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THE ROLE OF DIGITAL INTEGRATION ON DISTRIBUTION EFFICIENCY THE MEDIATING ROLE OF ORDER FULFILLMENT

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Abstract

This study aimed to explore the role of digital integration in improving distribution efficiency, and how order fulfillment serves as a mediator between digital integration and distribution efficiency in engineering companies in Jordan. As reliance on digital technologies and systems in the supply chain grows, the need to understand the role of digital integration in delivering better distribution performance and organizational responsiveness is growing even more. The study focused on two aspects of digital integration that had a direct as well as indirect impact on distribution efficiency: order fulfillment capabilities and the direct influence of digital integration. A quantitative research approach was used, and a questionnaire was used to collect data from 350 representatives from engineering companies in Jordan. The results of the study were analyzed through advanced statistical methods to assess the research hypothesis and to explore the mediation effect between the study variables which is the Partial Least Squares Structural Equation Modeling (PLS-SEM). The results showed that the integration of digital has a positive and significant impact on order fulfillment and distribution efficiency. The findings also showed that order fulfilment has a significant mediating function between the influence of digital integration and distribution efficiency. The study showed that those organizations that are more digitally integrated can better improve the coordination processes, speed up product delivery, make their operations more responsive and increase their distribution efficiency. The study builds on the current literature and literature review by expanding the knowledge of integrating digital in supply chain and distribution management. It also emphasizes the strategic significance of order fulfillment as an operational instrument which can improve results in distribution. The study suggests that tech be incorporated into engineering companies' systems, as well as advanced order fulfillment technologies, to enhance distribution capability and operational competitiveness in a rapidly changing business world.

Keywords: *Digital Integration, Distribution Efficiency, Order Fulfillment, Supply Chain Integration, Digital Transformation, Operational Efficiency, Logistics Performance, Engineering Companies.*

1. INTRODUCTION

In recent years, Digital technologies have led to a significant transformation of distribution activities in engineering companies. In increasingly competitive sectors, organizations are always looking for more sophisticated technological solutions that can boost their operational efficiency, build the coordination system, and optimize their distribution system. Hence, digital integration has become a strategic approach that allows organizations to integrate operational systems and enhance information sharing and support real-time decision making throughout supply chain activities (Adem

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et al., 2018). Product distribution, delivery co-ordination, order processing, and customer response are some common operational issues faced by engineering companies. Operational systems that are traditional are not sufficiently flexible and responsive enough to operate the business efficiently in today's dynamic market conditions, leading to delays, higher operating expenses, and less service efficiency. However, current digital technologies and data analysis, artificial intelligence, cloud systems and integrated digital platforms offer new opportunities to enhance distribution processes and organization's responsiveness (Weerabahu et al., 2023). They help to increase the visibility of the operations, speed up communication flows, boost the accuracy of demand forecasting, and facilitate efficient use of resources for distribution activities. Digital integration is the ability to create integrated operating environments within an organization that enable the sharing of information between various departments, suppliers, distributors and customers. With the help of integrated digital systems, engineering companies can get real-time information about the activities they are carrying out, increase coordination between all the parties involved in the supply chain, and enhance the order management process. The level of integration plays a crucial role in boosting the distribution efficiency, as it helps to minimize disruptions in the operational workflow, delays, and inaccuracies in deliveries (Ivanov, 2021).

In addition, digital integration technologies enable organizations to be more agile, less complex, and more satisfying to their customers when implemented successfully. The overall trend of digital transformation in Jordan has made organizations more interested in implementing integrated digital solutions within the engineering industry to enhance their operational competitiveness. While Jordan seeks to continue moving toward industrialization and foreign investments, engineering companies are increasingly being pushed to deliver better distribution results and response to operations. In this respect, digital integration can be considered an important tool for digitalizing the operational processes of an organization, optimizing distribution processes, and reinforcing market competitiveness (Sharabati et al., 2024). Concurrently, order fulfilment has evolved into a vital element in determining the distribution performance in the organization. Effective order fulfillment processes help improve delivery speed, customer satisfaction, reduce operational errors and improve overall delivery efficiency. Digital technology integration in order fulfillment operation is more likely to improve inventory coordination, delivery scheduling and operational performance (Park & Li, 2021). Hence, order fulfillment can be a crucial mediating variable between digital integration and the improvement of distribution efficiency of engineering companies. Although digital transformation and supply chain integration have been gaining attention, few empirical studies investigated the relationship between digital integration, order fulfillment and distribution efficiency in the context of engineering companies in Jordan. Earlier research has focused on technologies to support operational automation and logistics while neglecting to evaluate the operational mechanisms by which digital integration can improve outcomes related to distribution. In this regard, this study aims to fill the research gap by examining the impact of digital integration on the efficiency of distribution with the mediating variable order fulfillment. Accordingly, the study seeks to answer the following research questions:

RO1: What is the effect of digital integration on distribution efficiency in engineering companies operating in Jordan?

RO2: What is the effect of digital integration on order fulfillment within engineering companies in Jordan?

RO3: What is the effect of order fulfillment on distribution efficiency in engineering companies operating in Jordan?

