Exploratory Study on the Impact of Digitalisation of the Supply Chain on Performance and Visibility in the Indian Manufacturing Context

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Abstract

In a rapidly changing world where technology is constantly evolving. The ultimate goal of any supply chain is to achieve end-to-end transparency by means of analysis of real time data. With the onset of the pandemic several supply chains have crippled. The inception of an intelligent supply chain can open doors to create a transformation in the existing supply chain management system into one that is independent and self-conditioning. Various tools such as Cloud Computing, Internet of Things, Big Data Analytics, sensors, etc. can be used for the digitalization of the supply chain. In the Indian Manufacturing industry, while multinational companies are aggressively working towards digitalizing their supply chains, the MSME sector is reluctant to undergo this transformation. The possible reasons for this might be the lack of information and research available which truly understands the benefits reaped by companies which have digitalized their supply chains in this sector. The focus of this research is to conduct an exploratory study on the impact of digitalization on the manufacturing industry. The study is based on data collected from a survey, which upon analysis using confirmatory factor analysis and structural equation modeling reveals that digitalization has a positive and direct influence on visibility and performance. Inculcation of digitalization improved transparency between the supplier, retailer and distributor. It also highly positively impacts the planning operations for MSME companies in the Indian manufacturing sector. Some of the most beneficial aspects were the performance of the order fulfillment rate followed up by the economic performance.

Keywords
Digitalization, Indian Manufacturing, MSMEs, Sobel Test and Structural Equation Modeling (SEM).

1. Introduction
In a world that is rapidly evolving and changing, the impact of technological innovations is constantly felt. Digital technologies have advanced faster than any other innovation owing to a majority of the world's population having increased access, and in just two decades resulting in significant changes to basic processes across a wide range of businesses.

According to a McKinsey report, Digital applications could improve almost every sector of India's economy. Information technology and business process management, digital communication services, and electronics manufacturing hold the capability to double their GDP to $355 billion to $435 billion by 2025. New digital ecosystems are already forming in agriculture, healthcare, retail, logistics, and other industries, redefining consumer-producer interactions (N. Kaka et al.2019).

India plans to raise the contribution of the manufacturing industry to the GDP from 15 % to 25% (S Mathur 2019). To accomplish so, a network of tier 1, tier 2, and tier 3 suppliers with high levels of quality, flexibility, and efficiency

is required, with a focus on maintaining this expansion. Industries can overcome the ever-increasing difficulties in their highly dynamic marketplaces by blending the virtual and real worlds of production with digital technologies. Lower costs, higher manufacturing quality, flexibility and efficiency, and a faster reaction time to customer requests and market demands are all benefits of digitalization, which also offers new and innovative business options.

While some large enterprises in India have been fast to embrace digital technology, the bulk of Small and Medium Enterprises (SME) in the manufacturing sector have yet to do so. Small and medium-sized businesses form the backbone of industrial development. Small-scale industries have contributed significantly to the country's industrial development, accounting for 40% of total industrial output (Mathur, 2021). This sector directly accounts for 35 percent of the country's total manufactured exports and generates employment for up to 36 million people, second only to agriculture in terms of job creation.

Despite the fact that SMEs make up the bulk of the industry, they are currently confronted with a number of difficulties that are impeding their growth. The most critical issues for SMEs are constant quality improvement, scope, and expansion. Extensive manual intervention in processes, interrupted data flow, and a lack of competent staff are all contributing issues (Abdulaziz Albaz et al. 2020). Only when the SME sector joins with enhanced technology and skills will manufacturing have a long-term future. SMEs can improve efficiency through digitalization to combat scale, lower production costs, decrease manufacturing defects, and cut production time. They will not only be able to achieve international quality requirements, but they will also be able to boost their position as competent worldwide suppliers.

To enhance the working and efficiency of the SME supply chains and in turn the overall performance, there is a need to upgrade from the traditional supply chain to a digital one.
The traditional supply chain was all about procurement, storage and distribution (plan and react). However, the new digital supply chain is all about prediction and prescription of the actions to take. Supply chains have come a far way from being just purely operational processes to an advanced planning process with the incorporation of analytics from real time data, leading to completely independent supply chain systems.
The eventual aim of any supply chain is end-to-end transparency achieved through real-time data. The upgradation of supply chains with the help of technology can help achieve this goal, leading to an increase in responsiveness and decrease in cost.

