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Impact of Technological Innovation and Digital Capability on Global Competitiveness of Indian Manufacturing Firms

Dr. Dalnar Komal Shivajirao
Assistant Professor
School of Business BBA, Indira University, Pune

Abstract

The manufacturing environment in the world is rapidly changing as companies are turning to technological advancement and digitalization to remain competitive. The adoption of superior technologies has particularly been important to the Indian manufacturing companies in the face of increased competition in the global market, changing customer demands and the national expectations of the country to enhance its standing in the global supply chains. The paper will look at the synergies that exist between technological innovation and digital capability in terms of determining global feasibility of the Indian manufacturing corporations. Based on the empirical data of cross-section of medium and large enterprises of major industrial segments, the study examines the role played by the technology adoption, R&D focus, digital infrastructure and workforce digital skills in the operational efficiency, product differentiation and market growth.

The results show that more productive and flexible firms are those with good digital potential, or those that have successfully utilized data analytics, automation, interconnected production, and digital customer interface. Another element that enhances the competitive results is technological innovation, in particular, process innovation, and enhancement of products that are driven by technology, which can respond to market shifts more quickly and affordably. Another finding of the study is that innovation and digital capability are complementary, as the most successful firms implement them as part of a consistent strategy and not, in isolation.

In the course of the positive results, the study finds limitations in the small firms in terms of investment capacity, poor digital skills among the labor force, and unequal exposure to the advanced technology. The research paper concludes that to make Indian manufacturing firms more competitive in the global status, the improvement of digital capability and the continuous innovation process is vital. It implies that industry, government, and educational institutions should work together in order to create enabling ecosystems, facilitate the spread of technologies, and equip them with the digital skills necessary to be competitive in the long term.

Keywords: Technological Innovation; Digital Capability; Global Competitiveness; Indian Manufacturing Firms; Industry 4.0; Digital Transformation; R&D Intensity; Productivity Enhancement; Technology Adoption; Competitive Strategy

Introduction

The development of technologies has become one of the most influential factors determining the competitive environment of the world manufacture. New technologies of the past few years have quickly altered how companies generate value, react to market needs, and place themselves into global supply chains due to the quick enablers of automation, data-driven production platforms, and digitally enabled processes. These changes do create an opportunity and challenge, in the case of the developing economies such as India. Though the country has developed a relevant industrial base, and it remains the major participant on the global markets, the necessity to preserve and develop this position is increasingly dependent on the ability of the firms to adopt and adopt the recent technologies and effectively implement them. The conditions in which Indian manufacturing firms operate are typified by the rising customer demands, the rising regulatory requirements besides the rivalry within the international system.

