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The Influence of Digital Transformation On the Re-configurability and Performance of Supply Chain: A Study of Home Appliances Manufacturing Industries in Pakistan

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Abstract
The proposed research aims at examining the effects of digital transformation on the performance of the supply chains using the mediating variables of supply chain integration, visibility and reconfigurability in the electronics, machinery and home appliances manufacturing sectors in Pakistan. Even though the digital transformation is now widely recognized as a competitive driver, there is a paucity of empirical evidence as to how digital features can be converted into quantifiable performance results in the developing economies. This study fills this gap with a proposed and tested integrated capability-based framework based on the dynamic capability theory. A quantitative, cross-sectional study design was utilized based on survey data gathered on 250 managerial respondents within the Pakistani manufacturing companies. Measurement of constructs was done on validated multi-item Likert scales. The data were analyzed with the help of a Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS to determine measurement validity, the structural relationships, mediation effects, and model fit. Findings show that digital management technologies and digital network connectivity have a positive impact on supply chain integration (β= 0.322; 0.336) and visibility (β= 0.284; 0.330). Integration of the supply chain can greatly lead to improvement in performance (β = 0.215, p =0.05) and visibility alone does not depict a significant direct effect. The model describes 62% of variance on performance of the supply chain (R^2 = 0.620). The present study has its contribution by empirically demonstrating the re-configurability of supply chains as a central mediating dynamic capability between digital transformation and performance in an emerging economy setting, which can have both theoretical and practical managerial implications.

Keywords: Digital transformation; Supply chain integration; Supply chain visibility; Supply chain re-configurability; Supply chain performance; Manufacturing industry; PLS-SEM; Pakistan; Dynamic capability theory

Introduction

The high rate of global industry competitiveness, organizational strategies, and modes of operation has also been greatly transformed by the high pace of digital technology proliferation. In contemporary manufacturing settings, digital transformation has become an inherent organizational change that incurs the redefinition of the nature of value creation, delivery, and capture across supply chains instead of a facilitating information technology program (Verhoff et al., 2021; Gregory, 2019). Buyu ozkan and Gocer (2018) and Nasiri et al. (2020) define digital transformation as the thorough implementation of the modern digital technologies, including big data analytics, cloud computing, the Internet of Things (IoT), artificial intelligence, blockchain, and digital platforms, into organizational processes, governance systems, and decision-making.

There are two basic attributes of a supply chain that may become useful in adaptive performance: supply chain integration and supply chain visibility. Supply chain integration is a metric of the coordination levels between companies, exchange of information, and the alignment of internal and external decisions made by companies with supply chain partners (Kim and Chai, 2017; Kang and Moon, 2016). Digital transformation facilitates real-time coordination between organizations, joint planning, and easy data exchange making integration possible (Prajogo et al., 2018; Kim, 2017).

The Supply chain re-configurability has turned in to a vital adaptive skill in volatile and disruptive circumstances. Dolgui et al. (2020) and Zidi et al. (2022) define re-configurability as the ability of a supply chain to rapidly and efficiently alter its form, processes, and resource deployments with respect to variations in the environment. Chandra and Grabis (2016) and Dev et al. (2016) describe this by the ability to switch suppliers, redesign the logistical networks, alteration of production capacity, and adjustment of their coordination techniques without unjustifiable expenses and time loss.

The performance of the supply chain touches on efficiency, responsiveness, dependability, adaptability, and cost effectiveness (Parmigiani, 2011; Tarigan et al., 2021). Hanaysha and Alzoubi (2022) and Tao et al. (2022) found that there is a generally expected idea that digital transformation would enhance performance by enabling the use of data in decision-making, reducing information asymmetries, and increasing the automation of processes. Nevertheless, the empirical evidence shows that the benefits of the digital transformation on performance are not universal and automatic (Zhai et al., 2022).

Pakistan provides a very relevant empirical setting when it comes to exploring the links between digital transformation, re-configurability, and performance. The manufacturing industry in Pakistan is a developing one, facing such problems as inadequate infrastructure, lack of energy, unstable organizations, and unstable business conditions (Rehman and Yu, 2020; Liu et al, 2021). At the same time, industrial sectors such as electronics, equipment and home appliances are increasingly integrated to regional and international supply chains exposing businesses to disruption and competitive threats.

Objective of the Study

The purpose of the study is to explore the impact of digital transformation on supply chain performance and re-configurability in the manufacture of electronics, machinery and household appliances in Pakistan. Whereas in the modern context, the market has become more volatile, the technology is developing at a blisteringly fast pace, and the supply chain is likely to break down at any moment, manufacturing companies need to adopt digital technologies to enhance their flexibility and competitiveness. This study intends to use empirical data to demonstrate the role of digital transformation in assisting businesses to develop essential supply chain capability that enables businesses to reconfigure continuously and to improve their performance.

Research Questions

RQ1. How does digital transformation affect the process of integrating supply chain within Pakistan manufacturing industries of electronics, machinery, and household appliances?

RQ2. How does digital transformation lead to supply chain visibility within the manufacturing industries of Pakistan in terms of machinery, electronics, and home appliances?

