency in the SC process.*

2.6. Digital Platforms and Robust Information

For a very long time, technology has been a key facilitator in company operations [80]. Reference [81] recognizes information generation, information management, and information application as the three main building blocks of technology. Information gathering is carried out to increase transparency; information management refers to managing and analyzing it; and information utilization is performed to plan, carry out, and analyze tasks. According to a global assessment of the United Nations' disaster management initiatives, using information, technology, and real-world case studies may be the key to managing a SC. As a result, numerous initiatives have been started to implement digital platforms in SCs. Technological integration with industry 4.0 has recently been noted as a potential solution to SC problems [56] relating to robust information.Academics and practitioners agree that the only way to ensure that the SC is transparent is to establish digital platforms that can track the movement of data and resources from their origin to their final destination and can identify the movements within the system [82]. Sharing knowledge on digital media improves performance in SCs [64]. Since organizations have started using technology, the logistics system has become impenetrable and incredibly transparent [65]. Because of this, it may be argued that digitization can enhance robust information [40], and as a result, we propose the following theory—H6.

Hypothesis (H6). *If there are digital platforms, the SC process will have robust information.*

2.7. Digital Platforms and Effective Inventory Management

Digital platforms in inventory management are a tool for increasing productivity and lowering costs. While some supermarkets have utilized digital platforms to control inventories, others have not been as successful [38]. SC management places a strong emphasis on the chain's long-term success through collaboration and information sharing [39]. This demonstrates the critical role that technologies play in SC, which is mostly driven by variable ordering. Studies on the impact of technologies on SC and interorganizational connections are becoming more prevalent [78]. Technology seems to play a significant role in cooperative partnerships. A widespread misunderstanding is that technology may help suppliers absorb information, strengthening connections and reducing uncertainty. Technology removes the human element from buyer–supplier interactions, cutting transaction costs and creating a more relational/cooperative governance structure [78]. Trust is founded on human connections. It strengthens buyer–supplier ties and weakens trust-based interorganizational alliances. We suggest H7.

Hypothesis (H7). *Digital platforms and EIM have a beneficial association.*

2.8. Supply Chain Traceability and Robust information

Organizations implement management procedures with the stated purpose of increasing their information capacities to handle challenges generated by offeringperformance to the SC process. Transparency facilitates SCsto make better decisions by eliminating problems such asthe absence of information and uncertainty. When there is a lack of transparency, bribery can be concealed more easily. Information costs increase when there is a lack of transparency [64]. SC sustainability depends on information management owing to the many stakeholders [77]. Traceability is the capacity of information to be tracked and traced. Traceability systems have been put into place all over the world as a result of governmental, societal, and economic considerations, as well as an interest in product safety and quality. Traceability can be used to increase transparency in the SC [71]. SC scenarios lack accurate data. Authors have proposed formulations to enable SCs with limited knowledge, introducing traceability using technology that may lead to robust information. The following hypothesis is put forth in this study—H8.

Hypothesis (H8). *Robust information in the supply chain may be produced by implementing traceability.*

2.9. Supply Chain Traceability and Effective Inventory Management

Regarding traceability as aninstrument for distinction, authors of [83], for instance, list five ways in which a company might benefit from traceability's competitive benefits.First, as a means of resolving any product safety issues and as evidence that quality control procedures safeguard consumers both before and after the sale of goods. Second, as a means of providing a business a good-faith legal argument in numerous product liability lawsuits. Thirdly, traceability might help manufacturers better understand their distribution networks. Fourthly, the company may be able to stay in touch with its customers thanks to a traceability system. Last but not least, traceability systems might support laboratory quality checks because research from test programs and field usage studies can help create long-term improvements to products. There are expenses associated with setting up and sustaining a traceability system for the authors, but those prices can seem reasonable in comparison to, say, the expense of sending back defective products that were previously sold on the market. A recent work [84] showshow traceability supports the degree of supply chain coordination.

A computerized traceability system is the best approach to constantly be aware of what is occurring throughout the entire supply chain, proving that tracking systems need not be seen from a narrow perspective. In actuality, traceability functions like a system of blood circulation for this company. Despite some initial resistance, the traceability system's deployment has been a huge success: the company's supply, warehousing, inventory, and production have all significantly improved both qualitatively and quantitatively. The initial expenditure was returned in less than two years. So, it may be argued that the SC process's use of traceability has a long-lasting, searchable, and eventually irreversible impact on inventory control. Thus, the following theory is put forth—H9.