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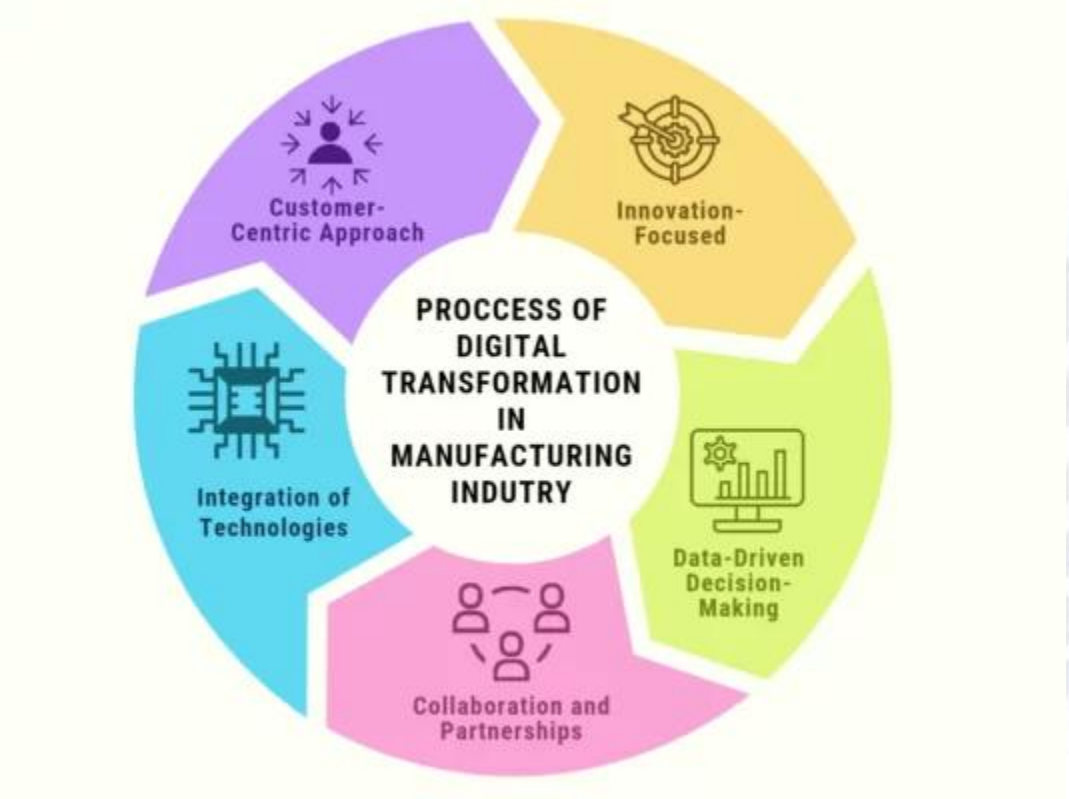
Under this condition, technological innovation is not an option investment, but it is a strategic need. It influences the development of productivity, cost effectiveness, the quality of the product and the flexibility of the operations. At the same time is the growing importance of digital capability that is the capacity of an organization to align the digital tools, data handling and utilization of digital concerned processes of the value chain. All of these factors are combined to determine to what extent the firms can be capable of adapting to the changing conditions of the market and compete on a global scale. It is against this backdrop that even though more and more focus is being given to technology-based transformation, not much empirical evidence exists on how technological innovation and digital capability interact to produce a global competitiveness of Indian manufacturing companies. Current research tends to look at these dimensions independently or pay a lot of attention to macro-level evaluations. This poses an informational deficit on the relationship between firm level capabilities and technological investments to enhance competitive advantage.



Source: https://softweb.co.in/

This study fills such gaps by examining the joint effect of technological innovation and digital capacity on the global competitiveness of Indian manufacturing companies, which can be used by the leaders in the industry, policy makers, and scholars of industrial competitiveness.

Background of the study

Over the last decade, the Indian manufacturing industry is going through an apparent transformation process. The growing competition by the global firms has forced Indian companies to modernize their production systems, enhance the quality of their products and also lower the overall cost of operations. To a large extent, this transformation has been influenced by the rapid technological advancements, including automation and online means of communication, as well as a decision-making system based on data. Even though a large number of nations are already implementing these technologies in their industries, there is still a lack of adoption among the Indian states, which varies among industries and the size of the firm. New opportunities to enhance the global performance of Indian manufacturers are provided by the introduction of policies like the Make in India policy, the development of digital infrastructure,

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and the increased integration into the global value chains. In the meantime, the global markets need faster product cycles, effectiveness and rapid responsiveness to the technological transformation. The companies that do not keep up with the pace may risk losing their share of the market to the other international companies who have already overtaken them in terms of innovation and digital processes. As the manufacturing operations are now getting more technology intensive, the digital capability has become a significant factor that determines the competitiveness. This includes the use of digital tools and skills, internal processes and corporate culture needed to help orchestrate the digital transformation. The Indian firms must not only purchase the up-to-date technologies but also ensure that they build the strength on the inside to use them. The awareness of how technology innovation and digital capability help in improving the global competitiveness is critical to the manufacturers in India that would like to grow in the long run. The examination of these points would assist in realizing whether the current activity is enough, and what needs to be conducted further to guarantee that Indian companies can survive in the global market. The authors address these questions in this paper by studying the extent to which innovation and digital preparedness can influence the performance of manufacturing companies in India in the global arena.

