

# **Impact of Digital Transformation Strategies on Performance of Manufacturing Companies in India**



**Research Committee**  
**The Institute of Chartered Accountants of India**  
*(Set up by an Act of Parliament)*  
**New Delhi**

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## Foreword

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The incorporating of digitalisation in the production process has become imperative with the advent of the 4<sup>th</sup> Industrial Revolution. The manufacturing industry worldwide has gradually started adopting advanced manufacturing technologies. Therefore, it is crucial for the manufacturing companies in India as well to pace up with technology adoption and meet the competition by exploring technologies such as Artificial Intelligence (AI), Cloud computing, Internet of Things (IoT), and Robotics.

This research study utilises **Technology - Organisation - Environment (TOE)** Framework to assess the level of technological readiness for adopting digital transformational change adopted by manufacturing concerns in India. It also explores the link between digital transformation and financial performance of manufacturing firms and utilises Theory of Transformation and Theory of Organizational Readiness for Change.

I am pleased to note that the Research Committee of the Institute under the 'ICAI Research Project Scheme 2020' undertook the Research Project on the topic of **"Impact of Digital Transformation Strategies on Financial Performance in the Indian Manufacturing Sector"**.

I would like to take this opportunity to express my thanks to CA. Anuj Goyal, Chairman, Research Committee and CA. Kemisha Soni, Vice-Chairperson, Research Committee, who took the initiative to introduce 'ICAI Research Project Scheme 2020' to encourage research-based activities. I would also like to take this opportunity to express my gratitude to members of the Research Committee who have made invaluable contribution through their expert guidance in the finalisation of the Research Report.

I am confident that this Research Report will be extremely useful for the members, Indian Manufacturing Industry and other stakeholders as well.

New Delhi  
January 29, 2021

CA. Atul Kumar Gupta  
President, ICAI



## Preface

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The findings of the Research Report on “**Impact of Digital Transformation Strategies on Financial Performance in the Indian Manufacturing Sector**” have an important implication for manufacturing firms in India, policymakers, regulators, financiers and other key stakeholders in the market. The findings of this research will form an important input into creating an effective environment and motivation for implementing digital transformation and Industry 4.0 strategies in India, thereby resulting in an increase in overall profitability and better firm value, positively impacting the country’s manufacturing sector and the overall economy.

I am thankful to CA. Atul Kumar Gupta, President, ICAI and CA. Nihar N. Jambusaria, Vice President, ICAI who inspired me and Research Committee to introduce ‘ICAI Research Project Scheme’ and undertake research projects on contemporary and relevant topics.

I would also like to extend my thanks to CA. Kemisha Soni, Vice-Chairperson, Research Committee and all the members of the Research Committee.

Further, I would like to take this opportunity to congratulate CA. (Dr.) Nisha Kohli for writing Research Report on the topic of “**Impact of Digital Transformation Strategies on Financial Performance in the Indian Manufacturing Sector**” and to express my thanks to CA. Saurabh Goenka, Expert for providing his valuable comments and suggestions for improvement of technical and presentation aspect of the Research Report. I also acknowledge the assistance and co-operation rendered by Dr. Amit Kumar Agrawal, Secretary, Research Committee and CA Rahul Paul, Project Associate who gave their valuable inputs during finalisation of this Research Report.

I believe and trust that this Research Report will be immensely useful to the members and to others interested.

New Delhi  
January 29, 2021

CA. Anuj Goyal  
Chairman, Research Committee



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## Executive Summary

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Technology has permeated in our lives leading to a paradigm shift in ways of doing business. The process of incorporating digitalisation in the production process has become imperative with the advent of the 4<sup>th</sup> Industrial Revolution. The manufacturing industry worldwide, primarily comprising non-tech firms, has gradually started adopting advanced manufacturing technologies and relying on intelligent machines generating intelligent data. It is crucial for manufacturing companies in India as well to pace up with technology adoption and meet the competition. Fortunately, the Indian manufacturing value chain is gradually transforming itself as reflected by some large corporates who are already exploring technologies such as Artificial Intelligence (AI), Cloud computing, Internet of Things (IoT), Robotics, and so on. Embedding traditional manufacturing with digital systems and transitioning to newer technologies has become inevitable for MSMEs as well. The focus of this study is on all sizes of manufacturing firms- large, mid, small and micro-cap in India.

Prior literature has emphasised that digital initiatives create high value for many firms indeed, yet some others destroy this value in the execution process due to lack of digital understanding and inability to cope with the disruptive economic realities of digital competition (Westermann et al., 2011). Firms often invest in digital transformation technologies without the relevant knowledge at both the technology and strategic levels. This study utilises Technology - Organisation and Environment (TOE) Framework to assess the level of digital ecosystem/external environment, impact of strategic focus, organisational readiness and technological readiness for adopting digital transformational change by manufacturing firms in India. Other theories utilised in this research are Theory of Transformation and Theory of Organizational Readiness for Change. The study also explores the link between digital transformation and financial performance of manufacturing firms.

We used both primary and secondary research methods for this study. Our research team,

- (a) Undertook a literature review of the theories mentioned above and identified key parameters for the survey questionnaire;
- (b) Employed interpretive research methods for conducting expert panel and individual interviews and incorporated the insights gathered into the survey questionnaire;

### **Impact of Digital Transformation Strategies on Performance of Manufacturing...**

- (c) Conducted a comprehensive survey of 90 leaders and managers from the manufacturing sector in India through telephone, face to face meetings, and online survey (survey monkey), followed by subsequent data analysis;
- (d) Conducted an in-depth case analysis of two manufacturing companies in the automotive sector - analysed digitalisation strategies at Hero MotoCorp and Tata Motors and evaluated their achievements in financial as well as non-financial terms; and
- (e) Analysed the annual reports, press releases and media reports of 100 manufacturing companies - 25 companies from each sector (large, mid, small, and micro firms) - using stratified sampling to assess the impact of Digital Activities on their financial performance. The team conducted textual frequency analytics and used that frequency as a proxy for digital activities. The proxy was correlated and regressed with parameters of financial performance to study the impact of digitalisation on firm performance.

Key findings of the research from stakeholder and panel discussions, primary survey and secondary data analysis are:

### **Findings at the eco-system level:**

- India has several eco-system characteristics required for digital transformation and adopting Industry 4.0 in terms of Information and Communication Technology (ICT) infrastructure, trainable human capital, competitive pressure, collaboration and knowledge sharing within the industry, a perceived ability of suppliers to adapt to changes resulting from adoption of Industry 4.0 technologies and consumer demand. However, this is not translating to digital transformation on ground.
- India is far behind countries around the world in terms of digital transformation and adoption of Industry 4.0 in the manufacturing sector, especially amongst MSMEs. Industry 4.0 adopted by large organizations such as Tata Motors and Hero Motor Corp can at best be considered as only one of cases of digital transformation in the country.
- Key bottlenecks are:

- There is a significant lack of awareness, understanding and technical knowhow about Industry 4.0 technologies, their advantages and application to manufacturing in India. Simple digitisation such as facial recognition in attendance are considered to be great advancements in technology adoption. Although more acute in MSMEs, the knowledge gap is widely prevalent in large manufacturing sector organizations as well.
- While the government has launched a number of initiatives to create a conducive eco-system for adoption of Industry 4.0 in the country, the effort has been fairly recent with limited results on ground so far. This is particularly an issue for the MSME sector that needs significant handholding and financial support from the government to undertake digital transformation.
- The country has a weak cybersecurity infrastructure, considered inadequate and risky for extensive digital transformation.

### Findings at the firm level:

- Manufacturing firms in India demonstrate organizational readiness for digital transformation in terms of leadership, commitment and resources and communication across the organisation (based on perception survey of manufacturing sector executives).  
  
(Note: This is likely to be an overestimation based on executives' assessment of basic digitization initiatives implemented in the organization, misunderstood as significant technological advancements.)
- However, the perceived organizational readiness is not translating into digital transformation and adoption of Industry 4.0 on the ground level due to the following key bottlenecks:
  - There is limited awareness and understanding about Industry 4.0 at the senior level, directly impacting ability of manufacturing sector firms in India to value the benefits and invest in digital transformation. Further, firms are unknowingly setting much lower goals and aspirations in terms of digital transformation due to limited knowledge.

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- Lack of multi-level readiness – i.e. different levels of awareness and understanding about digital transformation at the lower, middle and senior management level - is impeding success of digital transformation at the strategy as well as implementation phase.
- There is piecemeal adoption of digital transformation in manufacturing organizations in India, thereby limiting cross-functional synergies and subsequently value creation.
- There is a significant skill gap in the manufacturing sector workforce impeding digital transformation.
- Prevalence of legacy infrastructure, for instance having old machinery that cannot be digitally connected, is a key bottleneck for adopting Industry 4.0. in India as it leads to multiplication in costs and effort for the firm
- Theoretical findings (based on the primary survey):
  - There is a strong positive correlation between organisational context-leadership and change management 0.89 and Governance 0.73 with technology context.
  - There is a strong positive correlation (0.71) between environmental context with technological context. This implies that favourable ecosystem and external environment with strong leadership commitment, governance and overall positive change management climate can lead an organisation to be ready for adoption of digital manufacturing technologies.
- Digital transformation and financial performance (based on secondary data analysis on 100 Indian manufacturing firms – large, mid, small and micro capitalization):
  - Profile of firms that adopt digital activity are relatively larger, more profitable and have better sales revenues. We report positive, though not so statistically significant, associations between digital activity and total revenues, which is consistent with prior studies that attributed the results to the performance pressure channel. Studies have shown that when market pressures force the firms to go digital, digitalisation does not necessarily result in improved sales. This is because in case of high market competition it is very difficult for the firms to increase their market shares through

digital activities as price is the main consideration. This is also consistent with our panel interview results and surveys conducted that firms which adopt digitalisation due to competitive pressures and on piecemeal basis without giving due regard to customer value proposition or understanding the ripple effects on different areas of the value chain may find it difficult to generate more sales due to digitalisation.

- Firms which have higher market capitalisation are more likely to adopt digitalisation. This suggests that firms show early signs of going digital when they receive higher valuations in the market. According to value creation theories, firms command better valuations in the market if they provide value proposition to customers and provide better quality products for their customers. Therefore, considering this theoretical concept we can presume that firms will command higher valuations indirectly if they focus their digitalisation strategies on value proposition and serve their customers well by using technologies. For manufacturing firms this is possible through digitalising the products, innovating and re-designing the product with tech capabilities and solutions for the customers.
- Digitalisation can be associated with profitability only in the long run due to challenges of integration between various complementary technologies both inside and outside the firm. Further, besides digital investments in new technologies, providing resources for operationalising the same also prove to be costly in the short term.
- Short term positive impacts can be seen in non-financial KPIs such as improvements in productivity, efficiency, and reduction in run time, defects and so on.

Our findings have important implications for manufacturing firms in India, policymakers, regulators, financiers and other key stakeholders in the market. The findings of this research will form an important input into creating an effective environment and motivation for implementing digital transformation and Industry 4.0 strategies in India, thereby resulting in an increase in overall profitability and better firm value, positively impacting the country's manufacturing sector and the overall economy.

## Target Stakeholders

The findings of this study will be extremely useful for the Government, the manufacturing industry and researchers and academia (see Table 1 below).

**Table 1: Target stakeholders**

| Target stakeholders | Potential use                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Government          | <p><b>Gain insights on:</b></p> <ul style="list-style-type: none"><li>• Issues in the manufacturing growth story in India despite several government initiatives.</li><li>• Overall level of adoption of digitization and Industry 4.0 in India, and also in comparison to worldwide adoption.</li><li>• Importance of Industry 4.0 for India to remain relevant in the global manufacturing scenario and increase contribution of manufacturing to India's Gross Domestic Product (GDP) and exports.</li><li>• Drivers of Industry 4.0 and digital manufacturing.</li><li>• Bottlenecks and shortcomings in adopting Industry 4.0 and challenges in the current eco-system.</li><li>• Gap areas in government policy support.</li></ul> <p><b>Potential application:</b></p> <ul style="list-style-type: none"><li>• Strengthen government policy support based on gap areas identified.</li><li>• Plan the incorporation of Industry 4.0 technologies on enterprises and institutions run by the Government.</li></ul> |
| Industry            | <p><b>Gain insights on:</b></p> <ul style="list-style-type: none"><li>• Issues in the manufacturing growth story in India.</li><li>• Meaning of Industry 4.0, the various technologies and their application in manufacturing.</li><li>• Drivers of Industry 4.0 and digital manufacturing.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

## Target Stakeholders

|                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                          | <ul style="list-style-type: none"> <li>• Overall level of adoption of digitization and Industry 4.0 in India, and also in comparison to worldwide adoption.</li> <li>• Benefits of digital transformation in manufacturing in terms of the manufacturing process, overall competitiveness especially in the international market and the firm's financial performance.</li> <li>• Performance of firms in terms of governance, motivation, multi-level readiness, quality of infrastructure and leadership, and time and resource commitment to undertake digital transformation.</li> <li>• Developing and implementing a robust digital transformation strategy.</li> </ul> <p><b>Potential application:</b></p> <ul style="list-style-type: none"> <li>• Use findings to generate value from successful digital transformation.</li> </ul>                                                                                                                       |
| Researchers and academia | <p><b>Gain insights on:</b></p> <ul style="list-style-type: none"> <li>• Overview of India's manufacturing sector.</li> <li>• Issues in the manufacturing growth story in India despite several government initiatives.</li> <li>• Importance of Industry 4.0 for India to remain relevant in the global manufacturing scenario and increase contribution of manufacturing to India's Gross Domestic Product (GDP) and exports</li> <li>• Meaning of Industry 4.0, the various technologies and their application in manufacturing.</li> <li>• Drivers of Industry 4.0 and digital manufacturing.</li> <li>• Overall level of adoption of digitization and Industry 4.0 in India, and also in comparison to worldwide adoption.</li> <li>• Bottlenecks and shortcomings in adopting Industry 4.0 and challenges in the current eco-system.</li> <li>• Benefits of digital transformation in manufacturing in terms of the manufacturing process, overall</li> </ul> |

### Impact of Digital Transformation Strategies on Performance of Manufacturing...

|  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>competitiveness especially in the international market and the firm's financial performance.</p> <ul style="list-style-type: none"><li>• Performance of firms in terms of governance, motivation, multi-level readiness, quality of infrastructure and leadership, time and resource commitment to undertake digital transformation.</li><li>• Developing and implementing a robust digital transformation strategy.</li></ul> <p><b>Potential application:</b></p> <ul style="list-style-type: none"><li>• Use findings as a base for further research</li></ul> |
|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