RQ3. What impact does digital transformation have on supply chain reconfigurability in the industrial sector of Pakistan?

RQ4. What is the relationship between supply chain visibility and supply chain integration and supply chain reconfigurability in the home appliance, machinery and electronic industries of Pakistan?

RQ5. What is the impact of supply chain reconfigurability on the supply chain performance of manufacturing industries of Pakistan in the fields of machinery, electronics and home appliances?

RQ6. Does supply chain reconfigurability mediate the relationship between the digital transformation and the supply chain performance?

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Literature Review

The aim of the chapter is to critically evaluate the existing literature on supply chain integration, visibility, efficiency, re-configurability and digital transformation. Along with establishing the key gaps in the research, which can be used to validate the proposed conceptual framework, the chapter also outlines the theoretical framework underpinning the study. The hypotheses of the chapter derive out of the past empirical and theoretical studies, in particular, the domains of Industry 4.0, digital supply chain, dynamic capabilities and reconfigurable systems and are used to elucidate the relationships between the variables being investigated in the context of electronics, machinery and home appliances manufacturing sectors in Pakistan.

Sambamurthy et al. (2003) and Zhai et al. (2022) define the term of digital transformation (DT) as the process of integrating digital technology through organizational structures, procedures, and strategies in such a way that generates and improves performance and value significantly. In the supply chain context, digital transformation comprises the technologies that enable connectivity and automation as well as real-time decision making: blockchain, digital twins, enterprise information systems, big data analytics and cloud-based platforms (Ivanov, 2021; Queiroz et al., 2020).

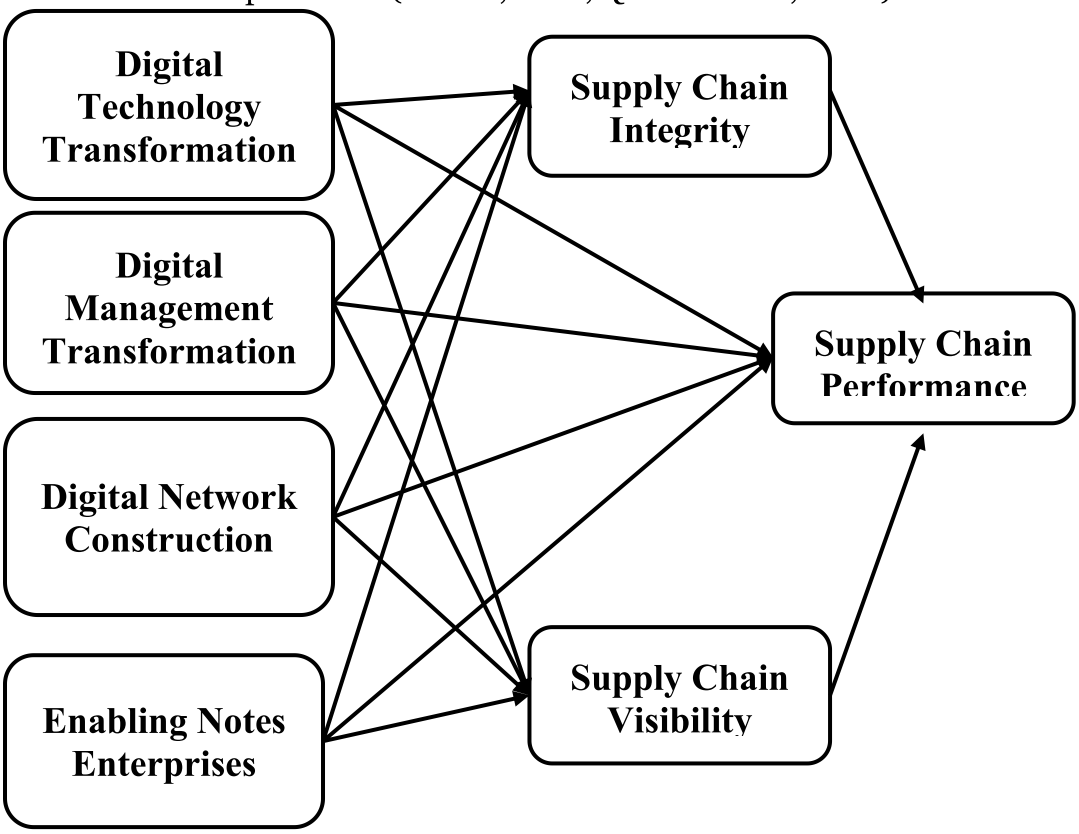

Figure 1 Conceptual Framework

According to the model, the supply chain performance will be directly and indirectly affected by digital transformation. Two of the key supply chain capabilities that realize indirect impacts are Supply Chain Visibility and Supply Chain Integrity (integration). Supply chain visibility is the ability of the firm to retrieve speedy, correct, and open information regarding the operations of the supply chain, and supply chain integrity is the degree of internal and external alignment, coordination, and collaboration among the partners of the supply chain. The hypothesis is that the two skills are enabling mechanisms, which enhance the overall supply chain performance by digital transformation. The study methodology is based on the dynamic capacity hypothesis that argues that the businesses achieve extraordinary performance by developing the skills required to identify any changes in the environment, understand opportunities, and deploy the resources accordingly. In this sense, digital transformation is a pre-requisite competence that enhances better performance outcomes through strengthening supply chain visibility and connection. The framework provides a systematic basis of making measurements, running hypotheses, and testing structural models using PLS-SEM.