Hypothesis (H9). *Traceability affects inventory management favorably.*

3. Research Design and Methodology

3.1. Population and Sampling

This studyfollows the methods of a quantitative research approach, as it statistically evaluates the mediating role of SC transparency between digital platforms and traceability and robust information and EIM. The empirical research approach aids in quantifying viewpoints and offering statistical evidence for the relative significance of various variables. Primary data were collected from Pakistani SC professionals who were part of the study's population using an online questionnaire that was uploaded to Google Drive in order to evaluate the consistency, authenticity, goodness of fit, and psychometric soundness of the study framework. As there was no sampling frame and it was unclear how many people were in the whole population, a nonprobability method known as snowball sampling was adopted. The authors first asked their contacts to complete the survey, forward details about other potential responders, or share the URL with their friends and colleagues across the country. The sample size was set by the suggestions in Reference [85], and the sample size was selected. Reference [85] suggested that a respondent-to-indicator ratio of 10:1 be used for multivariate research. The current article contains5hiddenvariables and 33visible variables (see Figure 2). Consequently, the lowest sample size for the current research should be 330 = 10 × 33.

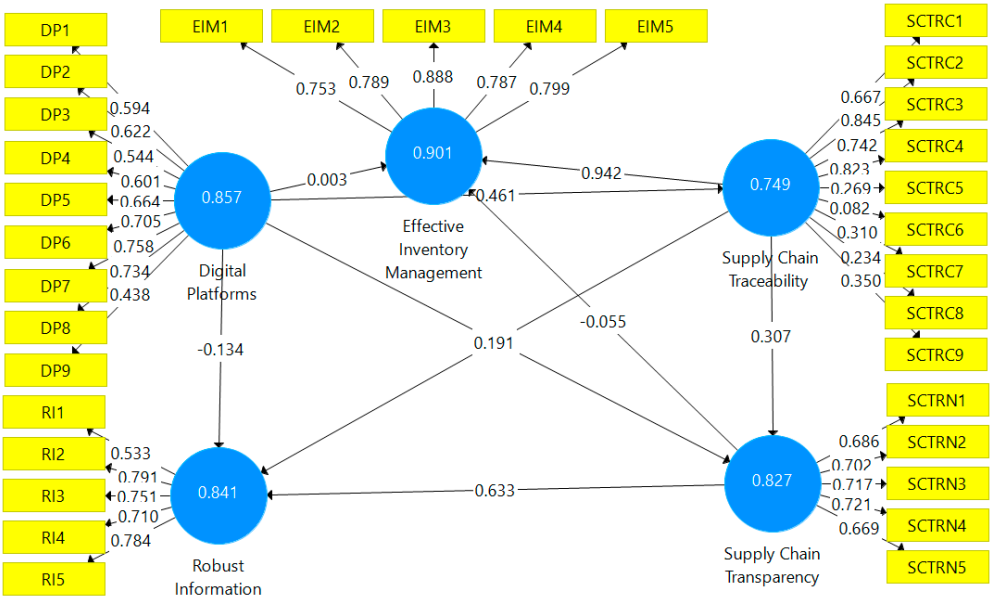

Figure 2. Composite reliability's values. Note: DP = digital platforms; SCTRC = supply chain traceability; SCTRN = supply chain transparency; EIM = effective inventory management; RI = robust information.

3.2. Questionnaire Development and Data Collection

This studyfolloweda previous study [86] on how to develop and confirm the questionnaire. To put the research framework into practice, the scale was developed from the relevant available literature. The measurement scale for digital platforms was adapted from Reference [40], SCT was adapted from Reference [38], SC transparency was revised from References [13,38], whereas the scale for robust information and EIM was adapted from Reference [38]. Respondents assessed thirty-three items on a Likert scale from 1 to 5. The indicators were created employing the English language and built using latest research. The situation required minor changes. After writing the questionnaire, subject experts—professors and managers—reviewed it. In response to their feedback, the questionnaire was revised to represent the mediation link of SC transparency between digital platforms and SCT, robust information, and EIM. After the results of a pilot study, the questionnaire that would be used for data collection was modified.