# Chapter 1

## The Indian Manufacturing Sector and Digital Transformation

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The Indian manufacturing sector is valued at INR 29,128 Billion (2019) and currently accounts for 14% of the country's Gross Domestic Product (GDP).<sup>1</sup> The sector includes a number of industries such as automobile, pharmaceuticals, textiles and garment, electronics, chemicals, food processing, defence manufacturing, electrical machinery, and leather. It employs around 12% (2014)<sup>2</sup> of India's workforce. Studies show that every job created in the manufacturing sector in India has a multiplier effect in creating 2–3 jobs in the services sector.<sup>3</sup>

In 2011, with the roll out of the National Manufacturing Policy, the Government of India set an ambitious target to increase the share of the manufacturing sector to 25% of the GDP and create 100 million new jobs in manufacturing by 2022.<sup>4</sup> This was followed by the launch of the Make in India initiative by Prime Minister Narendra Modi in 2014 with the aim to make India a global design and manufacturing hub.<sup>5</sup> Ever since there has been no looking back. The

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- 1 Manufacturing, value added (current US\$), World Bank Data. Retrieved from <https://data.worldbank.org/indicator/NV.IND.MANF.CD?locations=IN> (last accessed January 09, 2021); Manufacturing, value added (% of GDP) – India, World Bank Data. Retrieved from <https://data.worldbank.org/indicator/NV.IND.MANF.ZS?locations=IN> (last accessed 2021, January 09)
  - 2 Confederation of Indian Industry (CII). *Manufacturing*. Retrieved from <https://www.cii.in/sectors.aspx?enc=prvePUj2bdMtgTmvPwvisYH+5EnGjyGXO9hLECvTuNsfVm32+poFSr33jmZ/rN+5#:~:text=The%20Indian%20Manufacturing%20sector%20currently.jobs%20in%20the%20services%20sector> (last accessed 2021, January 09)
  - 3 Confederation of Indian Industry (CII). *Manufacturing*. Retrieved from <https://www.cii.in/sectors.aspx?enc=prvePUj2bdMtgTmvPwvisYH+5EnGjyGXO9hLECvTuNsfVm32+poFSr33jmZ/rN+5#:~:text=The%20Indian%20Manufacturing%20sector%20currently.jobs%20in%20the%20services%20sector> (last accessed 2021, January 09)
  - 4 Department of Industrial Policy & Promotion, Ministry of Commerce & Industry, Government of India (2011). *Press Note NO. 2 (2011 Series). National Manufacturing Policy*. Retrieved from <https://www.meity.gov.in/writereaddata/files/National%20Manufacturing%20Policy%20%282011%29%20%28167%20KB%29.pdf> (last accessed 2021, January 09)
  - 5 Make in India Website. *About Us Section*, Retrieved from <https://www.makeinindia.com/about> (last accessed 2021, January 09)

## Impact of Digital Transformation Strategies on Performance of Manufacturing...

Government has rolled out a number of schemes and initiatives to boost the manufacturing sector of the country (see Table 2 below).

**Table 2: Key government initiatives to boost the manufacturing sector in India**

|                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                          |                                                                                                                                                                                                                  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>National Policy on Electronics (2019)</b> <sup>6</sup> <ul style="list-style-type: none"><li>• Promote domestic manufacturing and export in the entire value-chain of Electronics System Design and Manufacturing (ESDM)</li><li>• Achieve a turnover of INR 26,00,000 crore by 2025.</li></ul> | <b>Reduction of corporate tax rates:</b> <sup>7</sup> <ul style="list-style-type: none"><li>• Corporate tax reduced to 22% for existing companies, and to 15% for new manufacturing companies.</li></ul> | <b>Defense Procurement Procedure (DPP) 2020 (Draft)</b> <sup>8</sup> <ul style="list-style-type: none"><li>• Aims to encourage indigenous design capacity and higher localization in defence equipment</li></ul> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

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6 Government of India (2019). *Cabinet approves the proposal of National Policy on Electronics* 2019. Retrieved from <https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1565285> (last accessed 2021, January 09)

7 (2020, January 16). Nirmala Sitharaman slashes corporate tax to fire up economy, market responds with a massive surge. *Economic Times*. Retrieved from <https://economictimes.indiatimes.com/news/economy/policy/corporate-tax-slashed-for-domestic-companies-and-new-domestic-manufacturing-companies/articleshow/71213356.cms?from=mdr> (last accessed 2021, January 09)

8 Das, P (2020, April 15). India's defence procurement policy 2020: Old wine in a new bottle. *Observer Research Foundation*. Retrieved from <https://www.orfonline.org/expert-speak/indias-defence-procurement-policy-2020-old-wine-in-a-new-bottle-64673/> (last accessed 2021, January 09)

## The Indian Manufacturing Sector and Digital Transformation

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Ease of doing business rankings (EoDB)<sup>9</sup></b> <ul style="list-style-type: none"> <li>The government has made significant efforts to improve India's ease of doing business rankings from 130 in 2016 to 63 in 2020</li> <li>The government focused on improving its EoDB rankings to make India attractive for foreign investors, encourage the private sector (especially manufacturing) and boost overall competitiveness as part of the Make in India campaign.</li> </ul> | <b>Atma Nirbhar Bharat<sup>10,11</sup></b> <ul style="list-style-type: none"> <li>INR 20 lakh crore package to enable India to compete in global supply chains and support vulnerable sections of society deeply impacted by the pandemic</li> <li>Increase in Foreign Direct Investment Limit under automatic route from 49% to 74% in defence manufacturing.</li> </ul> | <b>SAMARTH Udyog Bharat 4.0<sup>12</sup></b> <ul style="list-style-type: none"> <li>Aims to facilitate and create an ecosystem for adoption of Industry 4.0 by all Indian manufacturing firms by 2025 through experiential and demonstration centres</li> <li>Five Common Engineering Facility Center Projects are: <ul style="list-style-type: none"> <li>Center for Industry 4.0 (C4i4) Lab Pune</li> <li>IITD-AIA Foundation for Smart Manufacturing</li> <li>I4.0 India at IISc Factory R &amp; D Platform</li> </ul> </li> </ul> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

- 9 The World Bank (2020). *Doing Business 2020. Comparing Business Regulation in 190 Economies*. Page 10
- 10 (2020, May 14). PM Modi announces Rs 20 lakh crore special economic package. *Economic Times*. Retrieved from <https://economictimes.indiatimes.com/news/politics-and-nation/pm-narendra-modi-address-live-centre-announces-an-economic-package-of-rs-20-lakh-crore/articleshow/75699154.cms> (last accessed 2021, January 09)
- 11 Singh, Rahul (2020, 16 May). Govt plans higher FDI, local weapons for self-reliant defence sector. *Hindustan Times*. Retrieved from <https://www.hindustantimes.com/india-news/govt-plans-higher-fdi-local-weapons-for-self-reliant-defence-sector/story-TkWWqfAwZuTnm70ek7xamL.html> (last accessed 2021, January 09)
- 12 SAMARTH Udyog Bharat 4.0. Retrieved from <https://www.samarthudyog-i40.in/> (last accessed 2021, January 09)

## Impact of Digital Transformation Strategies on Performance of Manufacturing...

|  |  |                                                                                                                                                                                                             |
|--|--|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  |  | <ul style="list-style-type: none"> <li>— Smart Manufacturing Demo &amp; Development Cell at CMTI</li> <li>— Industry 4.0 projects at DHI CoE in Advanced Manufacturing Technology, IIT Kharagpur</li> </ul> |
|--|--|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## The manufacturing growth story is missing

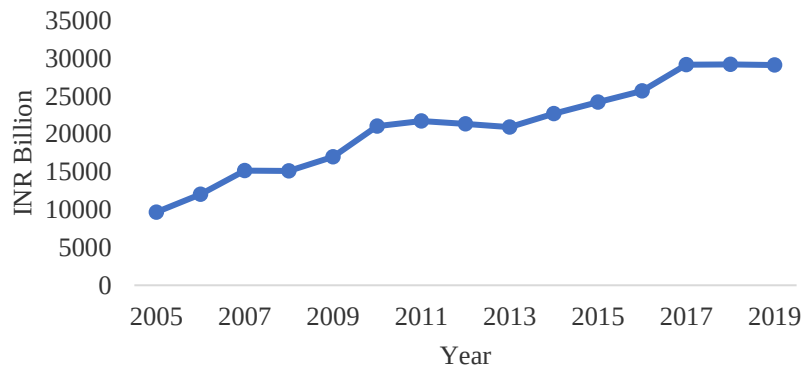
Despite the impetus provided by the government, the manufacturing sector growth story continues to be a miss. Although India's manufacturing sector value added grew at a compounded annual growth rate (CAGR) of approximately 7% from 2005 to 2019 (see Figure 1 below), the growth trajectory is far behind in achieving the goals set by the government. In fact, the contribution of the manufacturing sector to India's GDP has declined from 17.3% in 2006 to 13.7% in 2019 (see Figure 2 below). These figures are much lower than countries such as Indonesia whose manufacturing sector contributes 20% to GDP, Malaysia (22%), Thailand (27%) and China (29%).<sup>13</sup>

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13 Banger, S. (2018, September 14). Economic slowdown: Manufacturing growth sluggish at 7%, share in GDP stagnant at 16%; urgent need of more than just a policy overhaul. *Firstpost*. Retrieved from <https://www.firstpost.com/business/economic-slowdown-manufacturing-growth-sluggish-at-7-share-in-gdp-stagnant-at-16-urgent-need-of-more-than-just-a-policy-overhaul-7338301.html> (last accessed 2021, January 09)

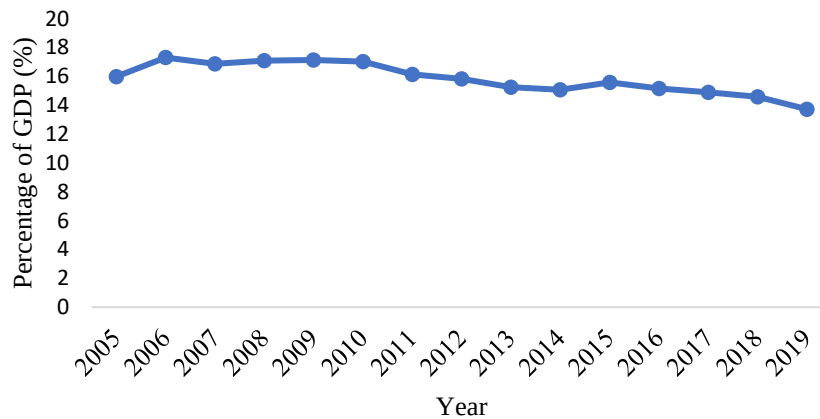
## The Indian Manufacturing Sector and Digital Transformation

**Figure 1: India's manufacturing sector value added (INR Billion)**



Source: The World Bank

**Figure 2: Contribution of India's manufacturing value added to GDP (percentage)**



Source: The World Bank

The reasons for the downfall of India's manufacturing sector are many - lack of financing and credit facilities further worsened by a crisis in the banking sector due to non-performing assets, contraction in government spending, challenges in transportation and logistics, shortage of power and infrastructure bottlenecks, burdensome government compliances and regulations, impact of

## **Impact of Digital Transformation Strategies on Performance of Manufacturing...**

demonetization on small and medium businesses, and shrinking demand from consumers and business due to a general slowdown in the Indian economy.<sup>14</sup>

However, one of the most important factors impeding growth of India's manufacturing sector is the lack of competitiveness of the domestic industry to compete in the global market as well as its increasing inability to cater to domestic demand due to competition from imports. The manufacturing sector has been lobbying with the government for protection from imports through tariffs and duties. While the government has set up import controls on and off in sectors such as electronics, cashew kernels, PVC, auto parts, and synthetic rubbers,<sup>15</sup> with the aim to protect and encourage the domestic value chain, it is important to recognize that this is only a temporary bandage.

Competing in the global market and from imports at home requires manufacturing firms in India to enhance their competitiveness and products by embracing digital transformation and Industry 4.0.

There are also other complexities and diverse factors which affect India's manufacturing sector. The investment that goes behind setting up captive power supply for stable and uninterrupted power becomes a huge cost burden for all relevant financial investors in energy-intensive manufacturing units. Further, with additional tax burdens being levied on heavy manufacturing industries like coal cess, etc. there is an increase in the overall energy cost for manufacturing firms. Also, in terms of international energy quality standards, India ranks 80 out of 137 countries as per World Economic Forum data. Recent data released by the World Bank brought forth that access to electricity is the second-most significant impediment for manufacturing firms and has played a major role in holding back corporate investments in the manufacturing sector.<sup>16</sup>

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14 Dhar, B (2019, July 08). Manufacturing sector: Struggling to take off. *Business Line*. Retrieved from <https://www.thehindubusinessline.com/opinion/manufacturing-sector-struggling-to-take-off/article28322705.ece> (last accessed 2021, January 09)

15 (2019, July 05), Budget 2019: Government hikes customs duty on CCTV camera, split AC. *ET Retail*. Retrieved from <https://retail.economictimes.indiatimes.com/news/consumer-durables-and-information-technology/consumer-electronics/budget-2019-government-hikes-customs-duty-on-cctv-camera-split-ac/70090707> (last accessed 2021, January 09)

16 EIA International Energy Outlook 2019 - Issue in Focus - U.S. Energy Information Administration (EIA). (2021). Retrieved 9 January 2021, from [https://www.eia.gov/outlooks/ieo/section\\_issue\\_aiso.php](https://www.eia.gov/outlooks/ieo/section_issue_aiso.php)

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## The Indian Manufacturing Sector and Digital Transformation

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Further, it also important to consider the cost behind Indian Logistics, estimated to be around 14%-15% of GDP, almost double of 7%-8% of GDP in developed countries. Nearly 60% of the cargo in India travels by road. Over-saturated railway networks, high rail freights, long transit times, inadequate port depths, high turnaround time at ports, and poor warehousing facilities have been attributed to these excess incurred costs.<sup>17</sup> Let's take the comparative base between China and India as anecdotal evidence, the distance from Guangzhou in China to Mumbai is five times greater than that between Delhi to Mumbai, but the cargo cost is almost comparable.