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2. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Digital transformation has brought digital technologies and supply chain management (SCM) together and made it one of the key research fields in logistics and operational management. The recent developments of Digital Integration have dramatically changed the supply chain structures by enhancing the connectivity, operational coordination, and real-time decision-making processes in organizational networks. The previous study showed that digital technology has a positive impact on the OPEF and Logistics Performance of engineering companies by improving communication systems, data synchronization, and automation of operational activities in the Supply Chain Integration (Chopra, 2021). In addition, Digital Transformation helps organizations enhance their Order Fulfillment capabilities, optimize their Distribution Efficiency and boost their operational responsiveness in highly competitive industrial settings (Rejeb & Rejeb, 2020). Logistics and chain activities have been transformed by recent technological advances such as cloud computing, the Internet of Things (IoT), artificial intelligence and big data. Overall, these technologies enable real-time monitoring, predictive analytics, automated decision-making, and integrated operational visibility, enhancing Logistics Performance and Operational Efficiency (Herold, Nowicka, Pluta-Zaremba, & Kummer, 2021). Although a large volume of literature has been developed in the areas of Digital Transformation, and Digital Supply Chain Integration, few studies have focused on the combined effect of Digital Integration, Distribution Efficiency, and Order Fulfillment on Logistics Performance in engineering firms in Jordan. Previous research focused primarily on the developed world or the industry as a whole and paid inadequate attention to engineering in emerging markets (Thakur & Breslin, 2020). Therefore, this study aims to solve this research gap by analyzing the relationships that exist between Digital Integration, Distribution Efficiency, Order Fulfillment, Supply Chain Integration, Digital Transformation, Operational Efficiency, and Logistics Performance in engineering companies.

2.1 Digital Integration

Digital Integration is the use of digital technologies to integrate technological systems, processes and information across supply chain activities. Digital Integration is playing a significant role in determining the competitiveness of organizations in today's supply chain environment due to its benefits of improving communication quality, real-time information exchange with supply chain partners and operational coordination (Herold, Nowicka, Pluta-Zaremba, & Kummer, 2021). There is a growing trend for organizations to implement integrated digital systems for better visibility through logistics operations and to help them navigate through the decision-making process. Such technologies as artificial intelligence, cloud computing, enterprise resource planning systems and big data analytics help organizations to enhance the synchronization of their operations and boost their responsiveness to market volatility and customer needs (Feizabadi et al., 2018).

Digital Integration also plays a key role in Supply Chain Integration which establishes a single operations network between suppliers, manufacturers, distributors, and customers. Integrated systems can help organisations boost data accuracy, minimise delays and optimise Logistics Performance. Studies have previously shown that Digital Integration makes a significant impact on increasing Operational Efficiency by making processes simpler, easing communication barriers and improving workflow co-ordination (Fu et al., 2023). Companies that are able to realize integrated digital systems are better equipped to enhance their Distribution Efficiency and strengthen their Order Fulfillments activities in dynamic business conditions. The above discussion leads to the following hypothesis:

H2: Operational efficiency affects Digital Integration in a significant positive manner.

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2.2 Distribution Efficiency

Distribution Efficiency is the capacity of companies to achieve maximum efficiency in the distribution of products, materials and information within logistics and distribution systems with the minimum loss and delay. To enhance customer satisfaction, ensure operational continuity, and boost organizational competitiveness, efficient distribution systems are crucial in industrial sectors (Kabra et al., 2019).

Digital Transformation technologies have taken a huge leap in improving the Distribution Efficiency through the use of automated inventory systems, real-time tracking technologies and predictive logistics analytics (García-Alcaraz, Maldonado-Macías, Alor-Hernández, & Sánchez-Ramírez, 2017). These technologies have the potential to allow companies to track the distribution process continuously, optimize routes, and be alerted to disruptions in operations and shifting market demands quickly.

Distribution Efficiency is also a significant aspect of improving the SC Integration as good distribution systems allow for coordination between suppliers, storage facilities, transportation units, and customers. Companies that have high levels of Distribution Efficiency can have a better ability to reduce lead time, improve resource allocation and improve Logistics Performance (Abushaikha, Al-Weshah, & Alsharairi, 2020). Distribution Efficiency is especially crucial in engineering firms, as any delays or logistical issues could impact production continuity and project execution. Organizations are thus increasingly taking an interest in digital logistics solutions to bolster distribution strengths and increase flexibility in operations. From the above discussion, it can be hypothesized that:

H2: Distribution Efficiency is significantly and positively associated with Logistics Performance.

2.3 Order Fulfillment

Order Fulfillment is the procedure that involves receiving, handling, processing and delivering customer orders in a timely and effective manner. Customer satisfaction, operational responsiveness and competitiveness can be achieved through having effective Order Fulfillment systems in the highly dynamic industrial markets (Kabra et al., 2019).

Digital Transformation (DT) technologies have revolutionized Order Fulfillment by empowering inventory visibility, warehouse management, demand forecasting and delivery coordination process (Feizabadi, Maloni, & Gligor, 2019).

The use of sophisticated digital systems allows businesses to manage customer orders more effectively, minimize delivery mistakes, and cut down on logistics expenses and delays. Order Fulfillment directly drives Operational Efficiency since organisations with efficient order fulfillment systems can optimise inventory management, coordinate workflows properly and eliminate unnecessary operational activities.

Engineering companies are increasingly using integrated digital platforms to enhance the speed of order processing, as well as the coordination between production and logistics activities (Jermsittiparsert & Pithuk, 2019b).

In addition, good Order Fulfillment improves Supply Chain Integration by enabling the exchange of information and operational coordination between the actors in the chain. Companies that can provide the products with accuracy and efficiency are more likely to be able to improve their customer relations and Logistics Performance. The above discussion leads to the following hypothesis:

H3: Order Fulfillment is very strongly positively correlated with Logistics Performance.