Hypothesis Development

Digital Supply Chain and Integration

Flynn et al. (2010) define supply chain integration (SCI) as the level of coordination and collaboration between the internal operations and external suppliers and consumers of the supply chain, including suppliers and consumers. It involves the exchange of information, collaborative planning and decision-making across organizational boundaries. Gupta et al. (2019) note that digital transformation promotes integration in a supply chain significantly by providing the digital integrated platforms and communication technologies that reduce information silos. As mentioned by Chen et al. (2019) and Mohr and Spekman (1994), the latest technologies, such as ERP systems, blockchain, and collaborative digital platforms, can facilitate the smooth exchange of data, increase trust levels among partners, and align operational objectives.

H1: Digital transformation has a strong and positive effect on supply chain integration.

Supply Chain Visibility and Digital Transformation

Supply chain visibility (SCV) refers to the extent to which the supply chain actors are able to receive timely and relevant information on supply chain inventory, manufacturing, flow of materials, and demand conditions across the supply chain (Basole & Bellamy, 2014). Digital transformation provides an answer to the increased visibility, and includes technologies of real-time data collection such as RFID, IoT sensors, blockchain-based tracking systems, and advanced analytics solutions (Ivanov, 2021; Chen et al., 2020). By employing these tools, companies will be able to monitor the activities of the supply chain, anticipate the disruption, and preempt.

H2: Digital transformation is positively and significantly related to supply chain visibility.

Supply Chain Integration and Re-configurability of supply chain

Zidi et al. (2022) define supply chain re-configurability (SCR) as the ability of a supply chain to respond to changes and disruptions in the environment by altering the network configurations, procedures, and resources of the supply chain. It is regarded as a dynamic ability that assists the businesses to identify changes, exploit opportunities, and reorganize their operating structures (Teece, 2007). Supply chain integration is the potential capability of re-configurability. The integrated supply chains also allow rapid coordination during the transition, collective decision-making, and efficient redistribution of resources (Zidi et al., 2022). Companies that are more internally and externally integrated find it easier to redesign supplier networks, change the production processes and realign logistics systems.

H3: Supply chain integration has a significant and positive influence on supply chain re-configurability.

Supply Chain Re-configurability and Supply Chain Visibility

Balole and Bellamy (2014) say that visibility in the supply chain will enhance the ability of any business to quickly detect bottlenecks, changes, and alternative configurations. To make reconfiguration choices successfully, visibility provides the informational foundation to such choices. The research shows that visibility assists businesses in the ability to forecast interruptions, model various supply chain scenarios, and carry out reconfiguration plans successfully (Ivanov, 2021; Zidi et al., 2022). Reconfiguration attempts can fail or take longer to complete in case visibility is poor.

H4: Supply chain visibility has a positive and significant influence on re-configurability of the supply chain.

Supply Chain Re-configurability and Supply Chain Performance

Supply chain performance (SCP) is the efficacy and efficiency of supply chain activities in terms of cost, responsiveness, dependability, flexibility and service quality (Gunasekaran et al., 2004). Reconfigurable supply chains are better positioned to import and export during ambiguity and interruption. Some studies (Zidi et al., 2022; Ivanov, 2021) claim that re-configurability enables businesses to reduce downtime, optimize resource utilization, and maintain the level of customer service in a volatile environment. Companies can take

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the initiative of adjusting the supply chain architecture passively, rather than in response to changes, due to the reconfigurable technologies.

H5: Supply chain re-configurability is positively and significantly related to supply chain performance.

Mediating Role of Supply chain re-configurability

Digital transformation enhances the integration and visibility at the very least and can indirectly impact performance by increasing the higher-order dynamic capabilities such as re-configurability. The dynamic capacity theory suggests that the only way to realize performance results in an organization is by reconfiguring the resources (Teece, 2007). It has been established that the mediating power of re-configurability can be seen in the connection between digital capabilities and performance outcomes (Zidi et al., 2022; Ivanov, 2021). Whereas action is possible through re-configurability, sensing and coordination are possible through digital transformation.

H6: Supply chain re-configurability mediates between digital transformation and supply chain performance.

Research Methodology

Research Design

The positivist research theory the study is based on states that the correlations between constructs can be objectively evaluated and tested statistically. Since the research seeks to confirm hypothesized correlations developed based on the existing theory using real data, positivism can be used in this study. It employs a deductive research methodology whereby theories are developed out of the literature and then tested using quantitative methods. In the given research environment, this approach will ensure the scientific rigor and enhance the external validity of the findings.