In today's times, when the COVID-19 pandemic has left countless supply chains crippled around the world, now more than ever, the need of having an agile and responsive supply chain is needed.
Digitalization is predicted to play a major role for supply chains globally. With the rapidly changing economic environment and increasing dynamic customer demands, the supply chain must transform itself into a more flexible and agile system, with accelerated process speeds and transparency or visibility across the chain in order to enhance responsiveness. The inception of an intelligent supply chain with the incorporation of analytics and smart devices can open doors to create a massive transformation in the current supply chain management systems into independent and self-conditioning ones. Various tools such as Cloud Computing, Internet of Things, Big Data Analytics, sensors, RFIDs, drones, additive manufacturing, robotic systems, augmented reality, Enterprise Resource Planning software (ERP), etc. can be used for the digitalization of the supply chain.
With the increasing level of stakeholders, more complex networks and multimodal distributions, the call for end-to-end visibility in supply chains is more than ever before. The capability to track individual components, sub-assemblies, and final goods as they journey from supplier to manufacturer to consumer is known as supply chain visibility. Visibility's main aim is to improve and bolster the supply chain. It helps prevent errors in orders, keep track of inventory, helps reduce risk and ultimately cost, etc.

The true impact of digitalization on the supply chain can be measured directly by the impact on performance of the supply chain. The aim of using metrics to measure the supply chain performance is to be able to hold accountability on the levels of performance of the chain. The employment of digital supply chains helps achieve a transparent supply chain which improves the visibility and in turn improves the performance of a supply chain. Enhanced visibility helps track performance expectation, improves communication and helps achieve future goals sooner.

The motivation for this project was to conduct an exploratory study to gauge the impact of digitalization for the MSME companies, which have upgraded their processes with the help of technology and the improvements they experienced in their chain performance as well as the impact on the overall visibility. The outcome of this study would then be to

benefit MSME leaders to understand the impact of digitalization which would then aid them to take a call as to whether digitalization would benefit them or not.

1.1 Objectives

To conduct an exploratory study on the impact of digitalization of the supply chain with respect to performance and visibility in the Indian manufacturing context.
In order to achieve this objective, the following hypothesis were drawn:
H1: Digitalization has a significant direct and positive influence on performance of the supply chain.
H2: Digitalization has a significant direct and positive influence on visibility throughout the supply chain.
H3: Visibility has a significant mediating effect on the indirect relationship between digitalization and performance.

2. Literature Review

2.1 Digitalization

Digitalization is the process of combining technology with a specific activity to improve it. This can be done with a product, a process, or even a supply chain in mind. The modern era is referred to as the "digital age" due to the huge impact digital technologies have on every aspect of our lives. Today, digitalization is viewed as an instrument for change that affects how businesses transact, interact, and function.
The various technologies that can be used for digitalization of the supply chain include but are not limited to; cloud computing, internet of things (IoT), big data analytics, sensors, RFIDs, drones, additive manufacturing, robotic systems, augmented reality, enterprise resource software (ERP) etc.
The inclusion of these technologies in the supply chain can lead to various advantages such as a reduction in the bullwhip effect, increase in traceability throughout the chain, increased information sharing and informed decisions based on real time data.

2.2 Visibility

Visibility with respect to the supply chain means transparency between the various segments and processes in the supply chain. It also leads to the increase in inter collaboration between the various teams in the chain, leading to a more effective and efficient supply chain. One of the biggest advantages of visibility throughout the chain is increased responsiveness, which has a domino effect of advantages, such as decrease in the holding inventory stock, lesser time to get the product from the distribution centers to the retail stores and increased tracking throughout the chain.

The main advantages of better visibility of the supply chain are: It makes agility possible. Visibility allows you to face anything with the management of a supply chain and make the necessary changes to increase productivity regardless of the conditions. It enhances speed. Data-backed decision-making allows the next step to be taken beforehand to increase the pace of action. Their agility goes hand in hand. It also reduces disturbances. A powerful data analysis and communication supply chain helps spot problems well beforehand and therefore takes time to solve them efficiently.

2.3 Performance

The performance measurement of the supply chain can be characterized as a methodology to assess the performance of a supply chain. The performance of a company's supply chain is critical to its growth. It determines an organization's

capabilities and whether it has the potential to achieve its long-term organizational goals. The behavior of an organization must be constantly monitored to ensure that there are no revenue losses or poor long-term growth.

Only until anything is quantified and expressed numerically can it be said to have a solid foundation and understanding. Otherwise, its comprehension is limited and inadequate.
Measuring supply chain performance will assist a business accomplish its short and long-term objectives starting from sales, financing, human resources, productivity, quality to the full product life cycle.

Certain significant factors that might increase the efficiency of companies in the supply chain are:
• Collaboration between supply chain partners
• Identification and implementation of appropriate key strategies and KPIs
• Regular monitoring of supply chain system
• Incorporation of supply chain technologies
• Employment of RFIDs, IoT, etc.
• Improve supply chain visibility.