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2.4 Supply Chain Integration

Supply Chain Integration is the strategic coordination and collaboration of the members of a supply chain through the integration of operational activities, information systems and logistics processes. The organization flexibility, quality of communication, and operational performance of industries are improved due to the integrated supply chains (Dubey et al., 2019).

Digital technologies have become an essential key to implementing Supply Chain Integration, as they facilitate the sharing of information, the synchronization of the operation and the coordination of supply chain partners in real time (Fan, Zhang, Yahja, & Mostafavi, 2021).

ERP, SCM Software, and IoT technologies enhance logistics network visibility and operational transparency. Supply Chain Integration plays a vital role in enhancing Operational Efficiency and Logistics Performance, as it decreases duplication, process inefficiencies and increases the responsiveness of the organization to environmental changes (Ivanov, 2021).

Companies with high Supply Chain Integration can better enhance Distribution Efficiency, Order Fulfillment process and ensure operational continuity in the event of uncertain business conditions. From the above discussion, the hypothesis is that:

H4: Supply Chain Integration has a significant positive impact on Logistics Performance.

3. CONCEPTUAL MODEL: THEORY OIPT

The Organizational information processing Theory (OIPT) offers a comprehensive framework for understanding how organizations innovate and adapt their processes to achieve competitive advantage(Benzidia, Makaoui, & Bentahar, 2021). Focusing on the collective effort and systemic changes required for an organization to embrace innovation, OIPT extends beyond individual consumer behavior towards adopting new technologies or products, as seen in models like TAM (Belhadi et al., 2021).

Exploring the implementation of OIPT, through examining how firms innovate in terms of implementing digital technologies for their end-to-end operational processes and supply networks could extend it to the field of supply chain management as well as beyond (Dubey et al., 2019). Highlighted here are the perceived usefulness and easy to use of these technologies, which suggests that ease of use and relevance do enable technological adoption (Srinivasan & Swink 2018).

Furthermore, OIPT suggests that social influence and facilitating conditions should be considered when trying to adapt innovative supply chain practices as they are the norms of the industry which affect conducting such practices execute and other assistances availability by way of helpful resources affects them significantly (Adam et al., 2018). Behavioral intent is embodied as good example by OIPT, where an organization's resolve towards the acceptance of novel advances in supply chain technology can predict their eventual realization (Adem et al., 2018; Belhadi et al., 2021).

This viewpoint also stressed the importance of successful innovation involving more than just new technology introduction, that a real commitment must come from within to make it work day in and day out. Exploring supply chain management with respect to OIPT will enable researchers to identify, which factors/driver fuel or hinder the implementation of digital technology for this particular context.

Taken together, the insights from such an approach enable organizations to develop a road map to innovate their supply chain and in turn improve efficiency, agility, and competitiveness in the era of digitalization.

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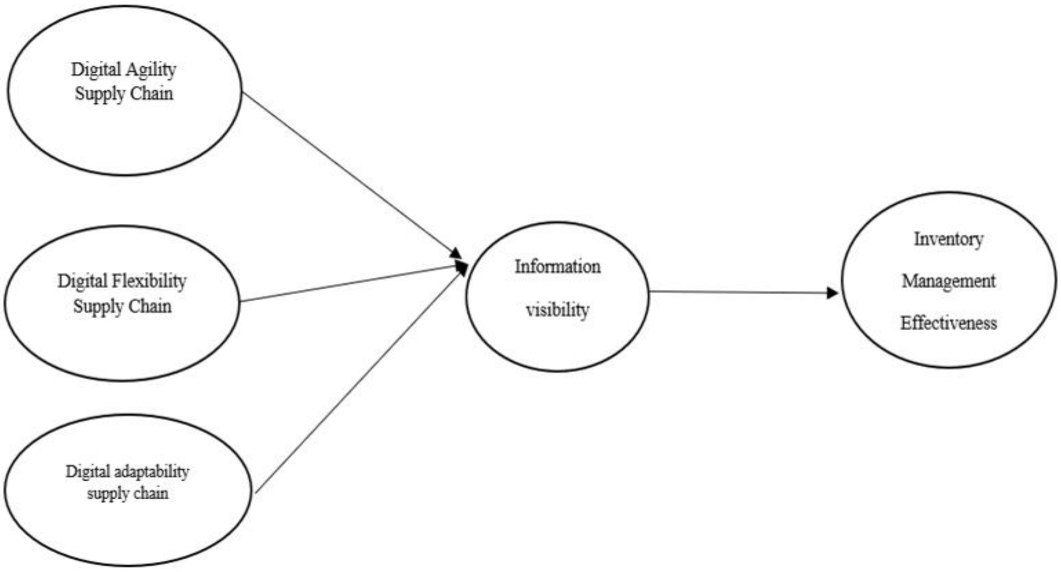