A cross-sectional study is the method used to collect respondent data at a specific point in time. This design is effective in examining the progress of supply chains of manufacturing companies, and digital transformation are currently at the moment. The respondents at a managerial level are sought to provide the data collected as they have adequate knowledge of supply chain operations and digital initiatives in their company, and the business is the unit of analysis. The survey method (survey) is the one adopted in the research as it is widely used in governmental research on supply chain and information systems because it is an efficient tool to collect organizational level and perceptual data.

The target population consists of Pakistani manufacturing firms that deal with electronics, industrial, and household appliances manufacturing industries. They were selected due to their strategic importance to the industrial foundation of Pakistan, their increasing exposure to digital technologies, as well as their complex structures of a supply chain that requires a high level of coordination, visibility, and re-configurability. The sampling technique is non-probability purposive. The strategy is appropriate because the survey will invite the responses of individuals who are directly involved in operations, supply chain management, digital transformations initiatives, or strategic decision-making. The common respondents include senior executives, IT managers, logistics managers, supply chain managers, and operations managers.

The sample size is determined according to the recommendations of PLS-SEM that focus on statistical power over population representativeness. Using ten-times rule and more up-to-date power analysis-based guidelines requires a minimum sample size that is more than ten times the largest value of the structural routes that the model construct purports to cover. In the end dataset, there are approximately 250 acceptable replies, which is sufficient to ensure the hypothesis test and sound estimate.

Data Collection

Data is collected using a self-administered systematic questionnaire. In order to get more response rates, the survey is distributed online and physically. Pilot research is conducted on a small sample of respondents to determine the time and clarity and relevance of the pilot study before full scale data collection is undertaken. The layout of the questionnaire and phrasing is enhanced according to the suggestions of the pilot research. Ethical standards which include informed permission, confidentiality, and anonymity are strictly followed throughout the entire data collection process.

Measurement of Constructs

Each of the operationalized reflective latent variables of the study is measured using multi-item scales based on previous studies that have been verified. It has a five-point Likert scale where 1 represents strongly disagree and 5 strongly agree. Digital transformation is a complex notion that consists of digital tools and technologies (DTT), digital networking and collaboration (DNC), digital management technologies (DMT), and enabling digital environment (ENE). The measurement items were based on previous studies on the adoption of digital transformation and Industry 4.0. Supply chain integration reflects the level of both internal and external cooperation between the members of the supply chain. Items in the supply chain capture the exchange of information, process alignment and collaborative decision-making. Supply chain visibility is the ability of the company to get quick, precise and comprehensive information regarding the supply chain. Measurement aspects focus on accessibility of data, openness and real-time tracking. The supply chain performance is measured using indicators that relate to effectiveness, responsiveness, efficiency and dependability. The concept captures both the strategic and operational performance results.

Data Analysis Technique: PLS-SEM

PLS-SEM is implemented with the use of Smart PLS 4.0 software. Such an approach is acceptable because the research is exploratory, the research model is complex, and the study has a number of mediation channels. PLS-SEM is suitable in both theory extension and prediction studies because it does not require multivariate normality.

Results and Discussion

This chapter presents the research The Influence of Digital Transformation on the Re-configurability and Performance of Supply Chain: A Study of the Electronic, Machinery, and Home Appliances Manufacturing Industries in Pakistan and its data analysis and empirical results. The primary objective of this chapter is to evaluate the proposed research framework and apply the partial least squares structural equation modeling (PLS-SEM) in testing the hypothesized connections. The reason why PLS-SEM was selected as the method of analysis is that it is free to complex research models, prediction-focused studies, and non-normal data distribution all of which are common in behavioral and management research. The analysis was conducted with the help of Smart PLS 4.0 software with the two-step approach recommended by Hair et al. (2019) that includes (1) measurement model evaluation and (2) structural model evaluation.

Reliability and Validity Analysis

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
DMT	0.855	0.863	0.902	0.698
DNC	0.705	0.708	0.871	0.772
DTT	0.793	0.800	0.879	0.707
ENE	0.775	0.783	0.898	0.815
SCI	0.795	0.797	0.880	0.709
SCP	0.807	0.812	0.886	0.722
SCV	0.809	0.812	0.887	0.724

Table 1 Reliability and Validity Analysis

The construct reliability and convergent validity analysis ensures the robustness of the measuring instruments, their internal consistency, and validity because all the latent variables in the measuring-model meet and exceed the a priori requirements of PLS-SEM. Specifically, all constructs show

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the value of Cronbach's alpha, as ranging between 0.705-0.855, which is above the minimum acceptable threshold of 0.70, which points to the acceptable internal consistency reliability and means that indicators in each construct are consistent in measuring the same underlying concept. Moreover, the values of composite reliability also confirm this conclusion, as both rho a and rho c point to the fact. The values of rho a are between 0.708 and 0.863 and rho c is between 0.871 and 0.902 which is much greater than the recommended 0.70. These findings provide evidence of the high level of common variance between the indicators and explain the possibility of measurement error, which provides a deeper measurement of reliability than Cronbachs alpha. Also, the average variance extracted (AVE) of all constructs that have values ranging between 0.698 and 0.815 exceed the most important 0.50 threshold. This provides the strong evidence of convergent validity and indicates that both constructs explain more than half of the variance in the indicators. Constructs such as ENE (AVE = 0.815) and DNC (AVE = 0.772) have quite high scores, which suggests that their indicator to construct correlations are very high and that there is minimal measurement error.