3. Methods

Step 1: Understanding digital supply chain, the current scenario of the Indian manufacturing industry
Discussions with industry experts and extensive literature review was conducted to understand the following:

- Existing levels of digitalization in various sectors of the Indian manufacturing industry,
- The various causes for lack of adoption of digitalization
- Future scope.

Step 2: Survey

The survey was focused on understanding the current practices followed by the companies and the impact and benefits reaped by companies upon digitalizing their processes on visibility and performance. And was also designed intending to assess the degree to which digitalization has been implemented.

Step 3: Data Analysis

The survey responses were analyzed in order to obtain key insights. The consistency of the response data was checked and ensured by means of Cronbach's alpha test. Tests were conducted to assess the presence of bias, reliability, convergent and discriminant validity, understanding the direct and indirect effect of the variables on one another using various tools.

Step 4: Hypotheses testing

Confirmatory factor analysis was carried out to identify the various contributing factors as well as the factor loading values. Structural equation modeling was performed to test the direct effect of digitalization on performance and visibility. Furthermore, a Sobel test was carried out to test the mediating effect of visibility on the indirect effect between digitalization and performance. All tests were carried out using IBM SPSS, IBM AMOS and Excel.

4. Data Collection

For Data collection, a survey instrument was designed and administered. A five-point Likert scale was used to gather responses for the visibility and performance evaluation items, with extreme points ranging from strongly disagree (1) to strongly agree (5). The first section was based on understanding the profile of the respondent and their company details. The second section is called 'Digitalization', it aims to capture the respondents' views about digitalization along with the level of digitalization the company has undertaken. The third and fourth section called 'Visibility' and 'Performance', focus on the impact of digitalization on chain visibility and performance. For ambiguity, clarity, and

appropriateness of measurements, the instrument was discussed with Industry experts whose opinion was taken into consideration and suitable modifications were incorporated according to the feedback provided.

Mode of administration of the survey was electronic administration. The target segment was the Indian manufacturing sector, specifically MSMEs. The target respondents were senior leadership, executives, senior managers, managers and individual contributors. The sampling type was a mix of random sampling and convenience sampling.

5. Results and Discussion

5.1 Numerical Results

In order to identify factors for visibility and performance factor analysis and factor loading was conducted. The results of the Factor Analysis and Model Fit Test include a detailed discussion of the Structural Equation Model, the Sobel test, and what they imply. The observed direct, indirect, and mediating effects have also been discussed in this section.

Table 1. Factors Identified for Visibility and Performance

PERFORMANCE	VISIBILITY
1. ORDER FULFILLMENT	1. Planning
a. Time	2. Supply
b. Production	3. Manufacture
c. Inventory	4. Retail / Distribution
2. ECONOMIC PERFORMANCE	5. Customer
3. HUMAN ASPECT	
a. Trust and Collaboration	
b. Post Delivery Performance	

Table 1 depicts three major factors identified. Performance consisted of Order Fulfillment, Economic Performance and Human Aspect. Under order fulfillment additional factors such as Time, Production and Inventory were identified. While under Human aspects, Trust and Collaboration and Post Delivery Performance were found. Visibility on the other hand had five key factors as seen in the table above.

5.2 Graphical Results

Structural Equation Modeling (SEM) is used as a technique to depict the relationships between variables. This was done using IBM AMOS. The beta (β) values represented in figure 1 are the Standardized regression coefficients, which represents the strength of the relation between the variables. The higher the absolute value of the beta coefficient, the stronger the effect. While a square of multiple correlation (R2), indicates the percent of the variation in the dependent variable, represented in the multiple regression equation by the collection of independent variables.