Professional input and pilot test results supported the questionnaire for data collection. To ensure privacy, the questionnaire did not request personal data from responders. September 2022–February 2023 was the survey period. Respondents were contacted using a variety of social media platforms, including but not limited to email, Facebook, WhatsApp, LinkedIn, and others. A cover note was sent with each contact that explained the purpose of the survey, and promised to keep their information private. Three email reminders yielded 410 usable responses. Just 26.59% were women. This percentage is more than the global trend (women make up approximately 17% of the workforce in SC all over the world) in support of the participation of women in SC-related fields [87].

3.3. Descriptive Statistics

According to Reference [88]'s criteria, skewed responses were compared to the first and final 30%, and late respondents were considered nonrespondents. We found $p > 0.25$ nonstatistical differences in all manifest variables. Thus, this study had a lower nonresponse bias. After normality testing, data were controlled for sex, age, experience, education, and occupational and SC specialization. All questionnaire processes, directions, directives, and exercises were carried out in Pakistan; moreover, all of the responses came from Pakistan. In total, 410 SC professionals took part in the research, with entry personnel contributing 9.51%, supervisors contributing 28.78%, managers contributing 25.86%, directors contribut-

ing 21.22%, and leaders contributing 14.63%. Respondents between the ages of 28 and 37 made up the largest age group (44.38% of total respondents). The bulk of respondents held a Bachelor's degree 51.22%, whereas only 21.22% were general SC professionals. As can be seen in Table 1, we also analyzed the mean, standarddeviation, frequency, variation, skewness, and kurtosis of the data.

Table 1. Demographic details.

Variable	Classification of Variables	Valid	Frequency	%	Mean	Std. Deviation	Variance	Skewness		Kurtosis	
								Statistic	Std. Error	Statistic	Std. Error
Gender	Male	410	301	73.41%	1.22	0.410	0.166	1.436	0.234	0.091	0.466
	Female		109	26.59%							
Age	18–27	410	82	20.%	3.23	1.154	1.220	−0.132	0.234	−0.364	0.466
	28–37		181	44.15%							
	38–47		86	20.98%							
	48–57		46	11.22%							
	58+		15	3.66%							
Years of Experience	<5	410	83	20.24%	3.80	1.566	2.345	0.332	0.234	−0.674	0.466
	6–10		110	26.83%							
	11–15		90	21.95%							
	16–20		63	15.37%							
	21–25		45	10.98%							
	25+		19	4.63%							
Education level	High school	410	49	11.95%	3.37	0.680	0.460	−0.991	0.234	1.234	0.466
	Bachelor		210	51.22%							
	Master		143	34.88%							
	Ph.D.		8	1.95%							
Occupational level	Entry	410	39	9.51%	2.73	1.078	1.153	0.244	0.234	−0.737	0.466
	Supervisor		118	28.78%							
	Manager		106	25.85%							
	Director		87	21.22%							
	Leader		60	14.63%							
Supply chain S specialty	Planning	410	39	9.51%	4.18	1.510	2.167	−0.546	0.234	−0.695	0.466
	Procurement		55	13.41%							
	Warehousing		81	19.75%							
	Transportation		79	19.27%							
	Logistics		69	16.82%							
	General SC		87	21.22%							

4. Analysis and Results

This investigation is theory-building, not a confirmation; hence, a PLS approach is recommended over one that is covariance-based (CB) [89]. SC research employs PLS-SEM [90]. If the structure of the study is complicated, PLS uses lagged variable values to analyze the data. The current study is composed of a complex research framework because it comprises reflective items, manifest variables, and latent factors, all of which are centered around the same subject matter. Hence, using PLS-SEM, the research framework was analyzed in two phases, as suggested by authors of [89], and utilized the SmartPLS tool, which is user-friendly, uncomplicated, and stands the test of time [85]. At the first step of the process, the measurement model was analyzed so that its validity and reliability could be determined. The structural model was assessed for its usefulness in testing hypotheses during the second stage. The measurement model's reliability was ensured using Cronbach's alpha and composite reliability (CR). The model's validity was assessed using convergent and discriminant validity tests. Before the testing of the measurement model's hypothesis, the measuring model's validity and reliability had already been demonstrated.Before utilizing the SmartPLS3 software available through SPSS, skewness and kurtosis were applied to evaluate the normalcy of the research. The results of this evaluation are displayed in Table 2. The numbers were correct, and they did not exceed the two-percent margin of error [91]. The results were typical. After that, a variance inflation factor (VIF) test was carried out in order to validate the multicollinearity. According to previous research [92,93], the values of VIF must be lower than 10; however, the values of VIF were lower than 2 in this study; hence, multicollinearity was not an issue in the current investigation.