Discriminant Validity

	Heterotrait-monotrait ratio (HTMT)
DNC <-> DMT	0.732
DTT <-> DMT	0.683
DTT <-> DNC	0.782
ENE <-> DMT	0.772
ENE <-> DNC	0.737
ENE <-> DTT	0.683
SCI <-> DMT	0.796
SCI <-> DNC	0.867
SCI <-> DTT	0.694
SCI <-> ENE	0.738
SCP <-> DMT	0.772
SCP <-> DNC	0.853
SCP <-> DTT	0.781
SCP <-> ENE	0.774
SCP <-> SCI	0.832
SCV <-> DMT	0.808
SCV <-> DNC	0.911
SCV <-> DTT	0.818
SCV <-> ENE	0.745
SCV <-> SCI	0.772
SCV <-> SCP	0.811

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Table 2 Discriminant Validity

The rigorous measure of the discriminant validity of the measurement model was done using the Heterotrait-Monotrait ratio (HTMT) which is commonly considered as the most stringent and credible test of construct distinctiveness in variance based structural equation modeling. These results give strong empirical evidence in the fact that all conceptions are conceptually and statistically distinct phenomena since by a large margin most of the values in HTMT are below the conservative value of 0.85 and the more liberal one 0.90. The values of the fundamental exogenous constructs such as DNC and DMT (0.732), DTT and DMT (0.683), DTT and DNC (0.782), ENE and DMT (0.772), ENE and DNC (0.737) and ENE and DTT (0.683) in particular remain well within the acceptable range indicating that these constructs represent unique and non-overlapping elements of the supply chain digitalization structure despite being theoretically linked to each other under the broad umbrella Moreover, since connectivity is a critical factor that enables inter-organizational integration, the values of the HTMT between mediating construct of supply chain integration (SCI) and the exogenous variables are between 0.694 and 0.867, which again proves that SCI is empirically different but the theoretically significant links between it and digital capabilities, especially digital networking and connectivity (DNC).

Just like this, the supply chain performance (SCP) relationships have HTMT values of 0.772, 0.853 and all these remain below critical cut-off values. This means that SCP does not mix up with its antecedents or mediators but is a unique outcome construct that evaluates advances in operational and strategic performance as compared to technological performance in and of itself. Whereas the HTMT value of SCV verses DNC (0.911) is somewhat over the heedful 0.90 mark, the majority of the HTMT values are also within the limited range with reference to supply chain visibility (SCV), which implies its discriminant validity relative to DMT, DTT, ENE, SCI, and SCP. Since existing methodology literature acknowledges that a value slightly greater than 0.90 can be regarded as acceptable when conducting research that theoretically distinct, yet conceptually close constructs, this is not a major threat to discriminant validity within the framework of a complex, theory-based model.

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PLS SEM Bootstrapping

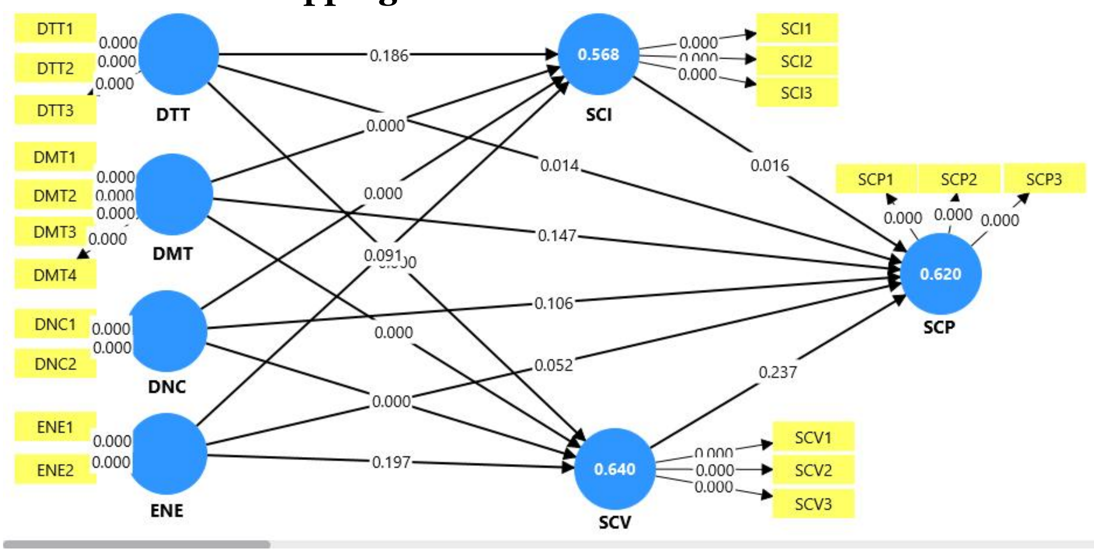

Figure 2 PLS SEM Bootstrapping

Hypothesis Testing

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
DMT -> SCI	0.322	0.323	0.083	3.891	0.000
DMT -> SCP	0.132	0.129	0.091	1.452	0.013
DMT -> SCV	0.284	0.285	0.075	3.783	0.000
DNC -> SCI	0.336	0.336	0.075	4.474	0.000
DNC -> SCP	0.153	0.156	0.095	1.618	0.011
DNC -> SCV	0.330	0.329	0.075	4.381	0.000
DTT -> SCI	0.103	0.105	0.078	1.324	0.186
DTT -> SCP	0.195	0.198	0.080	2.448	0.014
DTT -> SCV	0.252	0.252	0.071	3.526	0.000
ENE -> SCI	0.138	0.136	0.082	1.688	0.015
ENE ->	0.149	0.149	0.077	1.945	0.012