Figure 1: Model of Study

4. HYPOTHESIS DEVELOPMENT

4.1 Digital Integration

In supply chain management, Digital agility is a part that can help companies quickly and effectively respond to changes in business strategy, market policies, production technologies, crisis, etc. The quick returns achieved (Gunasekaran et al., 2018). Equipped with digital technologies, digital agility dramatically changes the picture of supply chain operations. The operations in the supply chain will thus be more flexible and agile to respond (Abou Kamar, Albadry, Sheikhelsouk, Ali Al-Abyadh, & Alsetoohy, 2023). The ability to respond quickly is not simply to endure disruptions, However, thanks to digital technology, the insight for real-time make certain as well as prediction that lies ahead. Consequently, digital agility (knowledge-driven and situation-aware) becomes today's most paramount instrument to identify, where to make long-term product and services improvements (Perks, 2017).Digital agility is at its essence taking care of customer needs to an unprecedented extent in precision and speed--in other words, it is cho an emphasis on meeting satisfaction (Atieh Ali, Sharabati, Allahham, & Nasereddin, 2024). With digital agility, organizations can provide customers with excellent user experiences by adjusting supply chain processes in response to changes in demand and supply levels (Nakabuye, Mayanja, Bimbona, & Wassermann, 2023). Concurrently, the agility ensures fast and precise customer needs responses. This is beneficial for creating customer loyalty and strengthening customer trust in the brand (Chan, Ngai & Moon, 2017). Ultimately, digital agility in the supply chain is a strategic move for more resilient, customer-focused operations--and, engineered ones. This idea was suggested by:

H1: Digital Integration has a direct and significant impact on Distribution Efficiency Management Effectiveness.

H2: Digital Integration has a direct and significant impact on Information Visibility.

4.2 Distribution Efficiency

Digital flexibility to manage the supply chain is a twist and a step forward from the traditional approach in handling the complex supply chain involved in the modern business world to a more dynamic and flexible solution. Digital flexibility, at its essence, is the ability to use digital technologies

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and skills (and other tools) to build a supply chain that can seamlessly respond to changes in demand, suppliers or partners and market shifts. “This ability to be flexible is extremely important in the modern business environment, which can easily change due to natural disasters and geopolitical events” commerce (García-Alcaraz et al., 2017). Digital flexibility is based upon integration of digital technologies within whole supply chain in a seamless manner (Kabra et al., 2019). “Every link in the chain, including procurement, production, distribution and final delivery will take advantage of real-time data and predictive analysis along with automated processes,” (Alshawabkeh, Abu Rumman, & Al-Abbadi, 2024). Moreover, this integration helps them speed up their operations, be more efficient and make the best out of decisions with real-time insights that help decision makers take immediate action if required. Digital flexibility, in addition to being able to make operating changes quickly also builds an attitude of innovation and resilience throughout the organization. In this way, businesses can "predict the unpredictable" (de Vass, Shee, & Miah, 2021), stay ahead of the curve and anticipate change before it becomes disruptive, by encouraging experimentation and continuous learning. The hypothesis was offered that digitally flexible supply chains are those that are proactive in their approach to change, and that through this approach they keep up with the changing environment in business.

H3: Distribution Efficiency has a direct and significant impact on Distribution Efficiency Management Effectiveness.

H4: Distribution Efficiency has a direct and significant impact on Information Visibility.

4.3 Order Fulfillment

Digital adaptability in SCM is the ability of an organization to navigate and maintain business sustainability in the midst of rapid changes in the business environment through the strategic integration of digital technologies (Dubey, Singh & Gupta, 2015). This flexibility is more than being flexible to changes but also in defining the future of Supply Chain with innovation and agility, predicting future trends (Jermsittiparsert & Pithuk, 2019a). In today's volatile marketplace and changing customer expectations, being digital is now a critical part of a company's competitive edge. (Uhl-Bien & Arena, 2018) Digital adaptability is the use of digital technologies to ensure the responsiveness and flexibility of the supply chain. These involve advanced analytics in predictive forecasting, robotics towards warehouse automation, blockchain guarding for transparent and safe transactions (Kabra et al., 2019). Such technologies enable supply chains to operate with unprecedented precision, speed and reliability and quickly adjust to market shifts and challenges that may arise (Wei et al., 2020). Therefore, the ability to promote digital adaptability is focused on nurturing an innovative culture within the organization (Benzidia et al., 2021). It encourages staff to be self-directed and think outside the box, and to take risks if they know they can learn and experiment without fear of failure using digital means. To stay ahead of the curve, it’s important to have this culture of adaptability where organizations are capable of questioning and upgrading their supply chain strategy and processes and for it always be as lean/optimal as possible against current/future challenges. was proposed this hypothesis:

H5: Digital adaptability supply chain has a direct and significant impact on Distribution Efficiency Management Effectiveness.

H6: Digital adaptability supply chain has a direct and significant impact on Information Visibility.

4.4 Digital Transformation

In the context of supply chain management, visibility of information can be explained as the degree of transparency and accessibility of information in the SCM system to stakeholders to enable them to have a comprehensive overall view of the flow of information, goods, or services in the system

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(Agarwal, Kant, & Shankar, 2019). It is important for the visibility that enables informed decisions to manage risks, and optimize sales operations (Dubey et al., 2019). In the highly interconnected and sophisticated business economy of today, High Digital Transformation is a must-have for providing efficient, agile and satisfactory customer service provision (Fan et al., 2021).

Digital technology also allows for greater Digital Transformation as it automates data collection, processing and exchange. With the introduction of systems such as Enterprise Resource Planning (ERP) software and Supply Chain Management (SCM) Software coupled with IoT devices, tons of data is being gathered from various parts of the supply chain that is now centrally available to all supply chain players in real-time (Valashiya & Luke, 2023).

A real-time access to data would provide for the first time the capacity of "visibilities" and " arrivals" of Distribution Efficiency positions, demand prediction processes, transportation plans, supplier presentation etc. “proactive Supply Chain Management”. (Dubey et al., 2019).