Further, from a bird's eye view, India's demographic and low labour cost may look like an advantage but a closer analysis reveals that this advantage is haunted and limited by growing skill mismatch and low productivity. While 62% of India's population is in the working age group and more than 54% of the total population is below 25 years of age, only 4.7% of India's workforce is skilled formally, significantly lower than the demographics in countries such as United States (52%), United Kingdom (68%), Germany (75%), Japan (80%), South Korea (96%) and China (24%). Estimates bring forward that India needs to train 126 million people across 34 sectors.<sup>18</sup> According to Aspiring Minds, an Indian employability assessment enterprise, 80% of engineers in India are "unemployable". All of this has resulted in much lower productivity for India in the manufacturing sector. For instance, as compared to India, China and Brazil's manufacturing productivity in terms of value added per hour worked are 1.6 and 2.9 times higher respectively.<sup>19</sup>

Expenditure on Innovations and R&D is critical if India is to realise its goal of increasing the manufacturing share in its GDP to 25%. The Economic Survey recently released India's R&D expenditure as a percentage of GDP to be stagnant at 0.6%-0.7% since the last two decades. This is much lower than

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17 Anon(2021). Retrieved 9 January 2021, from [http://niti.gov.in/writereaddata/files/document\\_publication/Freight\\_report.pdf](http://niti.gov.in/writereaddata/files/document_publication/Freight_report.pdf)

18 Priya, P. and Ghosh.A. (2018, September 06). Why India's manufacturing sector needs a big push. *Financial Express*. Retrieved from <https://www.financialexpress.com/opinion/why-indias-manufacturing-sector-needs-a-big-push/1303968/> (last accessed 2021, January 09)

19 Priya, P. and Ghosh.A. (2018, September 06). Why India's manufacturing sector needs a big push. *Financial Express*. Retrieved from <https://www.financialexpress.com/opinion/why-indias-manufacturing-sector-needs-a-big-push/1303968/> (last accessed 2021, January 09)

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the United States (2.8%), China (2.1%), South Korea (4.2%) and Israel (4.3%).<sup>20</sup> Along with greater state and central government spending there is also a need for industrial application oriented R&D and greater collaboration with the private sector. An exchange of researchers between public research organisations and industry has become very important for facilitating transfer of knowledge and understanding each other's perspectives.

If we want to see India's manufacturing sector grow, it becomes really important for us to push the frontier for MSMEs which contribute to nearly 29% of the GDP.<sup>21</sup> We have to see that necessary steps are taken to reduce the cost of capital for these firms so that they stay competitive and innovative.

The Indian manufacturing sector needs to upgrade to compete globally, however, without effective and targeted policy support it would not be possible for the sector to progress. It will stagnate and not be able to compete with its emerging market peers. Only through effective collaboration between the government and the private sector will India's manufacturing sector be able to see any progress.

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20 EAC-PM (2019). *R&D Expenditure Ecosystem. Current Status and Way Forward*. Retrieved from [https://www.indiascienceandtechnology.gov.in/sites/default/files/file-uploads/roadmaps/1571900991\\_R%26D%20book%20expenditure%20ecosystem.pdf](https://www.indiascienceandtechnology.gov.in/sites/default/files/file-uploads/roadmaps/1571900991_R%26D%20book%20expenditure%20ecosystem.pdf) (last accessed 2021, January 09)

21 (2019, July 05). MSMEs to contribute 50% to India's GDP, provide 15 cr jobs in 5 years: Gadkari. *Economic Times*. Retrieved from <https://economictimes.indiatimes.com/small-biz/sme-sector/msmes-to-contribute-50-to-indias-gdp-provide-15-cr-jobs-in-5-years-gadkari/articleshow/70092226.cms?from=mdr> (last accessed 2021, January 09)

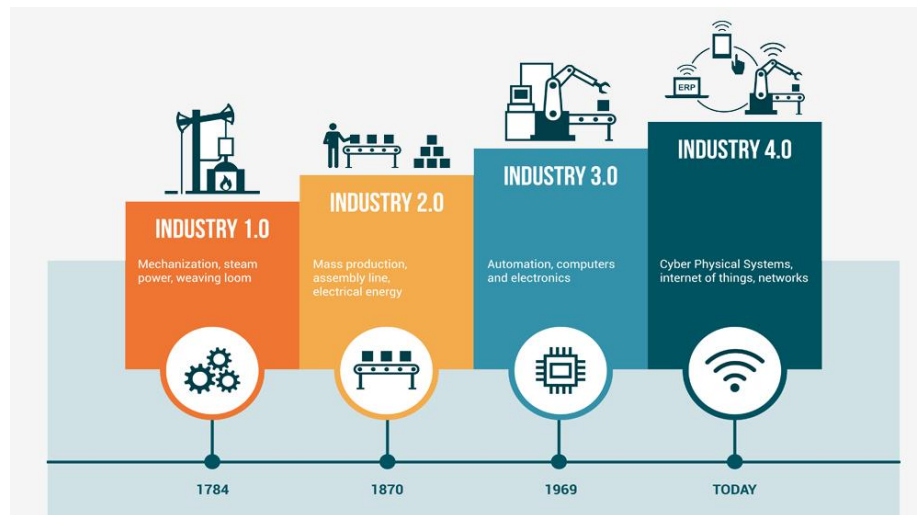
## Chapter 2

# Digital transformation and Industry 4.0 in Manufacturing

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From Britannica to Wikipedia, from Encyclopaedia to Google, and from hand assembly to robots and automation, the journey of industrial transformation and the use of technology is constantly evolving. Industrial revolutions were historically marked by the use of power. The 1<sup>st</sup> Industrial Revolution mechanised the production process through the power generated by water and steam. The 2<sup>nd</sup> Industrial Revolution made mass production possible by the use of electricity. The 3<sup>rd</sup> Industrial Revolution was marked by information technology leading us to the 4<sup>th</sup> Industrial Revolution (Industry 4.0) which uses integrated technologies and has touched all spheres of our life making it a truly distinct revolution. The impact, scope and exponential pace of revolution is phenomenally marked by breakthroughs. The disruption created by Industrial Revolution 4.0 heralds the transformation of covering entire organisational systems, management and production.

**Figure 3: Industrial revolutions**



Source: Momentum, L. (2019). *The Industrial Revolution: From Industry 1.0 to Industry 4.0*. Retrieved 15 January 2021, from <https://www.seekmomentum.com/blog/manufacturing/the-evolution-of-industry-from-1-to-4>

### Impact of Digital Transformation Strategies on Performance of Manufacturing...

Industrial revolution 4.0 is marked by the power of Data. As stated by some experts **“data is the new oil”**. Digital-born businesses like Google and Amazon are power producers and other digital savvy companies are the companies of next industrial age. Traditional manufacturing companies have to advance and digitally transform themselves to become new age companies. Therefore, digital transformation entails changes in job and income creation strategies, changes in business models, facing the competition and meeting customer expectations. It requires reinventing of business models, digitisation of supply chains and use of technology in all the operational and functional departments of the company”.<sup>22</sup>

Digital transformation should not be construed as merely a technological leap. It is more than just implementing new software and platforms in an organisation. Leaders and managers should not just focus on the technical capabilities or hardware and software updates, rather they should focus on adapting their business models, their institutional and operational ecosystems in line with digitalisation initiatives. Digital transformation is essentially an application of a flexible business model which is focused on digitalisation.

Furr et al in their Harvard Study, ‘Digital Doesn’t Have to Be Disruptive’, have stated that digital transformation is not only a rearrangement of technology, business models, and processes but also transformation of the core using digital tools and discovering new opportunities. They stated that the key to success is the focus on customer needs and organisational flexibility.<sup>23</sup> The adoption of digital transformation is actually determined by customer pull. Digitalised organisations are able to reduce the product design and manufacturing time to meet the demands of customers. This is only possible when data is used for optimal and faster decision processes at every level of manufacturing. This results in increase in productivity and, growth, and lowers costs.

In a nut shell, *“[I]ndustry 4.0 is the information-intensive transformation of manufacturing (and related industries) in a connected environment of big data, people, processes, services, systems and IoT-enabled industrial assets with*

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22 Schallmo Daniel, Willams Christopher A.; Boardman Luke (2018)“Digital Transformation of Business Models-Best Practice, Enabler, and Roadmap”, International Journal of Innovation Management, 21(8): 1740014-(17 pages)

23 Digital Doesn’t Have to Be Disruptive. (2019). Retrieved 9 October 2020, from <https://hbr.org/2019/07/digital-doesnt-have-to-be-disruptive>

## Digital transformation and Industry 4.0 in Manufacturing

*the generation, leverage and utilization of actionable data and information as a way and means to realize smart industry and ecosystems of industrial innovation and collaboration”<sup>24</sup> It integrates Information Technology (IT) and Operational Technology (OT) to evolve into a cyber-physical system in which it brings together physical industrial assets and digital technologies.<sup>25</sup>*

### Key technologies associated with Industry 4.0 and their real world applications

In the Table 3 below we have described the key technologies in manufacturing:

**Table 3: Key technologies associated with Industry 4.0 and digital transformation in the manufacturing sector**

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Industry 4.0 – Device layer Technologies                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b><u>Industrial Internet of Things (IOT) - Device Layer</u></b><br>IOT connects physical devices digitally and facilitates information exchange through the Internet.<br>In the manufacturing sector, IOT facilitates collection of real-time data about parameters such as machine condition and performance by integrating sensors, Radio Frequency Identification (RFID) tags, software and electronics with industrial machines and systems.<br>In the manufacturing sector, tracking is one of the major applications of IOT and it is highly used for asset management. BJC Healthcare in the United States used RFID tags to track and manage its medical supplies across 15 hospitals. <sup>26</sup> |
| <b><u>Open Process Automation (OPA) - Device Layer</u></b><br>OPA provides an open architecture of automation which is flexible and can be easily adapted for industrial application. Open Process Automation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

24 I-SCOOP. *Industry 4.0: the fourth industrial revolution – guide to Industrie 4.0*. Retrieved from <https://www.i-scoop.eu/industry-4-0/> (last accessed 2021, January 09)

25 I-SCOOP. *Industry 4.0: the fourth industrial revolution – guide to Industrie 4.0*. Retrieved from <https://www.i-scoop.eu/industry-4-0/> (last accessed 2021, January 09)

26 (2019, March 28). Industry 4.0: 7 Real-World Examples of Digital Manufacturing in Action. AMFG. Retrieved from <https://amfg.ai/2019/03/28/industry-4-0-7-real-world-examples-of-digital-manufacturing-in-action/#:~:text=Industry%204.0%20in%20a%20nutshell,connectivity%2C%20intelligence%20and%20flexible%20automation> (last accessed 2021, January 09)

results in easy updating and low maintenance, therefore, manufacturers can put focus more on improving their manufacturing process than on supporting automation. It allows integration of best in class components as well as significantly reduces the costs of future replacements.

An example of ExxonMobil Corporation can be cited here which used OPA to replace their old and obsolete DCS installations.<sup>27</sup>

#### **Advanced Robotics - Device Layer**

Robotics have always been part an integral of the manufacturing sector, however Industry 4.0 has given it a new dimension. Powered by state of the art software and sensors, robots today are able to recognise, analyse and act upon information received from the environment. They can also collaborate and learn from humans.

A new concept of “Cobots” has also emerged where robots work in a collaborative setting with humans, taking over repetitive and dangerous tasks performed by humans.

Fetch Robotics in the United States is manufacturing Autonomous Mobile Robots (AMRs) for performing tasks such as locating, tracking and moving inventory in their warehouse and logistics facilities. DHL in the Netherlands is using Fetch AMRs to perform pick and place operations in their facility alongside humans.

#### **Augmented and virtual reality (AR/VR) - Device Layer**

AR superimposes virtual images or data onto physical objects and stitches the gap between the digital and physical world. This technology involves use of AR capable devices such as smartphones, tablets and smart glasses. In the manufacturing, AR glasses can project data, such as layouts and sites of possible malfunction on a real machine part, thereby making work procedures more efficient and relatively easier.

General Electric is piloting AR glasses at its jet manufacturing facility in the United States. AR glasses are not only eliminating the need for supervision by engineers but also ensuring that tasks are undertaken correctly.<sup>28</sup>

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27 Forbes, H. (2018, January 19). What is Open Process Automation? *ARC Advisory Group*. Retrieved from <https://www.arcweb.com/blog/what-open-process-automation> (last accessed 2021, January 09)

28 (2019, March 28). Industry 4.0: 7 Real-World Examples of Digital Manufacturing in Action. AMFG. Retrieved from <https://amfg.ai/2019/03/28/industry-4-0-7-real-world-examples-of-digital-manufacturing-in->

## Digital transformation and Industry 4.0 in Manufacturing

Factory workers are also increasingly being trained with AR based learning systems where they can simulate their operating the machines in a learning environment without actually operating them.

### Industry 4.0 – Data Layer Technologies

#### **Big Data and Data Engineering Analytics - Data Layer**

Big data refers to large and complex data sets collected through IOT devices such as sensors and cameras and from databases such as ERP and CRM. The data collected from various sources can be stored in data lakes in a structured or unstructured form at any scale.<sup>29</sup> It is then analysed to provide actionable insights or tangible/lucrative business benefits. Machine learning models and data visualisation are important tools that support the analysis of big data.

In the manufacturing sector, insights obtained from analysis of these initially isolated sets of data helps optimize processes.

Bosch has combined the use of IOT and big data in its automotive diesel system factory China. The company uses sensors fit in its machines to predict failures and plan maintenance well in time. Data analysis has helped Bosch increase output by more than 10% output in certain areas, along with an improvement in delivery and customer satisfaction.<sup>30</sup>

#### **Cloud Computing - Data Layer**

Cloud Computing is the revolutionizing concept where a platform which can be accessed remotely becomes the storage point of all data collected by manufacturers. While cloud computing is not a solution by itself, it saves the manufacturer from investing in computing infrastructure and enables implementation of solutions that require heavy computer power.

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action/#~:text=Industry%204.0%20in%20a%20nutshell,connectivity%2C%20intelligence%20and%20flexible%20automation (last accessed 2021, January 09)

29 AWS. *What is a data lake?* Retrieved from <https://aws.amazon.com/big-data/datalakes-and-analytics/what-is-a-data-lake/> (last accessed 2020, January 09)

30 (2019, March 28). Industry 4.0: 7 Real-World Examples of Digital Manufacturing in Action. AMFG. Retrieved from <https://amfg.ai/2019/03/28/industry-4-0-7-real-world-examples-of-digital-manufacturing-in-action/#~:text=Industry%204.0%20in%20a%20nutshell,connectivity%2C%20intelligence%20and%20flexible%20automation> (last accessed 2021, January 09)

One of the pertinent roles of cloud computing is that it allows organizations to have centralized operations and the information stored on cloud can be accessed by all members of the organisation.