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SCP					
ENE -> SCV	0.097	0.098	0.075	1.290	0.197
SCI -> SCP	0.215	0.215	0.089	2.407	0.016
SCV -> SCP	0.116	0.115	0.098	1.182	0.237

Table 3 Hypothesis Testing

The structural path analysis provides detailed data regarding the direction, strength and statistical significance of the suggested links within the model when analyzed by bootstrapping methods. The results reveal that the digital management technology (DMT) has a positive effect on supply chain integration (SCI) (β=0.322, t = 3.891, p = 0.001) and supply chain visibility (SCV) (β=0.284, t = 3.783, p = 0.001), which means that the improved level of DMT capabilities produces a strong positive influence on transparency in information and integrative coordination among the partners of the supply chain. However, DMT has a direct influence on supply chain performance (SCP). Although positive (β= 0.132), it has a slightly higher statistical significance and lower magnitude (t = 1.452, = 0.013), which suggests that the effect of DMT on the outcome of performance is indirect and occurs mainly via mediating variables, such as SCI and SCV, instead of a direct relationship. Similarly, digital networking and connectivity (DNC) emerges as one of the strongest antecedents in the model that has strong and highly meaningful impact on SCV (β= 0.330, t = 4.381, p = 0.001) and SCI ((β= 0.336, t = 4.474, p = 0.001), and the importance of the integration and visibility constructs as mediating factors is immense; , yet, has rather a minor effect on SCP (β= 0 Digital tracking and traceability technologies (DTT), in turn, display a somewhat important and significant impact on SCP (β= 0.195,t= 2.448,p= 0.014) and SCV (β=0.252, t=3.526, p=0.001), which reveals that DTT has a direct positive impact on operational performance and real-time visibility through better monitoring, traceability, and control in the supply chain activity.

Meanwhile, DTT shows a non-significant effect on SCI (β = 0.103, t = 1.324, p = 0.186), suggesting that tracking technologies alone are insufficient to foster deeper supply chain integration. The findings for energy or environmental efficiency (ENE) show a mixed pattern of effects: while ENE has a statistically non-significant effect on SCV (β = 0.097, t = 1.290, p = 0.197), it has a significant positive influence on SCI (β = 0.138, t = 1.688, p = 0.015) and SCP (β = 0.149, t = 1.945, p = 0.012), suggesting that sustainability-oriented practices contribute to integration and performance.

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Additionally, SCI shows a statistically significant positive effect on SCP (β = 0.215, t = 2.407, p = 0.016), confirming that higher levels of coordination, collaboration, and alignment among supply chain partners lead to superior performance outcomes. These mediating relationships within the model also highlight the critical role of supply chain integration. On the other hand, even while the route from SCV to SCP is positive (β = 0.116), it does not reach statistical significance (t = 1.182, p = 0.237). This suggests that visibility alone is not enough to increase performance unless it is successfully utilized through integrative decision-making processes. Together, these results offer solid empirical support for the suggested model by showing that digital capabilities have the biggest indirect effects on supply chain performance through integration and visibility mechanisms, with supply chain integration emerging as the predominant mediating pathway. This supports the theoretical idea that digital resources must be integrated within cooperative and coordinated structures in order to produce significant performance gains.