There is more to Digital Transformation than simply having access; but rather the potential ability of making sense and acting on it (Dubey et al., 2018). It gives better operational visibility, so that organisations can determine where potential bottlenecks are likely to occur, what might happen there and what they can do to remedy the situation at the right moment (Ivanov, 2021).

However, improved visibility is not only good for business as usual, it is also useful for businesses when they are planning their future strategy, enabling them to spot future trends and adapt their supply chain plans. The hypothesis was that:

H7: Digital Transformation mediates the relationship between independent variables (Digital Integration, Distribution Efficiency, Digital Adaptability Supply Chain) and Distribution Efficiency Management Effectiveness.

5. RESEARCH METHODOLOGY

The method that employed in this research is to investigate the effect of Digital Integrationpractices on the Distribution Efficiency management efficacy in engineering sector companies working in Jordan. The research team used the advanced statistical methodologies using Smart PLS 4 software to investigate results based on data from 350 engineering companies.

This approach afforded us a detailed examination of the links between Digital Integrationadoption and Distribution Efficiency management outcomes Data was obtained via a survey that aimed to gather the executive manager’s perspective of their companies. This survey was conducted with an objective to measure: The overall situation regarding the integration of Digital Integration and its impact on Distribution Efficiency management specifically in terms of accuracy, turnover rate, carrying cost all in correlation with each other.

After the collection of data, a complete statistical analysis was performed with the help of Smart PLS 4, and then an extensive report generation is done. The report further demonstrated statistical results illustrating that the Digital Integration has a positive impact on improving Distribution Efficiency management.(Hair, Sarstedt, Matthews, & Ringle, 2016).

The findings underscored the importance of digital technologies in improving Distribution Efficiency accuracy, reducing lead times, and lowering costs, thereby contributing to the overall competitiveness of engineering companies in Jordan.

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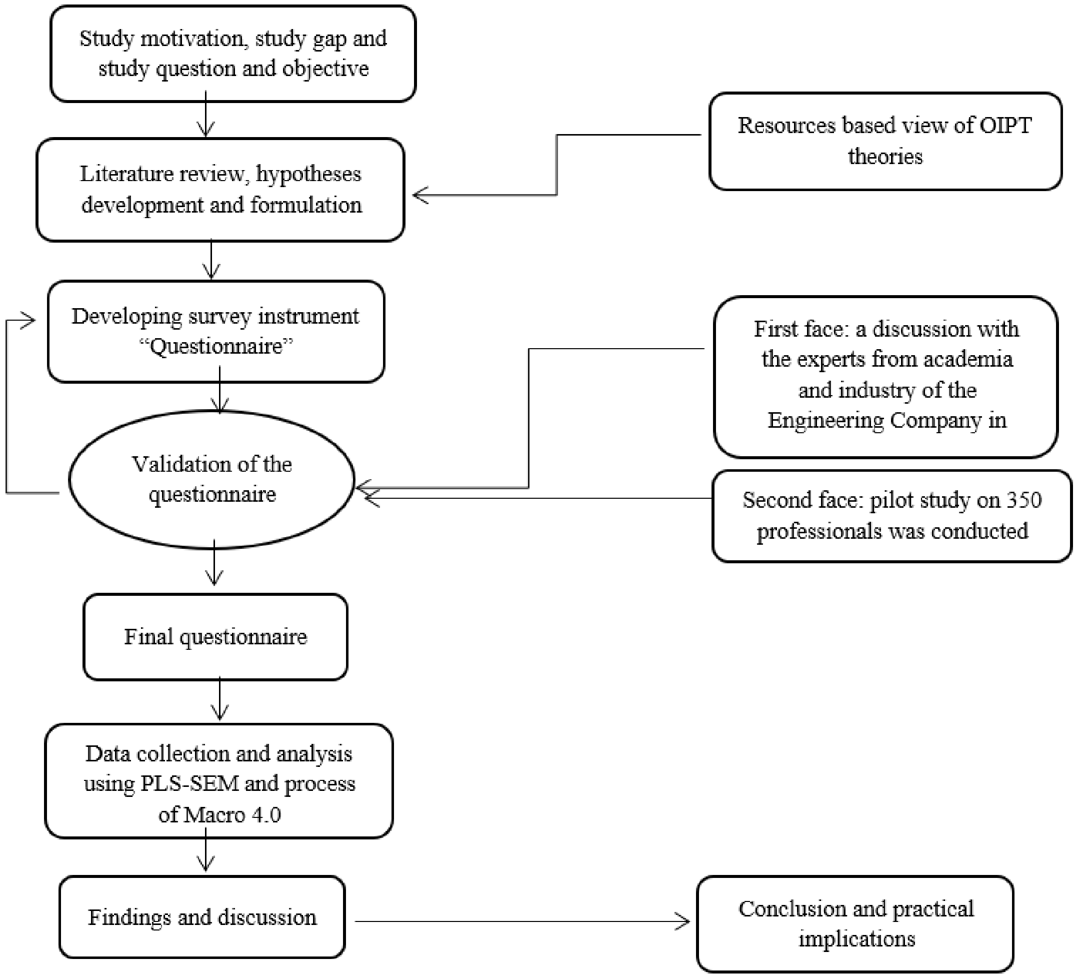

Figure 2: Research framework

6. DATA ANALYSIS

According to (M. Hair J. F., 2017) the analysis for this research was done through a variance-based method. The method was implemented via Smart PLS software, which is a program for computing Least Squares structures. For research with small samples or data that are not normally distributed, immersed in the lower level of traditional structural equation models and thus not staying as rigorous as we might hope for, in particular Smart PLS comes into its own. This is because Smart PLS is appropriate for analyzing relationships which are highly complex in nature and as such, as was explained earlier on, describes the nature of all relationships in structural equation modeling. The analysis process has a total of two steps, which involve testing all variables involved in the study and making use of predicted correlations between them to investigate concepts of direction and strength of connection.