**Edge Computing ( Data Layer- Distributed Computing)**

Edge Computing enhances the power for processing and allows more activities to be performed by user end devices. This decreases inefficiency by reducing the stacks associated with the IOT and cloud computing, increasing information security , and reducing conveyance costs. Edge allows increased handling capacity and opens up numerous conceivable outcomes inside the scope of the IOT such as dodging deterrents, dialect handling, protest location, face recognition and other machine learning applications.

We can see several applications of the Edge Computing in Autonomous vehicles where they were first used to track obstacles and relay real time data on the road ahead to the vehicles adaptive system.

**Fog computing** provides a network connecting cloud servers and machines with data entry points and storage locations. Fog Computing forms a link between edge and cloud machines.

**Artificial Intelligence (AI) - Data Layer**

AI is an extension of computer science that enables smart machines to perform like humans having similar intelligence as they learn from experience, continuously incorporate inputs into their response , make decisions and judgments which *“normally require human level of expertise and help people anticipate problems or deal with issues as they come up”*.<sup>31</sup>

**Advanced Analytics and Machine Learning – Data Layer**

Analytics helps executives understand – (a) What is happening in their business? - descriptive analytics, (b) Why is it happening? – Diagnostic Analytics, (c) What is likely to happen? – Predictive Analytics, and (d) What do I need to do? – Prescriptive Analytics.<sup>32</sup>

31 Shubhendu and Vijay (2013) In West, D. M. (2018, October 04). What is artificial intelligence? *Brookings*. Retrieved from <https://www.brookings.edu/research/what-is-artificial-intelligence/> (last accessed 2021, January 09)

32 (2017, January 19). The 4 Types of Data Analytics. *Principa*. Retrieved from <https://insights.principa.co.za/4-types-of-data-analytics-descriptive-diagnostic-predictive-prescriptive> (last accessed 2021, January 09)

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## Digital transformation and Industry 4.0 in Manufacturing

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Analytics have become the backbone of industry's several digital applications. Real time updates received from sensors and other data collection points can be analysed easily. Machine learning is a very powerful means of using data to understand the behaviour and performance of machines in setting up manufacturing as algorithms.

There are several uses of ML in manufacturing - ML based predictive maintenance of digitalised instruments and predicting demand for inventory management and mapping with production schedules.

### **Blockchain: Data layer- Distributed Technology**

Blockchain is defined as a decentralized technology which uses distributed network systems. Blockchain enables improved tracking and traceability and superior data security due to encryption. It can be used for supply chain auditing, streamlining warranty lifecycles by closing information asymmetries between manufacturers, warranty providers, other supply chain participants and the consumers, and creating smart contracts to minimize transaction costs for instance, a smart contract can automatically assess if the pre-set conditions to successful delivery have been met.<sup>33</sup>

### **Cybersecurity: Data layer**

This has to deal with the aspect of data integrity and is done through the protection of internet-connected systems such as hardware, software and data from cyber-threats. We have mostly seen its utility in protecting against unauthorized access to data centres and other computerized systems.

The goal of implementing cybersecurity is to make a good secure system accessible to stakeholder's computers, servers, networks, mobile devices and the data stored on these devices from attackers with malicious intent. We have seen incidents in the past where cyber-attacks have been designed to access, delete, or extort an organization's or user's sensitive data, making cybersecurity vital.<sup>34</sup>

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33 Birlasoft. *Three blockchain use cases that will accelerate Industry 4.0 journey for manufacturers*. Retrieved from <https://www.birlasoft.com/articles/three-blockchain-use-cases-that-will-accelerate-industry-4-journey-for-manufacturers> (last accessed 2021, January 09)

34 (2019, March 28). Industry 4.0: 7 Real-World Examples of Digital Manufacturing in Action. AMFG. Retrieved from <https://amfg.ai/2019/03/28/industry-4-0-7-real-world-examples-of-digital-manufacturing-in-action/#~:text=Industry%204.0%20in%20a%20nutshell,connectivity%2C%20intelligence%20and%20flexible%20automation> (last accessed 2021, January 09)

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### Industry 4.0- Process Layer Technologies

#### **Robotics Process Automation (RPA)- Process**

RPA enables organizations minimize manual time spent on tasks such as data entry, generating financial reports, or culling out insights from a customer management system. RPA automates administrative and mundane tasks that do not require deep cognitive abilities and unlike machine learning the software does not learn from inputs or results over time.<sup>35</sup>

#### **Additive Manufacturing (AM)- Process Layer**

AM works by using digital 3D models and manufacturing parts through 3D printing layer by layer.

AM is proving to be a valuable digital manufacturing technology. AM offers the possibility of manufacturing from tooling to mass customizations across all industries. The primary function of AM is distributed manufacturing which is storing of parts as design files in virtual inventories and producing them on demand or customising them. This leads to saving in travel, inventory and storage spaces.

AM is being used by Fast Radius offers supply chain optimization through its virtual inventory. The company has created a warehouse of 3000 virtual parts for a heavy equipment manufacturer instead of storing all parts - including those that are rarely used - physically. It is able to print and supply the parts on demand.<sup>36</sup>

### Industry 4.0 – Enablers

35 Sremack, J. (2018, September). An Introduction to Robotic Process Automation for Manufacturers. *BDO United States*. Retrieved from [https://www.bdo.com/insights/industries/manufacturing-distribution/an-introduction-to-robotic-process-automation-for#:~:text=Robotic%20Process%20Automation%20\(RPA\)%20is,to%20deliver%20mission%20critical%20work](https://www.bdo.com/insights/industries/manufacturing-distribution/an-introduction-to-robotic-process-automation-for#:~:text=Robotic%20Process%20Automation%20(RPA)%20is,to%20deliver%20mission%20critical%20work) (last accessed 2021, January 09)

36 (2019, March 28). Industry 4.0: 7 Real-World Examples of Digital Manufacturing in Action. AMFG. Retrieved from <https://amfg.ai/2019/03/28/industry-4-0-7-real-world-examples-of-digital-manufacturing-in-action/#:~:text=Industry%204.0%20in%20a%20nutshell,connectivity%2C%20intelligence%20and%20flexible%20automation> (last accessed 2021, January 09)

### **Digital Twins. (Simulation) - Enabler**

Digital twin technology uses digital representation of a real-world product, machine, process or system in order to provide better understanding, analysis and optimisation of processes for companies through real-time simulation. The simulation helps predict potential issues and improves machine up-time. It also helps in improving the design and performance of a product.

American pro-racing squad Team Penske is using a digital twin application to create a virtual test bed for testing innovations in new parts and optimising car performance before incorporating the changes into a physical car.<sup>37</sup>

### **Asset Performance Management (APM) – Enabler**

APM enables data analytics. This technology can integrate data from multiple plants and sites and can get equipment from OEM. APM enables predictive forecasting, reliability asset maintenance and condition monitoring. Commonly it is used for web applications. APM leverages data analytics and digital twin models to detect very subtle indicators of potential failure.

Companies like GE Digital, Bruce Power and Xcel Energy use APM to reduce costs and increase efficiency.

Sources: See the Footnotes<sup>38</sup>

<sup>37</sup> (2019, March 28). Industry 4.0: 7 Real-World Examples of Digital Manufacturing in Action. AMFG. Retrieved from <https://amfg.ai/2019/03/28/industry-4-0-7-real-world-examples-of-digital-manufacturing-in-action/#:~:text=Industry%204.0%20in%20a%20nutshell.connectivity%2C%20intelligence%20and%20flexible%20automation> (last accessed 2021, January 09)

<sup>38</sup> (2019, March 28). Industry 4.0: 7 Real-World Examples of Digital Manufacturing in Action. AMFG. Retrieved from <https://amfg.ai/2019/03/28/industry-4-0-7-real-world-examples-of-digital-manufacturing-in-action/#:~:text=Industry%204.0%20in%20a%20nutshell.connectivity%2C%20intelligence%20and%20flexible%20automation> (last accessed 2021, January 09); Forbes, H. (2018, January 19). What is Open Process Automation? ARC Advisory Group. Retrieved from <https://www.arcweb.com/blog/what-open-process-automation> (last accessed 2021, January 09); AWS. What is a data lake? Retrieved from <https://aws.amazon.com/big-data/datalakes-and-analytics/what-is-a-data-lake/> (last accessed 2020, January 09); Shubhendu and Vijay (2013) In West, D. M. (2018, October 04). What is artificial intelligence? Brookings. Retrieved from <https://www.brookings.edu/research/what-is-artificial-intelligence/> (last accessed 2021, January 09); 2017, January 19). The 4 Types of Data Analytics. Principa. Retrieved from <https://insights.principa.co.za/4-types-of-data->

Figure 4: Industry 4.0 Technologies



Source: Industry 4.0: fourth industrial revolution guide to Industrie 4.0 Industry 4.0: fourth industrial revolution guide to Industrie 4.0. (2021). Retrieved 15 January 2021, from <https://www.i-scoop.eu/industry-4-0/>

[analytics-descriptive-diagnostic-predictive-prescriptive](#) (last accessed 2021, January 09); Birlasoft. *Three blockchain use cases that will accelerate Industry 4.0 journey for manufacturers*. Retrieved from <https://www.birlasoft.com/articles/three-blockchain-use-cases-that-will-accelerate-industry-4-journey-for-manufacturers> (last accessed 2021, January 09); Sremack, J. (2018, September). *An Introduction to Robotic Process Automation for Manufacturers*. BDO United States. Retrieved from [https://www.bdo.com/insights/industries/manufacturing-distribution/an-introduction-to-robotic-process-automation-for#:~:text=Robotic%20Process%20Automation%20\(RPA\)%20is,to%20deliver%20mission%20critical%20work](https://www.bdo.com/insights/industries/manufacturing-distribution/an-introduction-to-robotic-process-automation-for#:~:text=Robotic%20Process%20Automation%20(RPA)%20is,to%20deliver%20mission%20critical%20work) (last accessed 2021, January 09);

## Key Performance Drivers of Industry 4.0 and digital manufacturing

Digital manufacturing creates a number of benefits and efficiencies for firms including:

**Higher productivity:** A 2019 study undertaken by Deloitte and the Manufacturer's Alliance for Productivity and Innovation (MAPI)<sup>39,40</sup> in the United States shows that companies reported up to 12% improvement in output, factory utilization and labour productivity through smart factory initiatives. Lower unplanned asset downtime and higher asset utilization are key benefits of Industry 4.0 technologies that enhance productivity of manufacturing firms and lead to cost savings. For instance, unplanned machine downtimes are one of the biggest challenges for manufacturers as they immediately stall the production process. As a result, manufacturers engage in costly periodic maintenance irrespective of need, wasting financial and time resources and reducing return on assets on the shop floor. IOT and data analytics – important Industry 4.0 technologies – can help minimize such losses. According to a study, a German automotive manufacturer was able to reduce downtime losses by more than 40,000 Euros per minute through predictive and real-time IOT.<sup>41</sup> Deloitte (2017) estimates that predictive maintenance using Industry 4.0 technologies can lower plant maintenance time by 20% - 50%, increase equipment uptime and availability by 10%-20% and decrease overall costs of maintenance by 5%-10%.<sup>42</sup>

**Improved asset turnover:** Productivity gains have been seen to improve asset turnover for firms. Tracking non-tech US firms over a 3-year period that adopted digitization, Chen & Srinivasan (2019) show their asset turnover

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39 Deloitte and MAPI interviewed 600 executives at manufacturing firms with their headquarters in the United States and with a global factory footprint

40 Deloitte and Manufacturer's Alliance for Productivity and Innovation (MAPI) (September 2019). <https://www2.deloitte.com/us/en/pages/about-deloitte/articles/press-releases/2019-deloitte-and-mapi-smart-factory-study-capturing-value-along-the-digital-journey.html> (Last accessed on 2020, November 11)

41 PTC (2019). Quantifying the Value of Digital Transformation in Manufacturing, Page 1

42 Coleman, C., Damodaran, S., Chandramouli, M., & Deuel, E. (2017). Making maintenance smarter. Deloitte Insights. <https://www2.deloitte.com/us/en/insights/focus/industry-4-0/using-predictive-technologies-for-asset-maintenance.html> (Last accessed on 2020, November 11)

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increased throughout the time period, with a 2%-7% increase seen in the third year compared to industry peers.<sup>43</sup>

**Operational efficiency:** Manufacturing firms often suffer from operational inefficiencies due to lack of synchronization between their information technology (IT) systems and operational technology (OT) systems. Industry 4.0 technologies enable integration between the IT and OT systems of manufacturing firms, providing a single-screen real-time view of all aspects of the production process to managers. Woodward Inc. – a manufacturer of designer, manufacturer, and service provider of energy control and optimization solutions for aerospace and industrial markets, headquartered in United States<sup>44</sup> - is able to save USD 1.7 million per plant by implementing the IOT enabled single view application.<sup>45</sup>

**Higher firm value:** A 2019 study<sup>46</sup> of US listed non-tech firms from 2010 to 2017 shows that the market-to-book ratio of non-tech US firms adopting digital technologies is 7%-23% higher than their industry peers. The study also finds that firms that engage in digital activities are *“larger, younger, less CapEx intensive, hold more cash and are in industries with higher digital activity”*. Further, the research shows that digitization leads to higher valuation for firms that have a relatively higher CapEx, stronger sales growth and operate in industries with significant digital activity and/or cater to business customers. Given that firms that adopt digitization are more valued, they also exhibit a 43% - 127% higher Earnings Response Coefficient (ERC) annually based on digital engagement as compared to peers. Digital disclosure also has a positive impact on the stock market.