Table 2. Statistics for descriptive purposes and collinearity (VIF).

		DP	SCTRC	SCTRN	RI	EIM
N	Valid	410	410	410	410	410
	Missing	0	0	0	0	0
Mean		3.89	4.09	3.94	4.10	4.01
Standard error of mean		0.039	0.045	0.051	0.050	0.049
Median		3.90	3.99	3.95	4.20	3.99
Standard deviation		0.447	0.551	0.561	0.574	0.694
Skewness		−0.633	−0.488	−0.147	−0.598	−0.221
Standard error of skewness		0.232	0.232	0.232	0.232	0.232
Kurtosis		−0.016	−0.089	−0.627	−0.578	−0.333
Standard Error of Kurtosis		0.466	0.466	0.466	0.466	0.466
VIF		1.300	1.940	1.386	1.244	1.264

Note: DP = digital platforms; SCTRC= supply chain traceability; SCTRN= supply chain transparency; RI = robust information; EIM= effective inventory management.

4.1. Measurement Model Evaluation

Pearson's coefficient R square (R2) and adjusted R square (AR2) were used to calculate endogenous variable variances. Table 3 reveals that R2 and AR2 were very comparable. The data demonstrated a significant and moderate effect magnitude and a good fit model [13].

Table 3. Validity/reliability.

	R Square	Adjusted R Square	Cronbach's Alpha	Composite Reliability	Average Variance Extracted
Digital platforms			0.814	0.857	0.527
Supply chain traceability	0.213	0.205	0.651	0.749	0.633
Supply chain transparency	0.354	0.341	0.740	0.827	0.526
Robust information	0.459	0.442	0.760	0.841	0.519
Effective inventory management	0.843	0.838	0.864	0.901	0.647

4.1.1. Reliability

Cronbach's alpha measures internal construction reliability whereas CR is used to determine the reliability of the constructs on an external level. When making exploratory assessments, a reliability of 0.60 is sufficient; however, a Cronbach's alpha value of less than 0.60 suggests that the variables do not fit together very well. Table 3 shows thatthe Cronbach's alpha score was more than the value that is suggested. As a consequence of this, the model was well fit [13]. In a similar vein, CR values that were higher than the 0.70 limits suggested that the model was a good match and showed a high degree of reliability [13,94] (see Table 3 and Figure 2).

4.1.2. Model Validity

In the absence of validity, a model cannot be relied upon [95]. Because of this, our study employed both convergence and discriminant validity tests. We deleted the DP1,

DP3, DP4, and DP9 items of digital platforms;regarding STRC5, STRC6, STRC7, STRC8, and STRC9 items of SCT and STRN5 items of SC transparency, the factor loadings of every item were higher than 0.70. In addition, all of the AVE results were higher than 0.50 [96] for every construct. Consequently, the significance of factor loadings along with the average variance extracted from the model demonstrates a striking degree of convergence between the observable variables and the constructs they measure, as seen in Table 3, also Figure 3.