PLS SEM

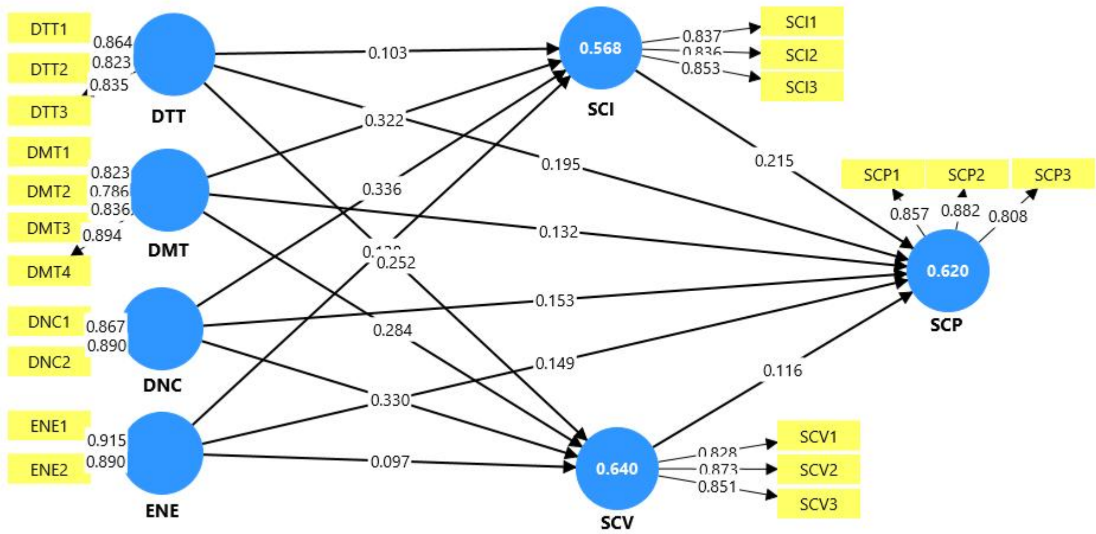

Figure 3 PLS SEM

Supply chain outcomes are greatly influenced by organizational and digital capabilities, both directly and indirectly, as the results of the structural model show a consistently positive pattern of interactions among the studied constructs. In particular, DMT shows a moderate impact on supply chain visibility (SCV) (β = 0.284) and a strong positive effect on supply chain integration (SCI) (β = 0.322), indicating that improved digital management practices significantly improve coordination, information sharing, and transparency across supply chain partners. However, its direct impact on supply chain performance (SCP) remains relatively weak (β = 0.132), suggesting that its performance benefits are primarily realized through mediating mechanisms.

Outer Loadings

	Outer loadings
DMT1 <- DMT	0.823
DMT2 <- DMT	0.786
DMT3 <- DMT	0.836
DMT4 <- DMT	0.894
DNC1 <- DNC	0.867
DNC2 <- DNC	0.890
DTT1 <- DTT	0.864
DTT2 <- DTT	0.823
DTT3 <- DTT	0.835
ENE1 <- ENE	0.915
ENE2 <- ENE	0.890
SCI1 <- SCI	0.837
SCI2 <- SCI	0.836
SCI3 <- SCI	0.853
SCP1 <- SCP	0.857
SCP2 <- SCP	0.882
SCP3 <- SCP	0.808
SCV1 <- SCV	0.828
SCV2 <- SCV	0.873
SCV3 <- SCV	0.851

Table 4 Outer Loadings

The results of the evaluation of the measurement model show that strong indicator reliability and good convergent validity occur across all the latent variables because the outer loading values are consistently high. The four items are strong and sound descriptions of the concept back to which they belong because the indicators of DMT have high loadings between 0.786 and 0.894. The greatest contribution is made by DMT4, and the $\lambda = 0.894$. The indicators of DNC construct also represent it well, with high loadings of 0.867 and 0.890 of DNC1 and DNC2 indicating strong conceptual representing of the latent variable and indicator reliability respectively. The values are loaded far higher than the recommended level of 0.70 with values of 0.823-0.864 indicating the strong measurement properties of the DTT construct as well as indicating that the indicators are dependable in reflecting the construct. ENE has the highest quality of measurement of all constructs with very high loadings of ENE1 (0.915) and ENE2 (0.890). The error of measurement is

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minimal, and the amount of common variance between the indicators and the latent construct is high.

R-Square

	R-square	R-square adjusted
SCI	0.568	0.558
SCP	0.620	0.607
SCV	0.640	0.632

Table 5 R-Square

The structural model is robust in the elucidation of variation in the context of the supply chain as seen in the coefficient of determination (R2) values which reveal that the structural model has a substantial power of explanation of all the endogenous constructs. Specifically, the R2 of supply chain integration (SCI) is 0.568, with adjusted R^2 0.558, that is, DMT, DNC, DTT, and ENE can explain supply chain integration across supply chain partners accounting to approximately 56.8 percent of this variance, which, according to PLS-SEM research, is considered important (Boo, 2018, p. 314). Similarly, the supply chain performance (SCP) exhibits an R^2 of 0.620 and adjusted R 2 of 0.607 indicating that its predictors, including the SCI, SCV, and the exogenous constructs, explain the variation in performance results by 62.0%. This indicates that the model is able to capture the key forces that determine supply chain performance and has a strong empirical backing to the proposed theoretical relationships. Besides, the supply chain visibility (SCV) in the model presents the highest explanatory value with an R^2 of 0.640 and adjusted R^2 of 0.632 meaning that the antecedent structures explain 64.0 percent of the variation in visibility.