**Improved decision-making and operational efficiency:** Embracing Industry 4.0 technologies also helps in strengthening strategic and operational decision making by leveraging the power of data. This plays a key role in improving efficiency and cost effectiveness of firms.<sup>47</sup>

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43 Chen, W. & Srinivasan, S. (2019). Going Digital: Implications for Firm Value and Performance. Harvard Business School, Working Paper 19-117, Pages 2-5

44 Woodward. *About Woodward*. Retrieved from <https://www.woodward.com/en/about> (Last accessed on 2020, January 09)

45 PTC (2019). Quantifying the Value of Digital Transformation in Manufacturing, Page 6

46 Chen, W. & Srinivasan, S. (2019). Going Digital: Implications for Firm Value and Performance. Harvard Business School, Working Paper 19-117, Pages 2-5

47 Vassallo, D. and Jacobs, M. Don't Lose Sight of the "Human Factor" in Industry 4.0. *DuPont Sustainable Solutions*. Retrieved from <https://www.consultdss.com/dont-lose->

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## Digital transformation and Industry 4.0 in Manufacturing

**Reduction of Defects and Wastages:** High resolution measuring of production processes and monitoring the production parameters throughout the entire process with the use of new Machine Learning technologies and IOTs can help firms reduce their defects and wastages during the production processes.

**Reduction of Costs:** Capturing and analysing the data throughout the digital value chains- production line, transportation, and logistics can help in cost reductions. Companies can predict their lead times and manage their inventory well without any stock outs. By using Robotics Process Automation back office costs be reduced to half in some cases.

**Product Customisation:** Digital transformation can help in increasing the value for the customers by enabling customisation. Data analysis can help in offering customised products with manufacturing lines with digitalization can offer varying options to the customers without affecting mass production at competitive pricing.<sup>48</sup>

**Safety of Workers:** The most important benefit of digital technologies is the improved supervision and safety of workers particularly in manufacturing sectors where greater supervision and safety is required of workers performing hazardous tasks. Some of these difficult tasks can be performed by robots. Use of sensors can greatly help in reducing hazards by alarming the workers of safety issues.

Other benefits of Industry 4.0 in manufacturing are greater agility, flexibility and operational performance, reduction in inventory, improved quality, a shorter time to market, and an expansion and customization in the range of products supplied.<sup>49</sup>

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[sight-of-the-human-factor-in-industry-4-0/#:~:text=The%20large%2Dscale%20digitization%20of,efficient%20and%20cost%20of%20operations">sight-of-the-human-factor-in-industry-4-0/#:~:text=The%20large%2Dscale%20digitization%20of,efficient%20and%20cost%20of%20operations](#) (Last accessed on 2021, January 09)

48 PTC (2019). Quantifying the Value of Digital Transformation in Manufacturing,

49 PTC (2019). Quantifying the Value of Digital Transformation in Manufacturing,

## Chapter 3

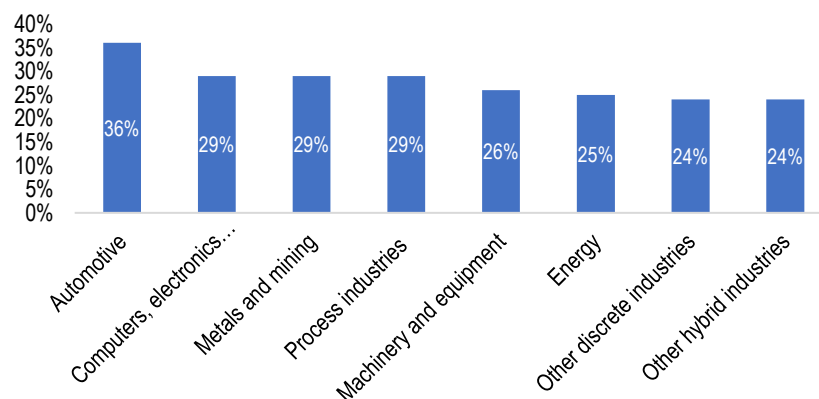
# Digital Transformation Ecosystem in India

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Industry 4.0 originated in Germany in 2006 when the German government presented its “High-Tech Strategy” at Hannover Messe with a proposal to drive innovation in the form of technical and social innovation in the country. ‘Digital economy and society’ was a key task identified by the German government as a means to create value and enhance quality of life going forward. The key characteristics of the future of production revolved around individualization of products, involving customers and business partners in value creation and connecting production with high-quality services to create hybrid products. The government promised clear support to the business and science sectors towards developing Industry 4.0. and even set up a Working Advisory Group for innovation policy. Five years later the work of the advisory group was presented, and Germany embraced Industry 4.0 thereon.<sup>50</sup>

Following Germany, Industry 4.0 has spread to various parts of the world across various industries. At an industry level, the automotive sector leads the way.

**Figure 5: Industry-wise penetration of Industry 4.0 (worldwide)**



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<sup>50</sup> I-Scoop. Industry 4.0: the fourth industrial revolution – guide to Industrie 4.0. <https://www.i-scoop.eu/industry-4-0/> (Last accessed on 11 November 2020)

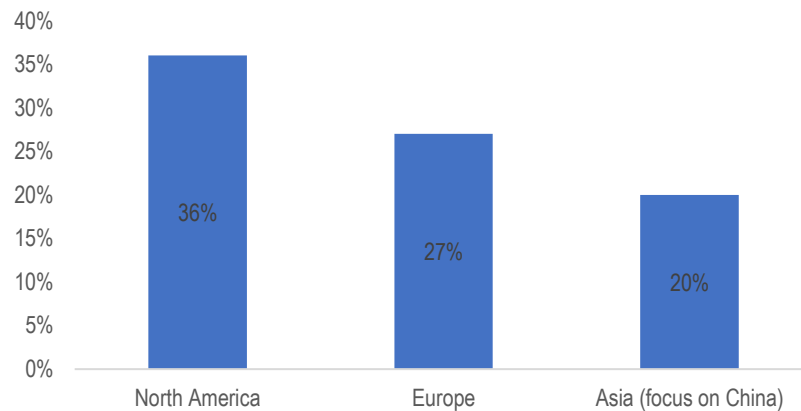
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## Digital Transformation Ecosystem in India

Note: The results are based on a survey of 150 OT and IT decision makers in manufacturing firms worldwide<sup>51</sup>

At a regional-level, North America has an Industry 4.0 adoption of 36%, followed by 27% in Europe and 20% in Asia (focus on China). The leading adopters are GE, Tesla and Boeing in North America, Siemens, ABB and BMW in Europe and Toyota, Huawei and Foxconn in Asia.

**Figure 6: Region-wise penetration of Industry 4.0 (worldwide)**



Note: The results are based on a survey of 150 OT and IT decision makers in manufacturing firms worldwide<sup>52</sup>

Despite the benefits, firms in India are far behind in embracing digital transformation and Industry 4.0. For instance, India has a robot density of only 3 Robots per 10,000 employees, much below the global average of 74 and far below that of geo-politically competing countries such as China.

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51 IOT Analytics (2020). Industry 4.0 & Smart Manufacturing Adoption. Retrieved from <https://iot-analytics.com/product/industry-4-0-smart-manufacturing-adoption-report-2020/> (Last accessed on 2020, November 11)

52 IOT Analytics (2020). Industry 4.0 & Smart Manufacturing Adoption. Retrieved from <https://iot-analytics.com/product/industry-4-0-smart-manufacturing-adoption-report-2020/> (Last accessed on 2020, November 11)

**Table 4: Robot Density in Manufacturing Companies in 2016 (Robots per 10,000 Employees)**

| Countries      | Number | Countries | Number |
|----------------|--------|-----------|--------|
| R Korea        | 631    | Singapore | 488    |
| Germany        | 309    | Japan     | 303    |
| US             | 189    | UK        | 71     |
| China          | 68     | Brazil    | 10     |
| Russia         | 3      | India     | 3      |
| Global average | 74     |           |        |

Source: International Federation of Robotics, (2018, February 07). Executive Summary, Robot density rises globally, World Robotics 2017, Industrial Robots<sup>53</sup>

Further, India ranked only 88 out of 134 on the World Economic Forum's (WEF) Network Readiness Index (NRI) 2020, much lower than Korea (14), China (40), Brazil (59), Vietnam (62), Mexico (63) and Indonesia (73). The NRI ranks countries on digital transformation based on their performance across 60 variables grounded in mainly four fundamental dimensions - Technology, People, Governance and Impact.<sup>54</sup>

Adoption of Industry 4.0 in India is particularly grave for the small industries. A 2019 survey conducted by SME India Forum showed that out of over 1,29,537 MSME respondents, only 7% adopt digital technologies. Over 70% of the MSMEs interviewed stated reasons such as lack of knowledge, high costs and lack of skilled manpower as key challenges impeding adoption of digital technologies.<sup>55</sup>

53 Bhat, T. P. (2020, January). *India and Industry 4.0*. Institute for Studies in Industrial Development

54 World Economic Forum in collaboration with A.T. Kearney. (2018)

55 (2019, November 20) Indian MSMEs struggle for technology adoption continues; poor digital understanding restricting growth. *Financial Express*. Retrieved from <https://www.financialexpress.com/industry/sme/msme-tech-small-business-technology-msme-cloud-adoption-digital-technology-india-sme-forum-intel-india/1770091/> (last accesses 2021, January 09)

## Immediate need for Indian manufacturing firms to adopt Industry 4.0 and digital transformation

According to the literature, as more companies adopt digital technologies and a critical mass is reached, ripple effects change the prevalent competitive dynamics in the market and also alters the existing commercial landscape. Further, digitization also disrupts business models and operations of traditional firms, creates changes in consumer behaviour and offers opportunities for smaller firms with smaller legacies, which can easily adapt to changes.<sup>56</sup> These ignored and unexploited opportunities lead to a loss of market share. For instance, Google Maps completely took over the market for stand-alone GPS makers within two year.<sup>57</sup> In the manufacturing sector, firms adopting additive manufacturing are completely re-inventing supply chain management through virtual inventories, eliminating the need for long transportation overhauls and physical inventory storage. Firms that do not embrace Industry 4.0 going forward face the risk of being left behind by not just immediate competitors but the entire industry.<sup>58</sup> 86% of the 600 manufacturing sector executives interviewed in the United States in 2019 said that smart factory initiatives will drive competitiveness in the sector over the next 5 years.<sup>59</sup>

On superimposing this theory to the global manufacturing scenario, it is important to note that if Indian manufacturing firms fail to embrace Industry 4.0 and digital manufacturing technologies, they will get left behind in being able to cater to domestic or international demand. This is especially relevant in today's era where customers are well informed and quick to embrace new technologies that create not only efficiencies and savings but are also environment friendly. Moreover, if India's manufacturing sector fails to digitize quickly and catch up with the global Industry 4.0 trends and consumer demands, it will not be able to reach its potential in attracting foreign

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56 Nadkarni, S., Prügl, R. Digital transformation: a review, synthesis and opportunities for future research. *Manag Rev Q* (2020). <https://doi.org/10.1007/s11301-020-00185-7>

57 Bughin, J. and Zeebroeck, N. V. (2017, May 09). The best response to digital disruption. *McKinsey Global Institute*. Retrieved from [mckinsey.com/mgi/overview/in-the-news/the-right-response-to-digital-disruption](https://mckinsey.com/mgi/overview/in-the-news/the-right-response-to-digital-disruption) (last accesses 2021, January 09)

58 PTC (2019). Quantifying the Value of Digital Transformation in Manufacturing, Page 1

59 Deloitte and Manufacturer's Alliance for Productivity and Innovation (MAPI) (September 2019). <https://www2.deloitte.com/us/en/pages/about-deloitte/articles/press-releases/2019-deloitte-and-mapi-smart-factory-study-capturing-value-along-the-digital-journey.html> (Last accessed on 2020, November 11)

### **Impact of Digital Transformation Strategies on Performance of Manufacturing...**

investment from companies who are looking to relocate their facilities from China amidst the ongoing geo-political tensions.

Further, digitization is the key to unlocking the potential of India's manufacturing sector<sup>60</sup> and moving towards achieving the government's ambitious target of manufacturing sector contributing to 25% of the GDP. Digitization in the manufacturing sector can lead to accelerated and distributed production, efficiency gains and harnessing of India's natural advantage in the IT sector (see Table 5 below).

**Table 5: Digitization - key to unlock the potential of India's manufacturing sector**

|                                        |                                                                                                                                                                                                                                                                                                                                        |
|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Accelerate and distribution production | Manufacturing can be made economically efficient at smaller scales with the help of digital manufacturing where technologies connect the factory floor with supply chains and the distribution network. India can greatly benefit from this and distribute manufacturing opportunities across states catering to different conditions. |
| Efficiency gains                       | Digitization can help India make traditional industries more efficient and also develop new cutting-edge technologies. The Government aims to create an IoT industry in India worth USD 15 billion by 2020. According to FICCI-EY report, the manufacturing sector will account for 18% of Internet of Things (IOT) revenue in India.  |
| Harnessing India's natural advantage   | Given its well-established IT sector and government initiatives such as Digital India and Start-Up India, India will be able to multiply the benefit of its inherent advantages by embracing Industry 4.0 and digital manufacturing successfully.                                                                                      |

Source: Annunziata, M. (2016, October 06). Why digitizing industry will create more and better jobs in India. *Medium*. Retrieved from <https://medium.com/@marcoannunziata/why-digitizing-industry-will-create-more-and-better-jobs-in-india-70ca3d6a4a9> (last accessed 2021, January 09); IOT Policy Document, [https://www.meity.gov.in/sites/upload\\_files/dit/files/Draft-IoT-Policy%20%281%29.pdf](https://www.meity.gov.in/sites/upload_files/dit/files/Draft-IoT-Policy%20%281%29.pdf); Rishi, R. and Saluja, R. Future of IOT, *FICCI and EY*, <http://ficci.in/spdocument/23092/Future-of-IoT.pdf>

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60 Molly R (January 2020). Industry 4.0: A great future. *Manufacturing Today*. <https://www.manufacturingtodayindia.com/sectors/6089-industry-40-a-great-future> (Last accessed on 2020, November 11)

## Chapter 4

# Strategy Framework for Digital Transformation

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Studies suggest that over time in the coming decade with the increasing digital maturity companies and the onset of Industry 4.0, there will be no separation of a digital strategy from a business strategy any longer.<sup>61</sup>

However, when firms get started with digital transformation, they fail to strategize effectively and follow a step-by-step guide with the following steps–

- First, analyse every aspect of the business;
- Second, reimagine the business model and aspirations;
- Third, understand how new technologies affect working processes;
- Fourth, understand where the business currently stands; and,
- Fifth, build the transformation roadmap.<sup>62</sup>

According to a study by Wipro Digital (2017), 35% of the 400 senior executives surveyed in the United States on digital transformation in their organizations found lack of a clear transformation strategy to be a key bottleneck preventing the firm from achieving its maximum potential.<sup>63</sup> In an earlier study undertaken by MIT Sloan and Deloitte University(2015), lack of a clear strategy was identified a key hindrance by 50% of the respondents for digital maturity

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61 Lipsmeier, A., Kühn, A., Joppen, R., & Dumitrescu, R. (2020). Process for the development of a digital strategy. *Procedia CIRP*, 88, 173-178. doi: 10.1016/j.procir.2020.05.031

62 Atluri, V., Eaton, J., Kamat, M., & Rao, S. (2018). *Tech-enabled disruption of products and services: The new battleground for industrial companies*. <https://www.mckinsey.com/>. Retrieved 1 October 2020, from <https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/tech-enabled-disruption-of-products-and-services..>

63 Wipro Digital (2017). *New Survey Highlights Leadership Crisis in Digital Transformation*. Retrieved from <https://wiprodigital.com/news/new-survey-highlights-leadership-crisis-digital-transformation/> (Last accessed on 16 November 2020)

amongst firms that were at a very early stage of digitization.<sup>64,65</sup>

Digital Transformation is a strategic change for any company resulting into *profound changes in structure that creates something new. Transformation occurs through a system of continual questioning, challenging, exploration, discovery, evaluation, testing, and creation of an organization's management theory and application; beginning with the realization or revelation that the organization's current thinking (i.e., management theory) is incomplete, limiting, flawed, or even worse – destructive (Daszko & Sheinburg, 2005)*<sup>66</sup>

An examination of the extensive literature on Transformational Change shows implementing and designing changes in an organisation requires consideration of a variety of contextual factors. Those contextual factors could be internal as well as external. The contextual factors relevant for adoption of technology in manufacturing organizations can be assessed using Technology, Organization and Environment (TOE) framework. The framework identifies three aspects of an enterprise's context which influence the process of adoption and implementation of a technological innovation: technological context, organizational context, and environmental context (Tornatzky & Fleischer, 1990).<sup>67</sup>

The TOE framework provides a useful analytical framework that can be used for studying the adoption and assimilation of different types of IT innovation.