Table 1: Factor loadings

Constructs	Items	Factor loadings	Cronbach's Alpha	C.R.	(AVE)
Digital Integration	DASC-1	0.869	0.869	0.910	0.716
	DASC-2	0.852			
	DASC-3	0.814			
	DASC-4	0.853			

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Distribution Efficiency	DFSC -1	0.846	0.929	0.942	0.701
	DFSC -2	0.813			
	DFSC -3	0.860			
	DFSC -4	0.844			
Digital Adaptability Supply Chain	DASC-1	0.794	0.868	0.904	0.654
	DASC-2	0.751			
	DASC-3	0.796			
	DASC-4	0.846			
	DASC-5	0.855			
Information visibility	IV-1	0.850	0.880	0.912	0.675
	IV-2	0.832			
	IV-3	0.839			
	IV-4	0.802			
Distribution Efficiency Management Effectiveness	IME -1	0.814	0.876	0.909	0.687
	IME -2	0.812			
	IME -3	0.831			
	IME -4	0.802			
	IME -5	0.825			

Table 1 provides a comprehensive analysis of the constructs used in the study, including Digital Integration (DASC), Distribution Efficiency (DFSC), Digital Adaptability Supply Chain (DASC), Digital Transformation (IV), and Distribution Efficiency Management Effectiveness (IME). These constructs demonstrate strong psychometric properties across their respective dimensions. The factor loadings for the items range from 0.751 to 0.869, indicating a strong relationship with their corresponding constructs and robust measurement validity. All internal consistencies (Cronbach's alpha) were above 0.7, indicating that the constructs are reliable More specifically, the individual Cronbach's alpha values range from 0.868 to 0.929 (high). Further confirmation of construct reliability comes from the composite reliability measures which ranged between 0.904 and 0.942 in this study (Table 3). In addition, the AVE values between 0.654 and 0.716 are higher than standard of 0.5, demonstrating acceptable convergent validity that reflects, on average more than fifty per cent commonality among items included in a component Thus, these metrics suggest that the measurement model with respect to the constructs under investigation are well founded enabling us to draw inferences regarding the effect of Digital Integrationcharacteristics on a variety of outcomes.

7. STRUCTURAL MODEL

In the context of composite constructs, tests for discriminant validity and cross-validation are two methodologies often employed with the purpose being; assessment of validity. In pursuit of its discriminant validity, the HTMT is first examined. The author advocated first that HTMT (Henseler, Ringle, & Sarstedt, 2015) should be no more than Wishful 0. (Franke & Sarstedt, 2019), however, recently have corroborated and revised this recommendation. These values are also shown in Table 2. They clearly come within the allowable range, and not one factor variable is poorly identified in terms of others. With this highlevel for those who have achieved such proficiency of expertise, we may reasonably conclude That the reliability and validity of measurement model has been satisfied.

Table 2: HTMT

	Digital Integration	Distribution Efficiency	Digital Adaptability Supply Chain	Information visibility
Digital Integration				
Distribution Efficiency	0.718			

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Digital Adaptability Supply Chain	0.741	0.835		
Information visibility	0.736	0.833	0.877	
Distribution Efficiency Management Effectiveness	0.713	0.834	0.867	0.803

Table 2 presents the Ratio (HTMT) of correlations among the constructs used in the study: Digital Integration, Distribution Efficiency, Digital Adaptability Supply Chain, Digital Transformation, and Distribution Efficiency Management Effectiveness. The HTMT values indicate the discriminant validity of the constructs. The values between Digital Integration and the other constructs are 0.718 (Distribution Efficiency), 0.741 (Digital Adaptability Supply Chain), 0.836 (Digital Transformation), and 0.813 (Distribution Efficiency Management Effectiveness). For Distribution Efficiency, the values are 0.835 (Digital Adaptability Supply Chain), 0.833 (Digital Transformation), and 0.834 (Distribution Efficiency Management Effectiveness). Digital Adaptability Supply Chain shows values of 0.877 with Digital Transformation and 0.867 with Distribution Efficiency Management Effectiveness. Finally, the HTMT value between Digital Transformation and Distribution Efficiency Management Effectiveness is 0.803. There is no significant HTMT value above the threshold of 0.90, this means that there are good discriminant validities among constructs "This indicates that the constructs are separate entities, which verifies that each construct measures another dimension of the model" (Hair et al., 2013). Thus, this robustness in discriminant validity also substantiates the construct, content SBM and that those constructs are valid measures of assessing the varying outcomes related to Digital Integrationattributes as per measurement model adopted for analysis.