Model Fitness

	Saturated model	Estimated model
SRMR	0.061	0.062
d_ULS	0.791	0.795
d_G	0.492	0.493
Chi-square	532.793	534.074
NFI	0.754	0.754

Table 6 Model Fitness

Some of the many goodness-of-fit indices that were applied to evaluate the overall model fit of the proposed PLS-SEM framework include the standardized root mean square residual (SRMR), the squared Euclidean distance (d uls), the geodesic distance (d G), the chi-square statistics, and the normed fit index (NFI). This has enabled the extensive testing of the ability of the model to replicate the observed data. The estimated model (0.062) and the saturated model (0.061) have a SRMR of considerably less than the

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recommended threshold (0.08). This is an indicator that the general model exhibits a good level of approximate fit and that the level of discrepancy between the observed and model-implicated correlations is low. Stability and resilience of the model specification are also supported by the fact that the SRMR of both saturated and estimated models are very close to each other indicating that the addition of structural routes does not contribute largely to misspecification. Besides, the d_ULS values of 0.791 of the saturated model and 0.795 of the estimated model, and d_G values of 0.492 and 0.493 of the empirical and model-implied correlation matrices, respectively, remain in the acceptable scales, showing that the disparities between the empirical and model-implied correlation matrices are not significant and do not signal structural shortcomings. It is anticipated that in complex models, using the chi-square measures, with which chi-square sensitivity to sample size is well-documented, relatively large values (532.793 with the saturated model and 534.074 with the estimated model) will occur with a large number of indicators and sample size. Consequently, they do not ought to be taken as evidence of ill model fit.

Discussion

It merges more theoretical justifications with the contextual interpretations relevant to the manufacturing industries in Pakistan related to the electronics, machinery, and home appliances with the real data presented in Chapter 4. Besides rephrasing the findings of the statistical analysis, this essay seeks to explain the cause and effect of these correlations, their implication on business, policy and philosophy. The findings of the structural model provided in Chapter 4 demonstrate that, although with varying degrees based on the dimension of digital, there is a significant influence of digital transformation on both performance and re-configurability of the supply chain. Digital manufacturing technologies (DMT), digital network connection (DNC), and even digital traceability technologies (DTT) affect supply chain integration, supply chain visibility, and ultimately supply chain performance differently. These findings prove that digital transformation is a complicated process whose impacts depend on the nature and the level of advancement of the technologies in use.

The results that have been found are that digital manufacturing technology (DMT) has a strong influence on supply chain integration (= 0.322, p = 0.001) and supply chain visibility (= 0.284, p = 0.001). This implies that automation, digitally linked shop-floor technology, real-time monitoring of production, and smart systems of manufacturing enhances internal department-external supply chain associates coordination. The inherent digital manufacturing technologies are a core ability that aligns procurement, production, and distribution operations in the Pakistan manufacturing industry where the production processes are often typified by manual coordination, disjointed planning, and lack of real-time information. The previous studies have revealed that digital manufacturing has a better effect on the operational synchronization and reduces coordination inefficiencies (Hofmann et al., 2019; Schniederjans et al., 2020). These findings are confirmed by this empirical data. In the perspective of dynamic capability, DMT enhances the flexibility of the supply chain through the ability of the businesses to recognize the interrupters in the operation and to respond to these changes accordingly.

Conclusion

This study was meant to investigate the effect of digital transformation on supply chain performance and re-configurability in terms of electronics, machinery, and household appliances industrial sectors in Pakistan. The paper provides concrete empirical evidence that digital transformation is a key to enhancing supply chain flexibility and performance results through a PLS-SEM approach. The results indicate that digital transformation has a great influence on supply chain re-configurability, which, in its turn, has a strong positive impact on the performance of supply chains. Based on these findings, companies can respond to operational disruptions, environmental vagaries and even competition better when they possess reconfiguration skills provided by the digital technology. The mediating role of supply chain re-configurability offers its strategic importance in the context of the connection between performance enhancement and digital capabilities.

In general, integrating both the supply chain re-configurability and the digital transformation in the explanatory framework is a contribution to the scientific body of knowledge and also a useful source of information to the Pakistani managers and policymakers. The research provides a firm ground on which additional research and practical implementation can be conducted in developing countries because it reveals how digital transformation has become a strategic position through which adaptable and efficient supply chains can be realized.

Future Research Directions

The findings present brief and helpful data to managers and professionals operating in the manufacturing industries in Pakistan. To begin with, the results indicate the necessity of strategic alignment between investments in digital technology and the projects of reconfiguration of supply chains. Managers would like to focus on integrating digital technologies in the primary decision-making of the supply chain, including digital platforms, enterprise systems, and real-time data analytics. The second performance lever that is significant that comes to mind is supply chain re-configurability. As a response to market shocks, variable demand or technology development, managers are encouraged to develop flexible logistical structures, as well as, flexible supplier networks and modular manufacturing systems that can be rapidly reconfigured. Digital transformation enables this flexibility to be possible as it improves the flow of information, coordination, and visibility among supply chain participants.

Third, the findings highlight the importance of investing in organizational competencies besides technology. To achieve the maximum of the performance benefits of digital transformation, training employees, the development of digital skills, and the culture of innovation and agility are necessary.

The results present meaningful policy suggestions to the governmental organizations and business authorities in Pakistan. Policymakers ought to design training programs, subsidies, and special incentives to motivate manufacturing companies, particularly the small and medium-sized enterprises (SMEs) to adopt digital technology. The improved use of communications between firms, cybersecurity systems, and digital infrastructure can be used to further increase the competitiveness and resilience of supply chains at the national level. Industry groups and politicians can also use the results to develop sector-specific digital roadmaps that would make the industrial supply chains in Pakistan more powerful and closer to the global value chains.

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