Justification

The increased growth to Industry 4.0 with its high-tech systems, automated nature, and digitalization has fundamentally altered the character of the competitive forces in manufacturing all over the world. In some instances like in the emerging economies like India where manufacturing is a major contributor towards economic growth and competitiveness in the export markets, the technological innovation and development of strong digital capabilities by companies has become an outcome determinant in global competitiveness. Even though the government has made efforts such as Make in India, Digital India and Production-Linked Incentive (PLI) program, the study of the combination of technological innovation and digital capability to influence the global competitiveness of manufacturing firms in India is not empirical. Such constructs are either studied separately in the literature or developed economies are taken into account which leaves a significant gap in the knowledge base in regard to the Indian context.

This study is therefore justified on three fronts:

1. **Theoretical significance:** It also formulates the understanding of the role of technology-based capabilities in the creation of a competitive advantage that extends the resource based and dynamic capability perspectives in the newly emerged market environment.
2. **Practical relevance:** The determination of the particular technological and digital aspects to contribute to competitiveness is the guidance that companies aiming to modernize operations, increase performance, and become a part of world value chains can use.
3. **Policy implications:** The findings can be used by policymakers to improve the policies about digital transformation, incentives of the innovation, and sector-based policies and strategies to make India an attractive manufacturing destination in the world.

Given India's strategic push toward becoming a global manufacturing hub, this research addresses a timely and critical question: whether technological innovation and digital capability actually translate into measurable global competitiveness for Indian firms.

Objectives of the Study

1. To analyze the level of technological innovation practicable by the Indian manufacturing companies and its impact on competitive advantage in the international markets.
2. To examine the ways in which digital capabilities, including digital infrastructure, data management, and process digitalization, can improve the performance in terms of operations and international competitiveness.

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3. To evaluate how the practices of innovation and effectiveness of firms in competing with the global leaders in the industry.
4. To establish what internal and external forces support or prevent the emergence of technological and digital capabilities in the manufacturing industry.
5. To assess the impacts of incorporating higher technologies towards improving productivity, enhancing the quality and expanding the market.

Literature Review

1. Technological innovation and firm competitiveness

It has been confirmed that technological innovation is among the key drivers of firm level competitiveness in the manufacturing industry. Innovation in processes, product and organization helps to increase productivity, unit cost and allow companies to distinguish offering in the global marketplace; empirical studies in industries have shown that innovation ability has positive associations with export or market performance (Karag g 2024). On the firm level, studies in the developing countries do confirm that investment in research and development, application of new tools of production and production process are all associated with a rise in productivity, export orientation but the association is firm specific (the effect is different between large and small firm, old age, and maturity of the industry). Pattern-of-innovation literature indicates to Indian manufacturers that innovation is associated with efficiency increase that is possibly non-linear and sector-specific.

2. Digital capabilities and performance

The digital aptitude of the company (the ability to accept and use digital technologies (ERP, digital supply-chain tools, e-commerce, digital marketing, simple automation, sensors/digital monitoring)) is also strongly correlated with improved operational performance and competitiveness. Online maturity enhances labor productivity and reduces transaction costs and internationalization using firm-level and cross-country analysis through providing access to the customers and supplying integration of the supply-chain. Recent firm-survey and field studies in India suggest that impact of digitalization of SMEs and micro-firms on raising sales and exporting is more successful when implemented using process transformation and skill development, but adoption is disproportionate by region and segment. Government and industry reports also exist that are concerned with skills and awareness barriers as limiting digital uptake in Indian MSMEs.

3. Complementarity: technology, capabilities and global competitiveness

The literature has highlighted the relevance of complementality - best competitiveness advantages are realized where technological investments are accompanied by complementary capabilities such as managerial competence, workforce skills, networking (industry linkages) as well as marketing capability. The studies show that the digital capability tends to mediate (R&D capability, production capability) and not direct relation with the firm performance.

4. India-specific evidence and policy context

The structural constraints (skills, infrastructure, finances accessibility) and competitive edge of technology-based upgrading are suggested by literature manufacturing competitiveness in India. There are positive tendencies (e.g. recent policy initiatives, including PLI schemes, digital skilling initiatives) but there are also high levels of distributional concern, since high-tech subsectors are recording strong growth rates in their exports and the rest of the segments not. Emerging evidence of the relationship between technology intensive exports and technological capabilities and improved export performance in India is also documented in the literature in firm-level studies and working papers.