Technological context describes both the internal and external technologies relevant to the firm. A firm's existing technologies are important in the adoption process because they set a broad limitation on the scope and pace of

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64 Study results were based on a survey of 4,800 business executives, managers and analysts from organizations around the world – across 129 countries, 27 industries and various organization sizes.

65 G. C. Kane, D. Palmer, A. N. Phillips, D. Kiron and N. Buckley (2015), *Strategy, Not Technology, Drives Digital Transformation*, MIT Sloan Management Review and Deloitte University Press..

66 Daszko, M., & Sheinberg, S. (2005). *SURVIVAL IS OPTIONAL: Only Leaders With New Knowledge Can Lead the Transformation*. Retrieved 2 October 2020, from <https://www.researchgate.net/publication/228484177>

67 Tornatzky, L.G. and Fleischer, M. (1990). *The Process of Technology Innovation*. Lexington: Lexington Books.

technological change that a firm can undertake (Collins et al. 1988)<sup>68</sup>. The ability of businesses to adopt new Industry 4.0 technologies will depend upon its easy access and related support infrastructure. To be technology ready firms have to train and educate their existing workforce and recruit new talent and also address issues related to data governance and cybersecurity. There should be compliance to standards and the technology should be comprehensive, interoperable, inter-connectable, analytics-enabled, and scalable.

Organizational context refers to descriptive measures about the organization such as scope, size, and managerial structure. The *Organizational Context* represents “characteristics and resources of the firm, including linking structures between employees, intra firm communication processes, firm size and amount of slack resources”. Organic and decentralized organizational structures are associated with adoption (Burns and Stalker 1962<sup>69</sup>; Daft and Becker 1978<sup>70</sup>).

Also, Organisational context can also be referred to organisational readiness. A practical definition of organizational digital readiness/ preparedness is “level at which an organization has optimized key attributes required to successfully implement internet-enabled business strategies and initiatives” (Hartman, Sifonis, & Kador, 2000)<sup>71</sup>. In general, Organizational readiness for change is a multi-level construct based on the individual, group, unit, department and organizational levels where the construct's meaning, measurement and interactivity with other variables differ (Weiner, 2009)<sup>72</sup>.

Further, Organizational readiness for change is not only a multi-level construct, but a multi-faceted one. Specifically, organizational readiness refers to organizational members' change commitment and change efficacy to

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68 Collins, P. D., Hage, J., & Hull, F. M. (1988). Organizational and technological predictors of 417 change in automaticity. *Academy of Management Journal*, 31(3), 512–543.

69 Burns, T., & Stalker, G. M. (1962). *The management of innovation*. Chicago: Quadrangle Books

70 Daft, R. L., & Becker, S. W. (1978). *The innovative organization: Innovation adoption in school 423 organizations*. New York: Elsevier.

71 Hartman, A. & Sifonis, J. & Kador, J.. (2000). *Net ready-Strategies for Success in the Economy*.

72 Weiner, B.J. A theory of organizational readiness for change. *Implementation Sci* 4, 67 (2009). <https://doi.org/10.1186/1748-5908-4-67>

implement organizational change (Weiner, 2009). Commitment to change refers to organizational members' shared resolve to pursue the courses of action involved in change implementation, and change efficacy refers to organizational members' shared beliefs in their collective capabilities to organize and execute the courses of action involved in change implementation (Bandura, 2012)<sup>73</sup>.

Studies have suggested that organisational readiness for transformation is dependent on five factors- Awakening, Vision, Method, Learning, and Integration. The aim of awakening is to impress the importance of the need to change, and it creates a deeply motivated vision for change. The method for transformation is the system of profound knowledge which includes specific thinking and the learning process involving the system of profound knowledge as a lens through which beliefs and paradigms, systems and processes, language and tools are developed and evaluated as the core of creating a transformation. Lastly, the feedback and reflection loop suggests an iterative and progressive transformation process. The challenge with each of these components is communication with others in the system. One person's dissatisfaction has to be effectively communicated to others. Leaders need to acknowledge the fears of employees. They should recognise that transforming an organization requires create an environment of openness and participation and preparing people for the journey.

There are four pillars of organizational readiness: Leadership, Governance, Competencies and Technology (Lalic & Marjanovic, 2010)<sup>74</sup> Dedicated and strong leadership is the prerequisite of effective implementation of the other pillars. The most successful organizations are those who have leaders who set the vision to grow the organization using ICT solutions strategically. Executives understand how web-based processes can create opportunities for innovation, productivity, and efficiency, hence they empower the organization to view information technology as a tool and a strategic asset.

The second pillar, Governance, describes the operational structure of the organization, including assignment of authorities, roles, and responsibilities.

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73 Bandura, A. (2012). Social cognitive theory. In P. A. M. Van Lange, A. W. Kruglanski, & E. T. Higgins (Eds.), *Handbook of theories of social psychology* (p. 349–373). Sage Publications Ltd. <https://doi.org/10.4135/9781446249215.n18>

74 B. Lalic and U. Marjanovic, Success of Social Networking Sites: Evidence from the University of Novi Sad, in: F. Jakab (Ed.), 15th IEEE Int. Conf. Emerg. eLearning Technol. Appl., IEEE, The High Tatras, 2017, pp. 233–238.

## Strategy Framework for Digital Transformation

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Governance establishes an effective model to organize, fund, and execute IT initiatives. A flexible and effective governance model of successful Internet-ready organisations establishes cross-functional teams to promote collaboration, focuses near-term results and tangible returns on IT investment, encourages accountability for e-business success, actively promotes web-based applications, considers IT department as strategic consultants in decision-making process, and dictates strong partnership between IT and business.

The third pillar, Competencies, include strategic components to address an organisation's ability to plan, operational, managerial, and technical competencies. Competencies determine how an organization addresses customers' demand or achieves its purpose. Technology as the last pillar contains three essential elements: skills in technological domain, IT applications and infrastructure. It determines the organisation's ability to develop or acquire a technology platform capable of supporting current and future growth.

Further, researchers have also suggested that organisations should define three sets of pre-requisites for prioritising digital initiatives and allocating resources. (Atluri, Rao & Sahni, 2018)<sup>75</sup>. At the foundation or functional level they should focus on data strategy, cybersecurity, cloud infrastructure, and analytics and at the organizational level focus should be on agile operating model and change fostering culture. Finally there should be emphasis on design thinking and development of digital ecosystem. Azhari et al. defined the model for the digital transformation focusing on eight dimensions of digitisation, namely strategy, leadership, products, operations, culture, people, governance and technology.<sup>76</sup>

The last element of TOE framework, the Environmental context is the arena in which a firm conducts its business—its industry, competitors, the presence or absence of technology service providers and dealings with the government. The level of competition is intense and is expected to stimulate the adoption

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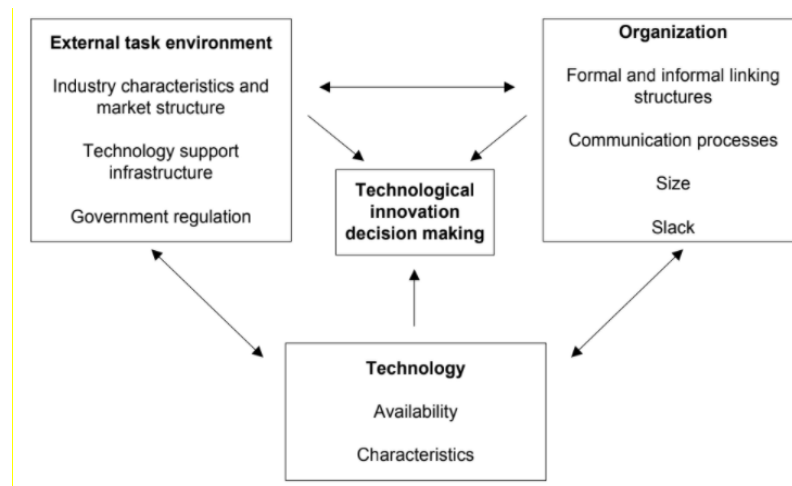
75 <https://www.mckinsey.com/~media/McKinsey/Industries/Advanced%20Electronics/Our%20Insights/Accelerating%20the%20impact%20from%20a%20tech%20enabled%20transformation/Accelerating-the-impact-from%20a%20tech-enabled-transformation.pdf>

76 Azhari, P., Faraby, N., Rossmann, A., Steimel, B., & Wichmann, K. S. (2014). Digital Transformation Report. Retrieved from [http://www.wiwo.de/downloads/10773004/1/dta\\_report\\_neu.pdf](http://www.wiwo.de/downloads/10773004/1/dta_report_neu.pdf)

## Impact of Digital Transformation Strategies on Performance of Manufacturing...

of new technologies and innovation. (Mansfield et al. 1977)<sup>77</sup>. Not only competitive pressures but also consumer pull and influence of dominant firms within the value chain can lead to adoption of new technologies by other firms. (Kamath and Liker 1994)<sup>78</sup>. There is an unclear evidence about innovation and technology adoption in the mature or declining industries (Tornatzky and Fleischer 1990)<sup>79</sup>. Other factors in the environment that lead to technological adoption are the availability of talent, skilled work-force, consultants, or suppliers of technology and services. (Rees et al. 1984). Finally, regulatory support can have a positive impact on the level of adoption. Regulatory pressures, on the other hand can have both positive as well as negative effects on technology. Investment in innovation and technology is inevitable if there are constraints placed on the industry, such as reduction in industrial emissions requiring pollution-control devices. Those firms, which do not comply would have to face penalties or reputation loss.

**Figure 7: TOE Framework**



77 Mansfield, Edwin, et al. 1977. "Social and Private Rates of Return from Industrial Innovations." *Quarterly Journal of Economics* May

78 A Second Look at Japanese Product Development , "A Second Look At Japanese Product Development". *Harvard Business Review*, 1994, <https://hbr.org/1994/11/a-second-look-at-japanese-product-development>.

79 Tornatzky, L.G. and Fleischer, M. (1990). *The Process of Technology Innovation*. Lexington: Lexington Books.

## Process for Development of Digital Strategies

While the need for digital transformation in manufacturing is apparent, the strategy and process itself are not very straightforward. There are no standard strategy templates available. Digital transformation of each firm needs to be customized based on its level of digital maturity and goals.

According to the management literature, there are three levels of strategies – (i) Corporate strategies (first level) which comprises the firm's mission statement, core competencies, and strategic business areas and programs; (ii) Business strategies (second level) which comprises of the business model, strategic success positions, products and services offered, measures for implementing strategy and so on in the different functional areas, along with the strategy compliant organisation work culture; and (iii) Sub-strategies (third level) where specific goals are decided for each functional area.<sup>80</sup> There is a lot of ambiguity around choosing the ideal level for positioning a digital strategy and whether the digital strategy should have a positioning integrated with business strategy or as an independent strategy. As a result, most often digital transformation gets implemented in silos which leads to loss of value from potential synergies across the organization.<sup>81</sup>

According to Andre Lipsmeier et al. / Procedia CIRP 88 (2020), digital strategy should be positioned at the second level i.e. business strategy level. Although initially a separate document, the digital strategy should eventually merge with business strategy as the firm matures digitally. Further, the firm should adopt a down-up approach<sup>82</sup> in terms of the process for development of a digital strategy as summarized in the paragraphs below (Figure 8).

**Step 1:** Form a strategic direction – **digital guiding principles** at the corporate and business level. The digital guiding principles comprise of:

- **Digital Assessment:** Assessing the current level of digital adoption and analysing the digital readiness of the firm.
- **Digital vision,** a concrete and feasible vision for the company with a

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80 Lipsmeier, A., Kühn, A., Joppen, R. & Dumitrescu, R. (2020). Process for the development of a digital strategy. *Procedia CIRP*. 88. 173-178. 10.1016/j.procir.2020.05.031

81 Lipsmeier, A., Kühn, A., Joppen, R. & Dumitrescu, R. (2020). Process for the development of a digital strategy. *Procedia CIRP*. 88. 173-178. 10.1016/j.procir.2020.05.031

82 Contains elements of bottom up and top-down approaches to strategy development

### **Impact of Digital Transformation Strategies on Performance of Manufacturing...**

time horizon of 5 – 8 years, and including digital transformation of product and services and/or value creation (this section focuses on value creation);

- **Digital mission**, comprising the rationale for digital transformation in the firm;
- **Digital policies**, comprising central values around digitization in the firm, for instance, principles governing digital leadership, data usage, IT security, change management, people policies and so on;
- **Digital targets and KPIs**, providing concrete shape to the digital transformation strategy and usually qualitative in nature; KPI's provide an effective tool for monitoring and,
- **Digital terms**, defining and unifying concepts related to digitisation across the firm.