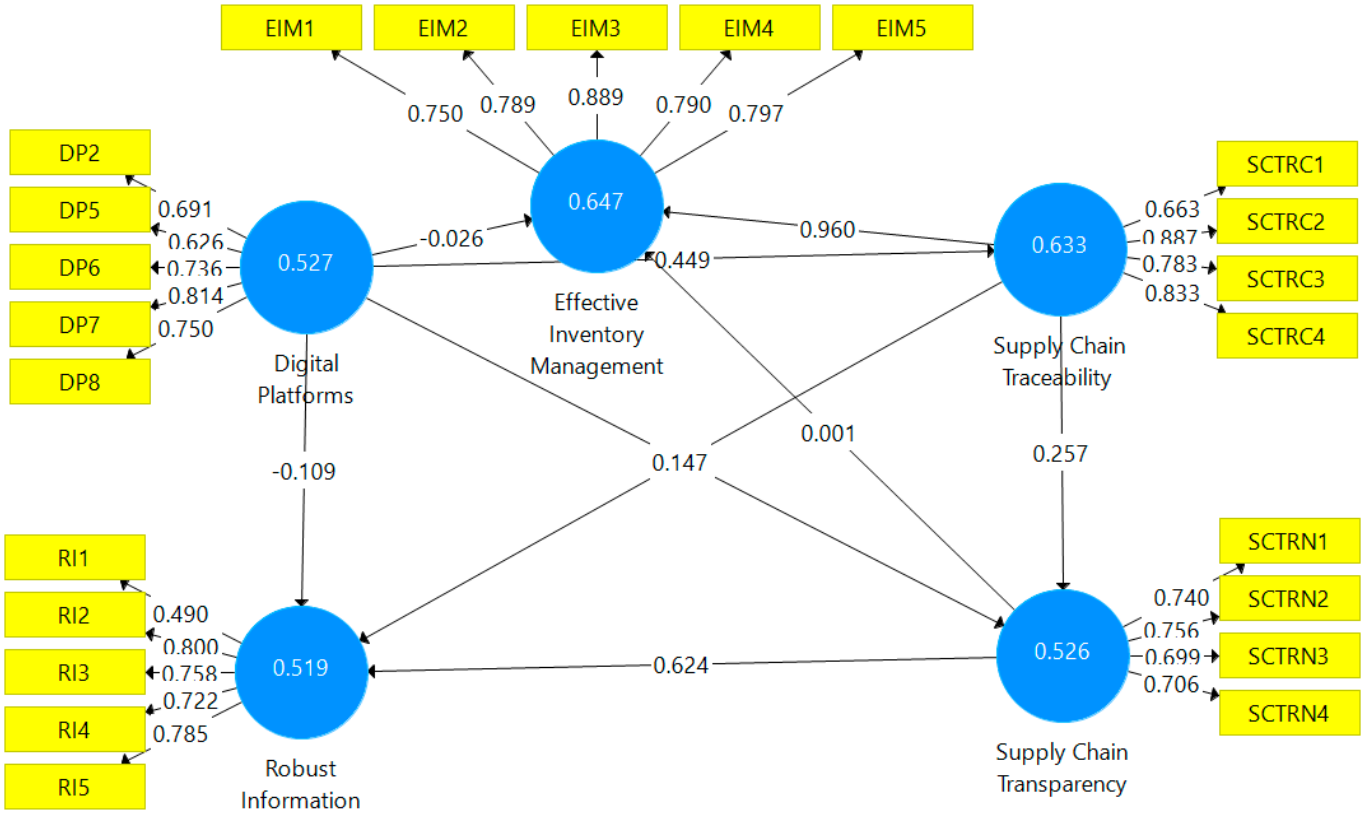

Figure 3. PLS with AVE values. Note: DP = digital platforms; SCTRC = supply chain traceability; SCTRN = supply chain transparency; RI = robust information; EIM = effective inventory management.

There are several methods for evaluating discriminant validity (DV). In order to determine if an item accounts for more variance in its linked observable construct than it does with other variables in the associated model, the measurement model was applied to determine the DV [97]. In the current study, the correlation matrix obtained using SPSS was applied to analyze the DV of the constructs and compare it to the square root (SQRT) of the AVE of each construct. The values below the diagonal and the diagonal elements, which reflect the SQRT of the AVE values for each construct, make up the inter-correlation matrix. All SQRT of AVE scores were higher than any other constructs employed in theresearch, according to the r_values for each construct concerning another construct in the same row or column. In general, each measurement element and research construct can be used to estimate the developed hypotheses and structural model. Consequently, the results of Table 4 demonstrate that all of the research's structures meet all of the DV standards, And that using the Fornell–Larcker criterion, no DV issues were found [89]. Yet, according to Reference [98], HTMT is the most effective technique for DV in PSL.

Table 4. Correlation using the Fornell–Larcker criteria.

	1	2	3	4	5
Digital platforms	1				
Supply chain traceability	0.335 **	1			
Supply chain transparency	0.427 **	0.451 **	1		
Robust information	0.462 **	0.477 **	0.521 **	1	
Effective inventory management	0.455 **	0.388 **	0.307 **	0.371 **	1

** The 0.01 level of significance for correlation (2-tailed).

The constructs'HTMT scores were under 0.85 [99], except for SC traceability with EIM and SC transparency with robust information, which had DV issues. The rest of the results suited the model and indicated validity (Figure 4 depicts this).