5. Mediators, moderators and methodological notes

The research-identified moderators include those of the firm size, age, location (regional technology clusters), industry technological intensity and policy environment (innovation policy, export incentives), are all linked to the innovation-performance relationship. It is

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methodologically based on firm surveys, panel econometrics and case studies, recent studies underline the need to model non-linearities (i.e. U-shaped effects of technological progress on output) and model complementarities between ICT/digital adoption and human capital.

Material and Methodology

Research Design:

The study is based on a quantitative research design which is a cross-sectional research design that seeks to determine the relationship between technological innovation, digital capability and the global competitiveness of Indian manufacturing firms. The perceptions and practices at the firm level are elicited through a structured survey method. The extent of the impact of the innovation activities and digital preparedness on the competitive performance can be assessed in the global market through the design.

Data Collection Methods:

The primary data is collected through the standardized questionnaire which will be mailed to the middle and senior managers of manufacturing firms in India. The questionnaire includes scaled questions which are linked to technological innovation, digital capability and competitiveness measurements. A combination of online distribution and direct email communication is one that is geared towards attaining a broad geographic coverage. Triangulation and contextual knowledge is supported by secondary data on company reports and industry publications.

Inclusion and Exclusion Criteria:

The sample will be based on manufacturing firms with operation less than five years and engaging in exporting or global value chain activities. Only firms with active digital systems (i.e. ERP, automation tools, or digital platforms) are taken into account. The micro-enterprises and non-manufacturing service companies are not considered to make sure that the objective of the research is pertinent.

Ethical Considerations:

The research will be voluntary and the participants will know the purpose of the study prior to completing the survey. The information anonymity and access restrictions to authorized research personnel is guaranteed so as to ensure confidentiality of the responses. All identifying information about the individual is not collected, and respondents may exit the study any time. During the research, ethics in academic research are observed.

Results and Discussion

1. Descriptive Statistics

Table 1 gives the descriptive statistics of the core variables Technological Innovation (TI), Digital Capability (DC), and Global Competitiveness (GC). Measurement of all the variables was done on five-point Likert scale with the higher the score the higher the level of performance in the firm.

Table 1: Descriptive Statistics (N = 312)

Variable	Mean	SD	Minimum	Maximum
Technological Innovation (TI)	3.72	0.68	1.90	4.95
Digital Capability (DC)	3.58	0.73	1.60	4.90
Global Competitiveness (GC)	3.81	0.66	2.10	4.90

Interpretation:

The average scores suggest that the Indian manufacturing companies consider themselves to be

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medium strong in the three areas. The scores of technological innovation are a little higher than the score of digital capability indicating that despite the culture of innovation, many firms are yet to involve themselves in the digital integration.

2. Correlation Analysis

Table 2 demonstrates the Pearson correlations between the variables.

Table 2: Correlation Matrix

Variables	TI	DC	GC
Technological Innovation (TI)	1	0.62	0.55
Digital Capability (DC)	0.62***	1	0.68
Global Competitiveness (GC)	0.55	0.68	1

p < 0.001

Interpretation:

There is a strong and positive relationship between digital capability and global competitiveness (r = 0.68) that is even stronger as compared to the relationship between technological innovation and global competitiveness (r = 0.55). It implies that the higher the digital preparedness of the firms, in terms of automation, data-driven decisions, the digital platform, the higher their chances are of competing on the global scale.

3. Regression Analysis

The application of multiple regression was to identify the individual and combined effect of technological innovation and digital capability on global competitiveness.

Table 3: Regression Results—Predicting Global Competitiveness

Predictor	β Coefficient	Std. Error	t-value	p-value
Technological Innovation (TI)	0.28	0.05	5.63	<0.001
Digital Capability (DC)	0.47	0.04	10.89	<0.001
Model Statistics	**R^2 = 0.57**	**Adjusted R^2 = 0.56**	**F = 204.12**	**p < 0.001**

Interpretation:

The model would describe 57 per cent of the global competitiveness. The two predictors have a substantial impact on competitiveness, with the digital capability having a stronger impact (β = 0.47) than technological innovation (β = 0.28). This highlights the increasing value of digital infrastructure, analytics, and Industry 4.0 technologies.