**Step 2:** Define detailed digitisation initiatives using a bottom-up approach. For each digital vision, define **Digital-Use Cases** i.e. specific digitization initiatives (e.g. predictive maintenance). Thereafter, group similar digital-use cases into **digital focus topics at the functional area level**.

**Step 3:** Define concrete strategic objectives and identify digital focus topics at the cross-functional level. Based on digital guiding principles and digital-use cases identified, define specific **strategic objectives for the functional areas**. Also, based on the function area digital focus topics, identify **digital focus topics at the business level**, which will form the basis for **cross-functional synchronization**.

**Step 4:** Assign **quantitative values to digital targets** set up in step 1, keeping in mind the cross-functional topics

**Step 5:** Given the digital guiding principles and cross-functional topics, create a **digital strategy for each business unit**.

The digital strategy comprises of primary strategic elements – digital guiding principles, strategic direction (i.e. digital transformation of products or services or value creation), and measures and organization, and secondary strategic elements – digital culture, digital competencies, IT/OT architecture and value creation network. These elements are specific for each business unit.

**Step 6:** Considering the strategic objectives identified, set-up **concrete digital programs and projects** to implement the digital strategy at the **business level**.

## Strategy Framework for Digital Transformation

**Step 7:** Create umbrella digital programs at the corporate level that bring together business level programs and create synergies across the organisation.

**Figure 8: Process for Development of Digital Strategies**

|                                          | Step 1                                                                                         | Step 2                                                                        | Step 3                                                                                                                             | Step 4                                        | Step 5                                                                             | Step 6                                                                                | Step 7                                                                              | Step 8                                                                              |
|------------------------------------------|------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| <b>Corporate strategy (first level)</b>  | Form a strategic direction - digital guiding principles                                        |                                                                               |                                                                                                                                    |                                               |                                                                                    |                                                                                       | Create umbrella digital programs for synergies across the firm                      |  |
| <b>Business strategy (second level)</b>  | -Digital vision<br>-Digital mission<br>-Digital policies<br>-Digital targets<br>-Digital terms |                                                                               | Create cross-functional digital focus topics<br> | Assign quantitative values to digital targets |  | Considering the strategic objectives identified, set up concrete digital programs and |  | Set up a business level implementation roadmap for the digital programs identified  |
| <b>Functional strategy (third level)</b> |             | Identify digital use cases, group into digital focus topics at function level | Define specific strategic objectives                                                                                               |                                               | Create a digital strategy for each business unit                                   | projects to implement at the digital strategy at the business level                   |                                                                                     |                                                                                     |

Source: Lipsmeier, A., Kühn, A., Joppen, R. & Dumitrescu, R. (2020). Process for the development of a digital strategy. *Procedia CIRP*. 88. 173-178. 10.1016/j.procir.2020.05.031

## Digital Technology Adoption and Firm Performance

Digital technology can improve the firm performance in two ways - by increasing productivity through better workflow efficiencies and by improving

the financial performance. Technology adoption has been linked to productivity and performance since the time of industrial digital revolution in 1990s. Researchers such as (Barua et al. 1995<sup>83</sup>) and (Brynjolfsson and Hitt 1998)<sup>84</sup> have attributed this relationship to a variety of factors. According to Melville et al (2004), the main driver of an organisation's performance is its ability to collect and process information for decision making.<sup>85</sup> Other researchers also argue that it is the actual usage and not the investment in technology that leads to improved performance (Devaraj and Kohli 2003).<sup>86</sup>

Emerging literature on ERP systems and Supply Chain Management also purport to similar views (Hitt et al. 2003)<sup>87</sup>. For instance, Baxter a pharmaceutical company implemented an Analytical Systems Automated Purchasing (ASAP) system which allowed hospitals to electronically generate 50k purchase orders annually directly from wholesalers reducing costs of data entry (Vitale and Konsynski, 1986).<sup>88</sup> Along with the automation of ordering system the entire supply chain was automated including inventory systems and stockroom space. The supply chain management system created several efficiencies in the processes. In 1988, Johnston and Vitale,<sup>89</sup> concluded that organisations can reduce costs, time and resources deployed for managing inventory and interacting with suppliers by implementing technologies such as

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83 Barua, A., Kriebel, C. H. and Mukhopadhyay, T. (1995). "Information Technologies and Business Value: An Analytic and Empirical Investigation". *Information Systems Research*, 6(1), pp. 3-23.

84 Brynjolfsson, E. and Hitt, L. M. (1998). "Beyond the Productivity Paradox". *Communications of the ACM*, 41(8), pp. 49-55.

85 Melville, N., Kraemer, K. and Gurbaxani, V. (2004). "Review: Information Technology and Organizational Performance: An Integrative Model of IT Business Value". *MIS Quarterly*, 28(2), pp. 283-322

86 Kohli, R. and Devaraj, S. (2003). Measuring Information Technology Payoff: A Meta-Analysis of Structural Variables in Firm-Level Empirical Research, *Information Systems Research*, 14(2), pp. 127-145.

87 Greve, Henrich & Hitt, Michael & Ireland, R. & Camp, Michael & Sexton, Donald. (2003). *Strategic Entrepreneurship: Creating a New Mindset*. *Administrative Science Quarterly*. 48. 348. 10.2307/3556674.

88 Vitale, M. R. (1986a) American Hospital Supply Corp. (A): the ASAP Systems, Harvard Business School Case Services, No. 9-186-304, Boston, MA 02163, March. [Google Scholar](#)

89 Johnston, H. and M. Vitale. "Creating Competitive Advantage with Interorganizational Information Systems." *MIS Q.* 12 (1988): 153-165.

## Strategy Framework for Digital Transformation

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electronic data interchange, internet-based procurement systems, and other interorganizational information systems.

Dell Computer showed improvements in sales and market share by enhanced customer interactions through a customer relationship management software and online technical support capabilities (Rangan and Bell, 1999).<sup>90</sup> Another example of technology based customer relationship is of UPS which handles 700,000 package tracking requests via the Internet every day. The company benefitted customers by reducing costs from USD 2 spent on telephonic enquiry versus 10¢ per piece for the information provided through the Internet (Seybold and Marshak, 1998).<sup>91</sup>

Several researchers have also examined the relationship between productivity of employees working on technology and a firm's productivity. Their estimates are consistent with prior estimates of technology's output (Black and Lynch, 1996).<sup>92</sup>

Therefore, many studies reveal clear positive relationships between firm's success in terms of productivity, cost reduction, and improvements in sales with implementation of information technology (Brynjolfsson and Hitt (1995)).<sup>93</sup> However, some studies have found that success varies with the size of firms and size of investments. There are questions about the success of these variations. Some companies spend disproportionately on their digital strategies. These expenditures or investments are mostly on intangible assets such as implementation of new processes, acquiring and developing human capital, and major transformational change management, which may not be recorded in the financial statements.

Newer studies explore the impact of technologies such as artificial intelligence and machine learning on firm performance (Cockburn et al. 2017).<sup>94</sup> They

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90 Rangan, V. Kasturi, and Marie Bell. "Dell Online." Harvard Business School Case 598-116, March 1998. (Revised March 1999.)

91 Seybold, P. B., & Marshak, R. T. (1998). Customers.com: how to create a profitable business strategy for the Internet and beyond. New York: Times Business.

92 Black, Sandra & Lynch, Lisa. (1996). Human-Capital Investments and Productivity. American Economic Review. 86. 263-67.

93 Brynjolfsson, E. and Hitt, L. M. (1998). "Beyond the Productivity Paradox". Communications of the ACM, 41(8), pp. 49-55.

94 John P. O'Doherty, Jeffrey Cockburn, Wolfgang M. Pauli, Annual Review of Psychology 2017 68:1, 73-100

conclude that such technologies increase the value of existing assets and resources by complementing them. Therefore, we can expect that there are invisible and intangible benefits of digital technologies.

## **Impact of Information Technology Investments – Financial Variables**

### **Productivity**

For measuring productivity - sales or value added can be used as the output and labour, information technology and materials can be used as inputs. This is modelled using the Cobb-Douglas Production Function (Brynjolfsson 1998).<sup>95</sup> In this study, we captured the input variable of technology adoption by conducting text analytics on firm's published media and annual reports.

### **Profitability**

Another important alternative method of measuring performance is the measure of profitability, derived from financial statements. Prior studies such as research conducted by the MPI group have stated that artificial intelligence helps manufacturing companies identify defects early in the production process and with reduced human errors, which in turn helps in lowering costs and improving the profitability of the firms.<sup>96</sup> Accounting profits such as Earnings Before Interest and Taxes (EBIT) or Net Profit (PAT) allow diversity of interpretations of performance and variables that go into the calculations of these figures help in interpreting the performance from various perspectives such as performance of resources, marketing strategies, costs, and so on.

| Ratio (Measure )    | Numerator      | Denominator |
|---------------------|----------------|-------------|
| Gross Profit Margin | Gross Profit   | Sales       |
| Return of Assets    | Pre-tax Income | Assets      |

However, there are certain limitations of these variables in capturing firm performance. These ratios are not forward looking as they are derived from

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95 Brynjolfsson, E. and Hitt, L. M. (1998). "Beyond the Productivity Paradox". *Communications of the ACM*, 41(8), pp. 49-55.

96 Howells, Richard. "SAP Brandvoice: How Industry 4.0 Boosts Productivity And Profitability In Intelligent Factories". *Forbes*, 2020, <https://www.forbes.com/sites/sap/2020/07/01/how-industry-40-boosts-productivity-and-profitability-in-intelligent-factories/?sh=4bfabbfa48ec>. Accessed 28 Dec 2020.

past financial information and are distorted by accounting conventions. These ratios do not reflect risk and do not capture the value of intangible assets. They also do not reflect time lags necessary for realizing the potential of organizational change.

### Market Value

Another important financial performance metric is the total market value of the firm which serves as an alternative to accounting measures. Various studies have used different constructs of market value such as Tobin's q ratio which is defined as stock market valuation of a firm divided by calculated book value, intangible assets and technological assets (Hall 1993<sup>97</sup>; Hirschey 1982<sup>98</sup>). Therefore, market value can be used as a reasonable measure to estimate the value of tangible as well as large intangible assets such as value added by human capital or organisational capital or value of improved information systems. Even though it is difficult to measure these intangible assets, market value is able to capture some insights into the impact of information technology-related intangible assets. These intangible assets have greater impact in the long run than the short term. Berndt, Morrison and Rosenblum, 1992<sup>99</sup> suggested that multiple years of adaptation and investment is required to realise the benefits of such assets.

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97 Hall, B. H. (1993). The stock market's valuation of R&D investment during the 1980's. *The American Economic Review*, 83(2), 259-264.

98 Hirschey, Mark, 1982. "Intangible Capital Aspects of Advertising and R&D Expenditures," *Journal of Industrial Economics*, Wiley Blackwell, vol. 30(4), pages 375-390, June.

99 Ernst R. Berndt, Catherine J. Morrison & Larry S. Rosenblum, *Journal of Econometrics*, vol. 65, no. 1, pp. 9-43, (1994) *Annals of Econometrics*

## Chapter 5

# Methodology and Research Findings

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## Section 1: Stakeholder Panel Discussions

### Identification of Speakers

We conducted expert interviews with stakeholders who are directly or indirectly involved in formulation and implementation of digital transformation in manufacturing firms in India. The choice of experts was made on the basis of the definition given by Bogner, Littig, and Menz, 2009<sup>100</sup>-*“An expert possesses technical, process and interpretative knowledge in their areas of expertise.”*

We used purposive sampling and made deliberate choices for deciding our expert panels and interviewees. Our sample selection was done on the virtue of the expert's proximity to the research question and those who were able to provide the richest and relevant information.

Glaser and Strauss (1967)<sup>101</sup> suggested that the number of interviews conducted impacts the quality of research. According to him, at least ten interviews should be conducted to adequately analyse. We made a list of approximately 100 stakeholders from different stakeholders groups like Government, Academia, Industry Experts, Consultants and Business Leaders. Then we contacted them by personally visiting, emailing and making phone calls. We conducted one panel discussion and two roundtables. Those speakers who could not join the roundtables were interviewed personally. Overall, we interviewed 40 experts. The table below provides the number of stakeholders and the method of their interviews or discussions.

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100 Bogner, A., Littig, B., Menz, W. (Eds.), Interviewing Experts, 2009, Palgrave Macmillan UK

101 Glaser, B., & Strauss, A. (1967). The Discovery of Grounded Theory: Strategies for Qualitative Research. Mill Valley, CA: Sociology Press.

**Table 6: Number of Stakeholders and Methods of Interviews**

| Stakeholder Type     | Panel Discussion/<br>Roundtables | Individual/ One –to-one interview |
|----------------------|----------------------------------|-----------------------------------|
| Government           | 3                                | 3                                 |
| Academia             | 2                                | 2                                 |
| Consultants          | 4                                | 6                                 |
| Industry Leaders     | 3                                | 17                                |
| Total: 40 interviews |                                  |                                   |

## Research Methodology

We designed research questions on the basis of literature reviewed to investigate the digital transformation phenomenon in India and the existing ecosystem. Our research questions were directed to analyse the three pillars of the TOE research framework. We conducted our discussions and interviews in an open minded way to understand how different stakeholders describe Digital Transformation/ Industry 4.0 approaches and how they understand the terms and implementation in their real life context (Saldaña, 2014) <sup>102</sup>.

Therefore, with an aim to understand the stakeholders' perceptions, activities, views/ opinions and their approaches, we adopted an interpretative research method. In interpretive research, the aim is to view social reality as being embedded within, and the reality is interpreted through a "sense-making" process rather than a hypothesis testing process (Saldaña, 2014). <sup>103</sup> A list of sample questions is provided in Appendix A.