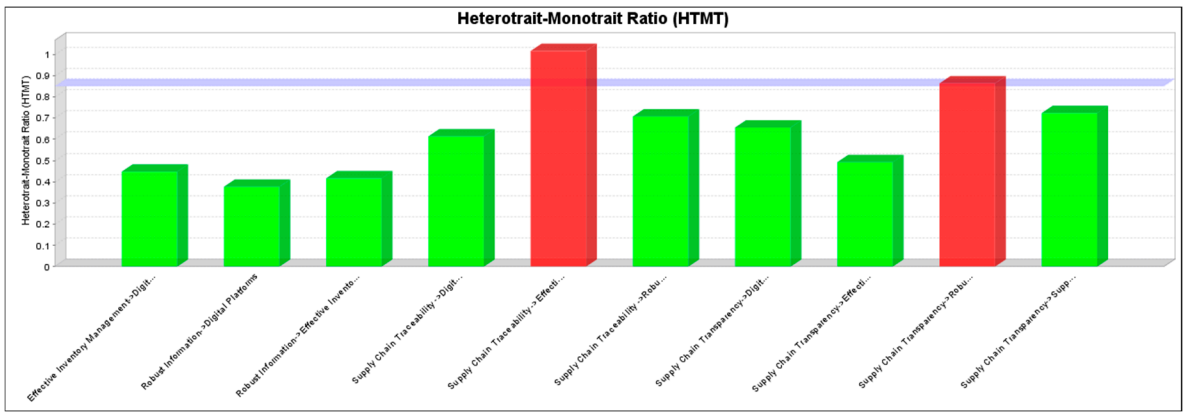

Figure 4. Using the HTMT ratio to determine discriminant validity.

4.2. The Predictive Validity

According to Cohen [100], the values of predictive validity (Q2) r Stone–Geisser indicator values of 0.02, 0.15, and 0.35, respectively, presented tiny, medium, and large impact sizes. According to the findings of this study, the endogenous constructs of SC transparency and traceability have values of 0.055, 0.156, 0.227, and 0.524, respectively. Hence, according to the findings of the research conducted in Q2, as shown in Table 5, the model has moderate predictive accuracy and requires variables for structural tweaking.

Table 5. Capacity for prediction.

	SSO	SSE	Q^2 (=1-SSE/SSO)
Digital platforms	900.000	900.000	
Supply chain traceability	900.000	850.942	0.055
Supply chain transparency	500.000	422.099	0.156
Robust information	500.000	386.365	0.227
Effective inventory management	500.000	238.083	0.524

4.3. Hypothesis Testing

The model was assessed for hypothesis testing once the variables had been verified for their validity and reliability.

According to the results of the tests conducted for the hypothesis, digital platforms had a significant beneficial impact on SCT (T 5.346, P 0.00). As a result, hypothesis 1 was validated. It was found that the use of digital platforms had a significant beneficial impact on SC transparency (T 4.082, P 0.000), which supports hypothesis 2. It was determined that SCT had a significant effect on SC transparency (T 3.130, P 0.002), which concurs with hypothesis 3. The transparency affected the RI, which validates hypothesis 4 (T 6.853, P 0.00). EIM was unaffected by the transparency of the SC (T 0.895, P 0.371), which means that hypothesis 5 was not confirmed. Digital platforms had no effect on RI and EIM, which did not verify hypothesis 6 and hypothesis 7 (T 1.2482, P 0.212) and (T 0.047, P 0212). The fact that SCT did not affect RI (T 0.183, P 0.068) meant that hypothesis 8 could not be validated. Hypothesis 9 was confirmed because SCT had a substantial impact on EIM (T 27.239, P 0.000) (see Figure 5 and Table 6).