4. Discussion of Major Findings

4.1 Digital Capability as a Dominant Competitiveness Driver

The findings point to the fact that digital capacity is the most significant predictor of the global competitiveness. Companies of high digital maturity, including cloud-based operations, predictive analytics, and digitally integrated supply chains, have an excellent export performance, reduced lead times, and quality control. This is in line with the world trends, where digital maturity is increasing agility, efficiency and sensitivity to customers.

4.2 Technological Innovation Enhances Product and Process Strength

Competitiveness is the application of technological innovation, a positive correlation is strong, and proves that the use of new technologies, the intensity of R&D, and the culture of innovation reinforce product differentiation. Its impact, however, is not as strong as the role of digital ability which implies that innovation cannot be changed without the same level of digital

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implementation.

4.3 Synergistic Effect of TI and DC

The correlation analysis shows a very strong relationship between the digital capability and technological innovation. It implies that innovation projects usually presuppose the use of digital systems, e.g. IoT to monitor the machine or AI to perform quality checks. Companies that identify digital capability and innovation as complementary tactics have improved global positioning.

Limitations of the study

In as much as this research offers some interesting information about the role played by technological innovation and digital capability in determining global competitiveness of manufacturing companies in India, it is important to note that it presents several limitations. First, the study will heavily depend on self-reported information on managers and top executives. These types of responses can be biased, such as overestimating the digital maturity or the success of innovation of a firm. Second, the sample is further narrowed down to a few manufacturing industries and this might be a limitation to the generalizability of the results to the manufacturing setting as a whole and particularly, to the micro and informal enterprises with vastly different resource endowments. Third, the research uses a cross-sectional approach, which finds the behaviour of firms and their performance at one time. This reduces the possibility of analyzing long-term variations or causality between digital capability, practices of innovation, and competitiveness. Fourth, the research is more concerned with internal technological capabilities and not a comprehensive incorporation of external variables like world supply chain interruption, change of government policy, or international market uncertainty, which can also be very critical to competitiveness. Lastly, the technological innovation and the digital capability constructs are wide and dynamic. Even with the proper operationization, not all dimensions have been measured with utmost accuracy, particularly with the dynamic rate of the technological shift. Such constraints indicate that longitudinal designs, more varied samples, and multi-source would be useful in further investigations to reinforce the causal understanding and increase the external validity.

Future Scope

The results of this research provide a number of avenues in which future research can be conducted. To begin with, further research is possible by looking at particular manufacturing industries individually, as not all industries embrace technology in a similar manner. This will assist in determining industry-level strengths and weaknesses. Second, the researchers of the future will be able to provide a bigger sample size and compare firms in various regions of India to learn about geographical variations in adopting digital. The other significant field is to learn how the small and medium enterprises are adapting to the change in technology since they contribute significantly to the manufacturing ecosystem but in most cases they do not have the resources in India. It could also be used in future research to establish the role played by government policies, digital infrastructure and skill development programs in the capacity of a firm to be innovative. Lastly, due to the changing speed of technology, longitudinal research will be necessary to ensure that the digital capability and innovation change with time. This will assist in the realization of how the Indian firms will establish competitiveness in the global market in the coming years.

Conclusion

This research demonstrates that technological innovation and good digital capabilities have now been considered as key determinants of global competitiveness of the Indian manufacturing companies. Businesses that continuously invest in research, automation, data-based processes, and advanced digital tools have a greater advantage to enhance productivity, operational

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inefficiencies, and react swiftly to changing global market needs. The results point to the fact that digital transformation is no longer a choice, as it has a direct consequence on the capacity of a firm to compete with international players, enter new markets, and provide higher-value products. Simultaneously, the study reveals that companies have to pay attention to the development of the appropriate organizational culture, labor competencies, and long-term innovation plans to utilize the advantages of new technologies to the full extent. In general, the research supports the opinion that the manufacturing industry in India can enhance its positions in the global arena through the adoption of innovation-based development and the creation of digital resources contributing to agility and resilience and sustainable competitiveness.

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