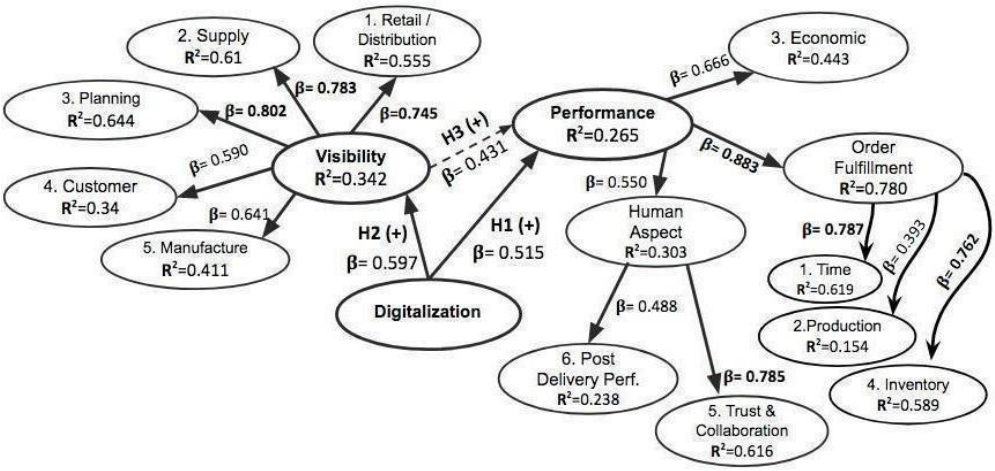

Figure 1. Structural Equation Model with Standard Beta Coefficients

From Figure 2 we can see that Digitalization has had the highest level of impact on Planning with a strong beta coefficient value of β = 0.802, Supply with a value of β = 0.783 and Retail and Distribution with a beta coefficient of β = 0.745 under the Visibility section. Under the Performance section digitalization has had the highest level of impact on, Time with a beta coefficient of β = 0.787 and Inventory with a beta coefficient of β = 0.762 under order fulfillment and Trust and Collaboration with a beta coefficient of β = 0.785 under Human Aspects (Table 2).

Table 2**:** Factors with the highest Standard beta coefficient

Factor	**Sub-Factors**	**Highest Beta Coefficient (β)**
VISIBILITY	1. Planning	β = 0.802
	2. Supply	β = 0.783
	3. Retail and Distribution	β = 0.745
PERFORMANCE	1. Time	β = 0.787
	2. Inventory	β = 0.762
	3. Trust and Collaboration	β = 0.785

Sobel Test

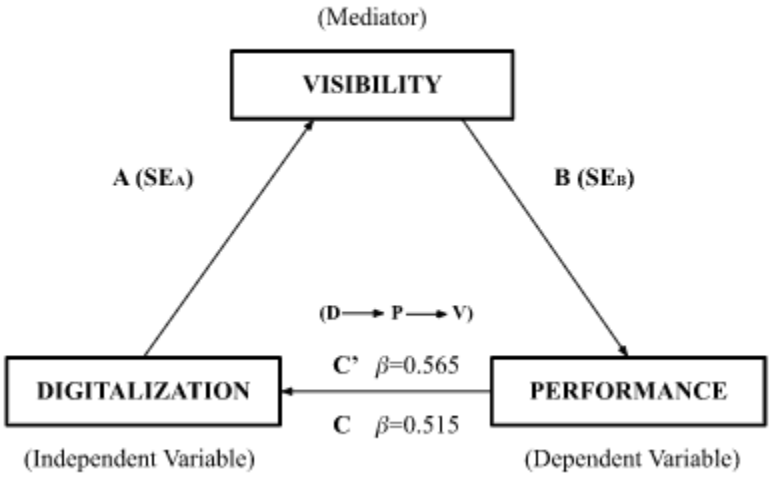

Figure 2. Sobel Test

Since the indirect effect of digitalization on visibility (β=0.565) is greater than the direct effect of digitalization on visibility (β=0.515), a mediation effect does exist. Digitalization has a positive and direct influence on visibility and performance. Visibility has a significant mediating effect on the relationship between digitalization and performance.

5.3 Proposed Improvements

Further divisions can be created to better understand the impact of digitalization on MSMEs.

- These divisions could be made on the basis of the geographical breakup of MSMEs to understand the impact of digitalization on the MSMEs in various states
- It could be done by going one level higher and dividing the country into north India, south India, east India and west India.
- Categorization can also be done to understand the impact of specific technologies on this sector such as the impact of just cloud computing/big data/sensors/additive manufacturing to name a few.
- Division could further be made to understand closely the impact of digitalization on a specific sector which lies under the umbrella that is the manufacturing industry such as, just the electronic parts manufacturing industry, or just the textile industry.
- The work would take a different path depending on the sections chosen to understand the impact and the various factors identified.
- The implications of changing control variables could also be absorbed and tested further.

5.4 Validation

In order to validate the hypothesis Test-retest reliability, Cronbach Alpha, Kurtosis and Skewness and Hypothesis Test - Model Fit was conducted.

6. Conclusion

The aim of the project was to understand the benefits reaped by digitalization in the MSME companies which have upgraded their supply chains. There was a targeted focus of investigating the direct effects of digitalization on the performance and chain visibility, and the mediating effect of visibility on the relationship between digitalization and performance.

Our research revealed that digitalization has a positive and direct influence on visibility and performance. The study also identified visibility as a significant mediating variable, with partial mediation. It was further found that the up gradation to a digitalized supply chain reaped benefits in several factors. Some of the most beneficial aspects were the Performance of the order fulfillment rate followed up by the Economic performance. Under the Visibility segment,

inculcation of digitalization improved transparency between the Supplier, Retailer and Distributor. It also highly positively impacts the Planning operations.

Hence deeming the up gradation to a digital supply chain highly fruitful and beneficial for MSME companies in the Indian manufacturing sector.

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Biography / Biographies

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