Table 3: Fronell-Larcker

	Digital Integration	Distribution Efficiency	Digital Adaptability Supply Chain	Information visibility	Digital Integration
Digital Integration	0.809				
Distribution Efficiency	0.631	0.847			
Digital Adaptability Supply Chain	0.672	0.751	0.837		
Information visibility	0.638	0.730	0.796	0.822	
Distribution Efficiency Management Effectiveness	0.619	0.729	0.787	0.799	0.817

As depicted in Table 3, according to Fornell-Larcker Criterion discriminant validity of the constructs Digital Integration, Digital Flexibility SC and Digital Adaptability S.C; Digital Transformation; Distribution Efficiency Management Factors' FCMEA effectiveness For the diagonal values, it is actually the square root of the Average Variance Extracted (AVE) between constructs, where it will display Digital Integration 0.809, Distribution Efficiency 0.847, Digital Adaptability Supply Chain :08787 Digital Transformation: 0822 Distribution Efficiency Management Effectiveness: 0817 Off-diagonal values represent the correlation between constructs (relationships). Digital Integration is correlated by 0.631 with Distribution Efficiency, then it will correlate of 0.672 with Digital Adaptability Supply Chain, and consequently correlates to Digital Transformation higher than the Distribution Efficiency Management Effectiveness (0.738>0.719). The correlation of DFA to "Digital Adaptability Supply Chain", "Digital Transformation" and "Distribution Efficiency Management Effectiveness" is at 0.751, 0.730 and, 0.729 respectively. Digital Adaptability Supply Chain shows correlations of 0.796 with Digital Transformation and 0.787 with Distribution Efficiency Management Effectiveness. Digital Transformation shows a correlation of 0.799 with Distribution Efficiency Management Effectiveness. The Fornell-Larcker Criterion indicates that each construct's square root of AVE is greater than its highest correlation with any other construct, demonstrating good discriminant validity. This confirms

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that the constructs are distinct and measure different aspects of Digital Integrationattributes, ensuring the reliability and validity of the measurement model.

Table 4: R2 Adjusted

Variable	R2	R2 Adjusted
Digital Transformation	0.727	0.723
Distribution Efficiency Management Effectiveness	0.639	0.637

Model -1 Collaboration0.020 0.315 Sustainability0.021 0.316 Transformative0.038 0. ourmet R2 Adj Table 4 Source: Authors own elaboration from World Bank (2018, p. 66). Collaboration has an R^2 of 0.727 (Adj. R^2 = 0.723) So the model explains 72.7% of the variance in Collaboration, with the model adjusting a little for the number of predictors, with an adjusted of 72.3%. Sustainability has an R^2 value of 0.639 and an R^2 Adjusted value of 0.637, which means the model explains 63.9% of the variance in Sustainability, and less (adjusted value—63.7%) after the number of predictors. This means that Transforming has an R^2 of 0.665 and an R^2 Adjusted of 0.662, meaning that 66.5% of the variance in Transforming is explained by the model, with an adjusted value of 66.2% In sum, they indicate robustness of the model with respect to the established variables of Collaboration, Sustainability, and Transforming; i.e., very little decrease in explained variance after correction.

Table 5 After making adjustments, the demographic data paints a picture of a well-rounded representation among the participants in our research. The distribution seems to reflect a balanced mix across different categories. Looking at gender, it's evident that men make up a significant majority, comprising 80% of the participants, while women represent 20%. This gender gap mirrors what we often see in the field of engineering, where men traditionally dominate. However, behind these numbers are individuals with unique stories and experiences. Age-wise of course, there is a lot of diversity which simply points towards the amount of youthful exuberance and experience that we have. The exact educational backgrounds, are as diverse; 50% of the writers' have bachelor's degrees and a whopping 30% report possession of master's or doctoral degrees. This just goes to show how much we value higher eds in our field and all the hard-working colleagues who are always on track pursuing it. But there is a lot of experience represented among our writers. In practice, many have spent years developing their skills in specific areas and as a result, the collective body of knowledge within engineering is deeper. This kind of experience is a testament to the strength and drive amongst people who have given their lives to this game. Combining all of these insights gives a complete understanding of the active and lively workforce across the engineering industry in Jordan.

Table 5: Demographic information of respondents

Characteristic	Frequency	Percentage
Gender		
Male	280	80%
Female	70	20%
Age		
Under 27	35	10 %
27-34	140	40%
35-44	105	30 %
45 and above	70	20%
Education		
Diploma	70	20%
Bachelor's Degree	175	50%
Master's/Doctorate Degree	105	30%
Experience		
Less than 10 years	35	10%

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10-14 years	70	20%
15-19 years	122	35%
20-24 years	87	25%
25+ years	35	10%
Specialization		
Business Management	157	45%
Finance & Accounting	122	35%
Social Sciences	52	15%
Other Fields	19	5%

8. HYPOTHESES TESTING

The path hypotheses, where the path coefficient is important as a result of using the PLS Algorithm function in Smart PLS 4.0 structural model (similar to beta weight in conventional regression analysis). The coefficient is a term to reveal how well different variables are related and in what order. The coefficient value can be between -1 and +1. If it is close to zero, there is no relationship. The closer the value is to -1 or +1, the stronger the negative/positive relationship. The coefficient has statistical significance, which is determined by the coefficient, standard error, T-Value, P-Value, and significance level. The standard error determines the precision of the error and smaller standard errors make greater precision. The T-value and P-value help to determine the statistical significance of the path coefficient. The P-value is a smaller value, which is always smaller or equal to 0.05, which means the relationship is statistically significant. The significance level is used to determine if the path coefficient has a statistical relationship. For the data analysis, the significance level is taken as 0.05. Through this analysis, the researcher can confidently test the hypotheses and understand the underlying relationship of the structural model, which is reliable and applicable to the target population. Shows in figure 2