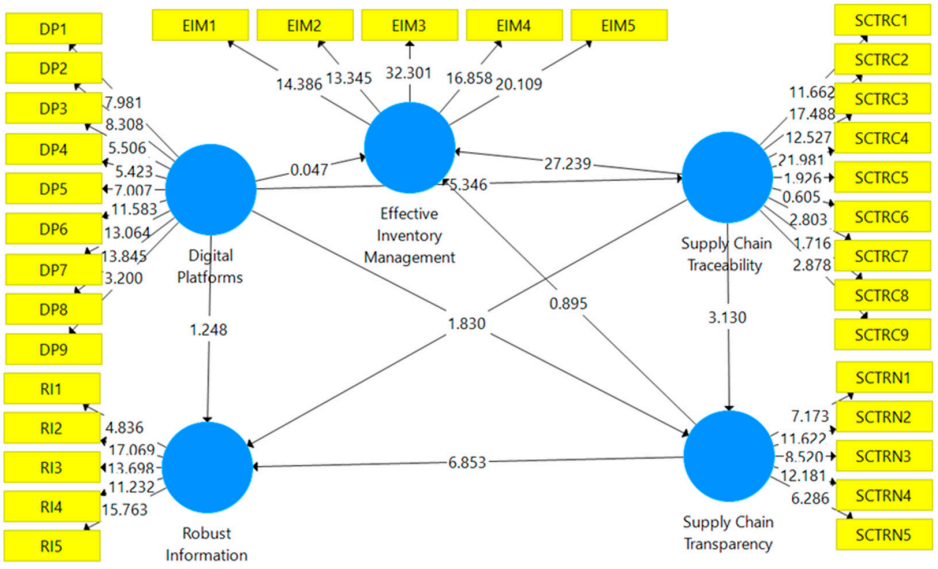

Figure 5. T-statistic value. Note: DP = digital platforms; SCTRC = supply chain traceability; SCTRN = supply chain transparency; RI = robust information; EIM = effective inventory management.

Table 6. Path analysis using bootstrapping.

	Path Coefficient	Sample Mean	Std. Deviation	T Statistics	*p* Values	Supported?
Digital platforms ≥ supply chain traceability (HI)	0.461	0.487	0.086	5.346	0.000	Yes
Digital platforms ≥ supply chain transparency (H2)	0.388	0.400	0.095	4.082	0.000	Yes
Supply chain traceability ≥ supply chain transparency (H3)	0.307	0.325	0.098	3.130	0.002	Yes
Supply chain transparency ≥ robust information (H4)	0.633	0.662	0.092	6.853	0.000	Yes
Supply chain transparency ≥ effective inventory management (H5)	−0.055	−0.064	−0.061	0.895	0.371	No
Digital platforms ≥ robust information (H6)	−0.134	−0.157	0.108	1.248	0.212	No
Digital platforms ≥ effective inventory management (H7)	0.003	0.004	0.058	0.047	0.962	No
Supply chain traceability ≥ robust information (H8)	0.191	0.180	0.104	1.830	0.068	No
Supply chain traceability ≥ effective inventory management (H9)	0.942	0.946	0.035	27.239	0.000	Yes

5. Discussion

The importance of digital platforms as well as the value outcomes that may be achieved via the successful implementation of digital platforms have been shown in previous studies. There is evidence from the body of published work of how SCT, transparency RI and EIM can benefit from the use of digital platforms. Motivated by digital platforms, we conducted researchto bridge a gap in the existing body of knowledge. Specifically, we investigated the various assessments of traceability, transparency, RI, and EIM, all of which, so far as we can identify, have only infrequently been investigated.as of yet, there is not a broad consensus on the identification degree or the benefits and drawbacks associated with it. We argue that in the SC industry, business process traceability and transparency may be of the utmost importance, and we outline research methodology to fill the gap inthe function of digital platforms concerning SC traceability and transparency. The outcomes of this study are consistent with those found in the aforementioned literature [21,38,39], which further demonstrates that SCT and transparency are greatly impacted by digital platforms. We argue that the process traceability model presented in this work may be used to easily handle a variety of traceability concerns in the SC. If the suggested framework generates a more useful response, it can offer opportunities to change the standard business process.