Table 6: Hypotheses testing estimates

Hypo	Relationships	Standardized Beta	Standard Error	T-Statistic	P-Values	Decision
H1	**Digital Adaptability Supply Chain -> Digital Transformation**	0.370	0.112	3.316	0.001	Supported
H2	**Digital Adaptability Supply Chain -> Distribution Efficiency Management Effectiveness**	0.336	0.099	3.388	0.001	Supported
H3	**Digital Integration -> Digital Transformation**	0.204	0.126	1.619	0.106	Unsupported
H4	**Digital Integration -> Distribution Efficiency Management Effectiveness**	0.185	0.116	1.600	0.110	Unsupported
H5	**Distribution Efficiency -> Digital Transformation**	0.433	0.126	3.452	0.101	Supported
H6	**Distribution Efficiency->Distribution Efficiency Management Effectiveness**	0.393	0.116	3.385	0.000	Supported
H7	**Digital Transformation -> Distribution Efficiency Management Effectiveness**	0.907	0.031	3.663	0.000	Supported

Table 6 presents the results of hypotheses testing estimates for the relationships between various constructs: Digital Adaptability Supply Chain, Digital Integration, Distribution Efficiency, Digital

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Transformation, and Distribution Efficiency Management Effectiveness. Hypotheses H1, H2, H5, H6, and H7 are supported, as their respective relationships show statistically significant results with p-values below 0.05. Specifically, the relationships between Digital Adaptability Supply Chain and both Digital Transformation ($\beta = 0.370$, $p = 0.001$) and Distribution Efficiency Management Effectiveness ($\beta = 0.336$, $p = 0.001$) are significant. Similarly, the relationships between Distribution Efficiency and Digital Transformation ($\beta = 0.433$, $p = 0.001$) and Distribution Efficiency Management Effectiveness ($\beta = 0.393$, $p = 0.000$) are statistically significant. Moreover, the relationship between Digital Transformation and Distribution Efficiency Management Effectiveness ($\beta = 0.907$, $p = 0.000$) is also significant. However, hypotheses H3 and H4 are unsupported, as the relationships between Digital Integration and both Digital Transformation ($p = 0.106$) and Distribution Efficiency Management Effectiveness ($p = 0.110$) fail to reach statistical significance. These findings shed light on the significant impact of Digital Adaptability Supply Chain and Distribution Efficiency on Digital Transformation and Distribution Efficiency Management Effectiveness, while also emphasizing the interconnectedness between Digital Transformation and Distribution Efficiency Management Effectiveness within the context of digital supply chains.

9. CONCLUSION

The results of hypothesis testing provide rich observations about the overall relationships between interesting Digital Integrationcharacteristics, Digital Transformation and Distribution Efficiency management effectiveness. In particular, the strong positive correlations found between Digital Adaptability Supply Chain and Distribution Efficiency with Digital Transformation and Distribution Efficiency management effectiveness demonstrate how important these traits are in enhancing supply chain performance.

Engineering companies should, following the reporting of these findings focus their investment efforts on Digital Integrationsystems that are adaptable and flexible enough to be able to manage information flow effectively, while having the ability to adjust Distribution Efficiency based and use it appreciatively. By looking at the absence of statistically significant relationships for Digital Integration with Digital Transformation and Distribution Efficiency management effectiveness, many might feel that no stone has been left unturned. However, I think these preliminary analyses are quite telling. “Other conclusions might be revealed by further investigation that show more specific effects of supply chain operation agility on these factors,” they wrote in conclusion.

This robust positive correlation implies that transparent and real-time information remains the most critical element in fostering effective Distribution Efficiency management practices. Engineering companies are encouraged to focus on bettering Digital Transformation by investing in leading digital technologies and data analytics functionalities, which can effectively promote informed decision-making processes and resource optimization.

These results, therefore, advance the extant theoretical knowledge on digital supply chains by specifying and explaining the different effects that characteristics have on supply chain performance measures. It highlights the need for a more detailed understanding of Digital Integrationprocesses and its consequences on Distribution Efficiency control in engineering companies.

10. RECOMMENDATION

Invest in Digital Adaptability and Flexibility: Engineering companies need to invest in Digital Integrationsystems which can be adapted and offer flexibility as per the demand changes from time to time. That might mean adopting agile methodologies and using technologies such as IoT and cloud computing. “Enhancing Digital Transformation: All actions to improve Digital Transformation should

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be promoted wherever possible across the supply chain" Such strategies might entail deploying the enhanced data management systems, tracking technologies in real time, and analytics capabilities to provide accurate information on time for productive decisions. However, Seamless Integration of Distribution Efficiency Management and Digital Transformation: In order to capitalize on the positive impact of Digital Transformation over Distribution Efficiency management efficacy, companies should integrate their Distribution Efficiency management systems with the Digital Transformation platform smoothly. Thus, this integration will help implement proactive Distribution Efficiency optimization solutions and resolve any problems related to stockouts and excess stock. Morever, Continuous monitoring and improvement: fostering a continuous culture of improvements, engineering firms should monitor the supply chain performance metrics consistently. Furthermore, they can use feedback mechanisms to see where they need improvements. "Regular audits, implementation of performance dashboards and developing a culture that is open to innovation" could support the same (Atieh Ali et al., 2024). In addition to that, recommendations mentioned above further allows engineering companies to strengthen the supply chain, enhance Distribution Efficiency management and also achieve a suitable competitive advantage in the market.

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