5.1. Contribution to Theory

In this work, we make predictions and create theories to explore if digital platforms might ultimately promote SCT and transparency. Based on this study's results, it may be argued that this paper offers some insightful theoretical insights. First off, real-time monitoring of business operations is made easier by digital platforms. The findings of this study, which demonstrate the value of traceability, are consistent with those of Reference [101]. Our findings also support the link between digital platforms and SCT. The empirical outcomes of this study demonstrate that digital platforms dramatically improve SCT and transparency, which support the findings of a previous study [21]. Third, authors of [102] focused on how digital platform techniques are utilized to determine daily demand and make sure there are not any inventory-related issues. According to Reference [44] transparency is made possible via traceability through tracking and tracing. Reference [71] stated that the usage of modern traceability information systems and information trails provided by traceability assessments help firms manage their resources more efficiently. The findings of this investigation indicate that using digital platforms is a good strategy to promote transparency and traceability in SC activities. Following the findings of Reference [78]. This research also showed that digital platforms have no direct influence on reliable information and EIM. The analysis supported Reference [84]'ss arguments that traceability has a significant direct impact on inventory management but no direct relationship with reliable information. Last but not least, companies can increase traceability as a key input and, as a result, improve firm performance and customer satisfaction [69]. This analysis experimentally strengthened the claims that traceability and transparency solutions based on digital platforms can increase information sharing, improve inventory management, and ultimately improve performance in the context of SC.

5.2. Implementation of Digital Platforms for SC Traceability and Transparency System

With the help of the digital platforms system, traceability information can be obtained in real-time. Finished products can have their history traced back, beginning with the arrival of various types of raw materials at supply plants and continuing up to the point where they are delivered to end customers. Five primary reasons led to the implementation of a digital platform for the traceability system. First, the business has a top management group that is steadfastly committed to any form of endeavor that suggests a source of competitive advantages. This was something that helped make the adoption of the traceability system easier because it increased the likelihood that the top management team would support the project. Second, the company must own the necessary human qualities as well as the financial resources, both of which are essential to the installation of such an expensive and

complicated system. Third, In terms of control, flexibility, and distinction, the system would be advantageous on both a qualitative and quantitative level. Fourth, it is recommended to begin with traceability solutions that are based on new technologies. This is because it requires the utilization of significant amounts of data and the participation of many different parties, both internally and externally. Fifth, the findings indicate that digital SC has the potential to be a game-changer in markets that are already competitive. The results of the questionnaires, which were filled out by professionals working in a variety of fields and at varying levels of responsibility, revealed that the effective implementation of digital platform systems contributed to a competitive advantage. It is imperative to implement digital platform systems at various stages of SC as soon as possible in order to improve traceability, transparency, and robust information, as well as for EIM. This is because the future holds several challenges for the product, as well as some variables, including population expansion, technological development, and the state of natural resources.

6. Conclusions

This quantitative study investigated digital platform-based traceability options. A paradigm (Figure 1) for SC shows how traceability based on emerging technologies might improve SC transparency. Traceability and transparency through digital platforms allow firms full control over their activities, according to the study. This study's conclusions demonstrate how digital platforms' traceability and transparency allow businesses to achieve complete operational control. A company can increase stock rotation, maximize warehouse space, cut back on the number of people working each shift, and lower inventory levels. Each consumer can acquire complete information on the manufacturing date, processing line, identities of all the operators, and the shifts in which an item was created by simply reading the label written on the bag. Moreover, the digital platforms aid in the identification of faulty batches. Through this, it is possible to assess a labor force's productivity. Ultimately, companies can determine when the production lot was first handled, who the line supervisor was, and how many pallets included the various raw ingredients. In addition to optimizing the delivery of their products to clients, businesses have achieved a more efficient use of their transportation system. In addition, the findings of this paper contribute meaningfully by providing organizations and other parties a method for determining the crucial factors that boost performance. Moreover, the current study's limitations open the door to further research. Although obstacles remain, the future of these technologies' inclusion is hopeful.

Developing a stronger and more complete SC is challenging because it requires a thorough understanding of realworld operations from a variety of viewpoints, including legal, economic, technological, and social considerations. As a result, this research has several limitations that might be addressed in future studies. For instance, this is the first study to empirically explore the digital platforms system in Pakistan; even though this was not carried out with a specific sample in mind, it could be viewed as a drawback. This study can be a starting point for further research because its conclusions do not apply to other industrialized nations. In addition, different mixed approaches are suggested because this study blended a quantitative approach with a qualitative approach for more in-depth analysis. Thirdly, despite having a sufficient response rate in comparison to other SC research, the data collection period was very short. An extended period, however, might improve the findings even more. Lastly, this study does not address digital transformation concerns, which an emerging research field. Future studies could also examine technology that drives and enables digital transformation.

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