## Expert Interview/ Panel Research findings:

Our discussions with industry experts and senior executives in the manufacturing sector in India yielded the following key insights -

**India is far behind in the adoption of Industry 4.0 in manufacturing, particularly amongst MSMEs.** While large firms such as Tata Motors, Hero Motor Corp, and Mahindra have embraced Industry 4.0 in India, at best these

<sup>102</sup> Matthew B. Miles, A. Michael Huberman, and Johnny Saldaña. Thousand Oaks, CA: SAGE, 2014. 381 pp. Johnny Saldaña. Thousand Oaks, CA: SAGE, 2013. 303 pp.

<sup>103</sup> Matthew B. Miles, A. Michael Huberman, and Johnny Saldaña. Thousand Oaks, CA: SAGE, 2014. 381 pp. Johnny Saldaña. Thousand Oaks, CA: SAGE, 2013. 303 pp.

### **Impact of Digital Transformation Strategies on Performance of Manufacturing...**

can only be considered as one of cases of digital transformation. Several large industries and manufacturing organizations in the country are still trying to comprehend the meaning and adoption of Industry 4.0.

Furthermore, the level of modernization and technology adoption is highly graded in India. For instance, while Siemens has adopted modern and smart factory initiatives, has set up demo factories and is taking its solutions to multiple industries, automotive plants located at the outskirts of Delhi NCR have no form of automation on their shop floor.

In the MSME sector, most Indian MSMEs are still operating in industry 2.0.

*“More than 80% MSMEs in India are still in industry 2.0 – there is hardly any automation, and automation is not even Industry 4.0.” – Mr. Anupam Kaul (CII), Principal & Head (Quality, Metrology & Standards)*

This is a huge bottleneck for India as a country in terms of achieving an industrial revolution as typically large industry cannot work in isolation of small industry.

*“You can’t unplug – large companies cannot be in industry 4.0 while others are still in industry 2.0. In fact, MSMEs have to drive the industrial revolution in India” – Mr. Anil Jauhri – CEO, NABCB*

Therefore, there is an urgent need to handhold the MSME sector in India and motivate them through a push from Original Equipment Manufacturers (OEMs), regulatory pressure, demonstrating benefits to sales and profit, and so on.

**Awareness and accurate understanding about Industry 4.0 is a critical issue amongst manufacturing firms in India:** Manufacturing companies in India are operating with a serious lack of understanding about Industry 4.0 technologies – their existence, application and benefits. While the problem is more widespread amongst MSMEs, it is rampant in large manufacturing organizations in India as well.

*“Even in multi-billion-dollar companies in India, the expected awareness of the senior management team in terms of Industry 4.0 policies is missing. They do not have the minimum knowledge in terms of Industry 4.0 technologies such as Internet of Things, Augmented Reality or Artificial Intelligence. Management also tends to take a cautious approach with little investment to see benefits of Industry 4.0 technologies before deployment to factories.” – Mr. Giri G, Academic and Consultant.*

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## Methodology and Research Findings

MSMEs consider basic digitalisation such as facial recognition for employee attendance to be great advancements in technology adoption - almost analogous with adopting Industry 4.0 technology. This reflects their complete lack of understanding of Industry 4.0 and the anomaly comes out very clearly in our primary survey results (discussed more in the sections below). In MSMEs, areas such as office accounting and human resource management may be found to be digitalised to an extent, however there is negligible digitalisation on the production line.

**Industry 4.0 is being adopted on a piece meal basis:** Another key characteristic of adoption of Industry 4.0 in the manufacturing sector in India is that companies implement technology on a piece meal basis, for instance from department to department.

*“From last 2-3 years of interactions with Indian companies, only two companies opted for a 5-year strategic plan for digital transformation and Industry 4.0. The rest of the companies are adopting Industry 4.0 technologies on a piece meal basis.”* – Mr. Giri. G, Academic and Consultant

**The government has started building an eco-system for Industry 4.0 in India:** A number of government agencies are working on the Industry 4.0 eco-system in India since the last two years and are proactively organizing webinars and trainings. For instance, NITI Aayog is working with McKinsey to set up India's first Digital Capability Centre (DCC) which will offer technologies and a test bed to manufacturing firms in the country. The Department of Heavy Industries launched the Samarth Udyog Bharat 4.0 initiative as part of its scheme on Enhancement of Competitiveness in Indian Capital Goods Sector. It aims to set up experiential and demonstration centers for Industry 4.0 to increase awareness amongst manufacturing firms. Ongoing Common Engineering Facility Center (CEFC) projects include Center for Industry 4.0 (C4i4) Lab Pune, IITD-AIA Foundation for Smart Manufacturing, I4.0 India at IISc Factory R & D Platform, Smart Manufacturing Demo & Development Cell at CMTI, and Industry 4.0 projects at DHI CoE in Advanced Manufacturing Technology, IIT Kharagpur.<sup>104</sup> However, the various government initiatives are yet to show progress at the ground level.

Industry bodies have also set up initiatives to build an Industry 4.0 eco-system

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<sup>104</sup> SAMARTH Udyog Bharat 4.0. Retrieved from <https://www.samarthudyog-i40.in/> (Last accessed 2021, January 09)

in the country. For instance, the Confederation of Indian Industry (CII) has set up a Smart Manufacturing Platform which will offer various services related to Industry 4.0 including trainings, case studies, state level intervention centre & demonstration facilities, policy research, standardization, and so on.<sup>105</sup> As part of the Smart Manufacturing Platform initiative, CII will work with key stakeholders in the eco-system including government agencies, technology providers, user industries, consulting and audit agencies, education & research institutions, and international organizations.<sup>106</sup>

**Government support for MSMEs is inadequate:** There is an urgent need for the government to reach out to the MSME sector to understand their requirements for adoption of Industry 4.0. While schemes have been rolled out for the MSME sector, their implementation and performance are questionable, a key indicator being large amounts of unspent money sanctioned for these schemes, implying that the MSME sector is not interested in the offerings being proposed under existing government schemes. MSMEs are struggling to stay in the market and most concerned about bottom line issues.

Financial support schemes for MSMEs will be key in their transition from Industry 2.0 to Industry 4.0.

**India must build Industry 4.0 across the value chain to be able to grow its manufacturing sector and capture the opportunity presented by the current geo-political developments around China:** India is well-placed to adopt Industry 4.0 given favourable government intent, a large and growing information technology sector and a young human resource with potential to be trained in Industry 4.0.

Further, on the geo-political front, as the international market is trying to move out of China, India presents a promising destination for relocation of global manufacturing facilities. However, to capture this opportunity, it is imperative for the country to build in and offer an Industry 4.0 enabled manufacturing value chain. Fundamentally, Industry 4.0 requires India to be able to integrate the new technologies to achieve a level of digital readiness of manufacturing firms and also across other sectors.

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105 CII Smart Manufacturing Platform. *About CII Smart Manufacturing Platform*. Retrieved from <https://smartmanufacturingindia.com/> (Last accessed 2021, January 09)

106 CII Smart Manufacturing Platform. *About CII Smart Manufacturing Platform*. Retrieved from <https://smartmanufacturingindia.com/> (Last accessed 2021, January 09)

## Methodology and Research Findings

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So far, the share of manufacturing in GDP is constantly shrinking and manufacturing firms in India have not been able to make much head way despite campaigns such as Make in India and Atma Nirbhar Bharat. Although the Government has announced and is trying to implement Industry 4.0 schemes, the said schemes are not translating into tangible progress on the ground and therefore adoption of Industry 4.0 is extremely poor. In comparison to China, United States and the developed world, India is nowhere close in terms of adoption of Industry 4.0 technologies.

*“India’s strategy going forward needs to focus on spreading Industry 4.0 from a few islands of excellence to all across the country.”* – Mr. Sanjeeva Shivesh, Founder and CEO of The Entrepreneurship School

In order to increase adoption of Industry 4.0 in India’s manufacturing sector, it will be key to work on the following three dimensions:

- Build talent: Universities in India should collaborate with innovators and leaders and offer Industry 4.0 programs.
- Focus on proximity to customers: This drives innovation and presents a business case for it. For instance, MSMEs primarily engage in industrial selling and B2B sales and are a feeder to larger businesses, who in turn have the responsibility to act as a mother board to create an eco-system that lifts MSMEs in the surrounding network and help them climb the Industry 4.0 ladder. An example is automotive industries in Pune who have modernized primarily because OEMs drove that innovation.
- Make government support well targeted and effective: The government must focus on Industry 4.0 to make manufacturing more competitive in India which will increase the sectors contribution to GDP as well as exports.

**The manufacturing sector in India needs to have an export focus to develop Industry 4.0:** The Indian market has grown tremendously over the last 15 years with the manufacturing sector largely content by selling to the domestic market. For selling to Indian consumers, the priority of manufacturing firms is to make their products cheap. In order to achieve this, their focus is primarily on ramping up capacity, with relatively less attention to quality. While the focus is on meeting demands, the companies may not want to deviate their resources towards innovation and implementation of digital technologies. They do not like to have disruption in their normal business. This has been an important factor leading to manufacturing firms in India being left behind in the Industry 4.0 revolution as there is limited motivation.

### **Impact of Digital Transformation Strategies on Performance of Manufacturing...**

Large manufacturing firms in India which have focused on export have improved their manufacturing process through implementation of Industry 4.0 technologies. An example of the same is Bajaj Auto, especially their 2-wheeler segment, which earns over 40% of its revenue from exports. The manufacturing set up of Bajaj Auto integrates Industry 4.0 technologies significantly more than other automotive companies.

*“The question for manufacturing firms adopting Industry 4.0 is to a great extent dependent on priority and choice of market where the manufacturer wants to sell. If the manufacturing firm intends to sell in the international market with higher quality standards based on Industry 4.0 and competitors such as China and South Korea, adoption of Industry 4.0 technologies is key. This criterion comes from the vision of the company as to whether it wants to be an Indian company or expand to be a global company, in which investment in Industry 4.0 technologies is imperative.”* – Mr. Sandeep Ruhela, Head Group Strategy, Escorts Ltd.

Further, it is noteworthy that manufacturing firms in the United States, Germany, Japan and so on have an average standard profitability in the range of 8%-10%.<sup>107</sup> In India, manufacturing firms are chasing profitability in the range of 15%-18%,<sup>108</sup> implying that they are not reinvesting the money to improve innovation or product standards. This is a key reason for the Indian manufacturing sector lagging behind its counter parts across the world. Therefore, the vision of the company is of great importance.

**A dedicated digital transformation project is key for embracing Industry 4.0 at the firm level:** Traditionally, manufacturing firms in India underwent transformation only to increase revenue and decrease costs. However, given increased competition, traditional manufacturing businesses in India cannot afford to run in this way anymore. Current focus on implementing an effective digital transformation strategy instead of focusing on financial performance will be the key to their sustenance in the long run.

Further, it is important for manufacturing firms in India to set up dedicated

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107 (January 2021) *Margins by sector US*. Retrieved from [http://pages.stern.nyu.edu/~adamodar/New\\_Home\\_Page/datafile/margin.html](http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/margin.html) (Last accessed 2021, January 09)

108 IBEF. *Indian Manufacturing: Profit Potential and Opportunities Across The Value Chain*. Retrieved from <https://www.ibef.org/download/Indian-manufacturing-profit-potential-and-opportunities-across-the-value-chain.pdf> (Last accessed 2021, January 09)

## Methodology and Research Findings

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Digital Transformation Projects with clear Key Performance Indicators (KPIs) across departments and levels. This will help manufacturing organizations prioritize digital transformation amidst their highly complicated manufacturing operations coupled with tight schedules. Business owners need to take specific decisions for implementation of digital transformation and incorporate the same in their business vision.

*“Key steps for planning digital transformation include (a) assess the current ecosystem – current company performance, market share, competitors and how to adapt to new technology, (b) undertake a SWOT Analysis, (c) define goals, KPIs and a clear Digital Transformation Road Map, (d) identify roles and responsibilities within and outside the organization, (e) prioritize what has to go first, (f) monetize the digital transformation plan, (g) follow a milestone and have monthly targets, and (h) have a strategy for financial and non-financial factors, assigning adequate weightage to the non-financial factors as well.” – Mr. Sooraj Jayaraman, Co-Founder and Country Head, Perfomatix*

Further, given that manufacturing firms in India are cash sensitive, supporting grants or funding from governmental or private organizations is a necessary booster.

### **Companies should consider both quantitative and qualitative advantages of digital transformation in their business case:**

- Quantitative benefits – Gains in productivity, being able to deliver the right products at the right time and at the right cost.
- Qualitative benefits – Being able to reduce the complexity in the manufacturing system which automatically improves quality or lowers down time.

**Skill gap is a key bottleneck:** Currently, there is a huge skill set gap for embracing digital transformation and Industry 4.0 in terms of leaders and availability of human resources who are capable of implementing the same. These difficulties are key bottlenecks in formulating and implementing the right digital transformation strategies. The skill gap bottleneck needs to be addressed at the country level as well as at the firm level.

### **Discussions and Conclusions**

The insights presented in this section based on expert interviews and panel discussions highlight that India's manufacturing sector is lagging behind in undertaking digital transformation and adopting Industry 4.0 technologies.

## **Impact of Digital Transformation Strategies on Performance of Manufacturing...**

There is a significant lack of awareness and understanding about Industry 4.0 and basic digitalisation initiatives, for instance, in human resource and accounting, are considered to be great advancements. It is also noteworthy that while the awareness issue is more acute amongst smaller organization, it is apparently evident in large organizations as well. Successful digitalisation cases amongst large organizations are more like exceptions rather than the norm.

Further, while the government is undertaking a number of initiatives to create a conducive eco-system for adoption of Industry 4.0 in the country, the initiatives are too new and yet to show results on the ground level. Going forward, the MSME sector will specifically need significant handholding and financial support from the government to undertake digital transformation.

Therefore, India's manufacturing sector has a long way to go and the stakeholders must act quickly to speed up the sector's adoption of Industry 4.0 technologies in order to (a) stay relevant and competitive in the worldwide manufacturing landscape, (b) realize externalities from the ongoing geo-political developments around China, and (c) increase the share of manufacturing in India's GDP (as envisioned by the Government).

At the firm level, key barriers to digital transformation include piecemeal adoption that limits value creation for the manufacturing organisation. Therefore, it is imperative for firms to undertake digital transformation as a dedicated project with a focused strategy (including a vision, goals, KPIs, roles and responsibilities and so on), assessing both quantitative and qualitative benefits.

Furthermore, there is a significant skill gap amongst the workforce to embrace Industry 4.0 in manufacturing firms. This is an issue that needs to be addressed at a national as well as firm level by building an adequate knowledge and training ecosystem.

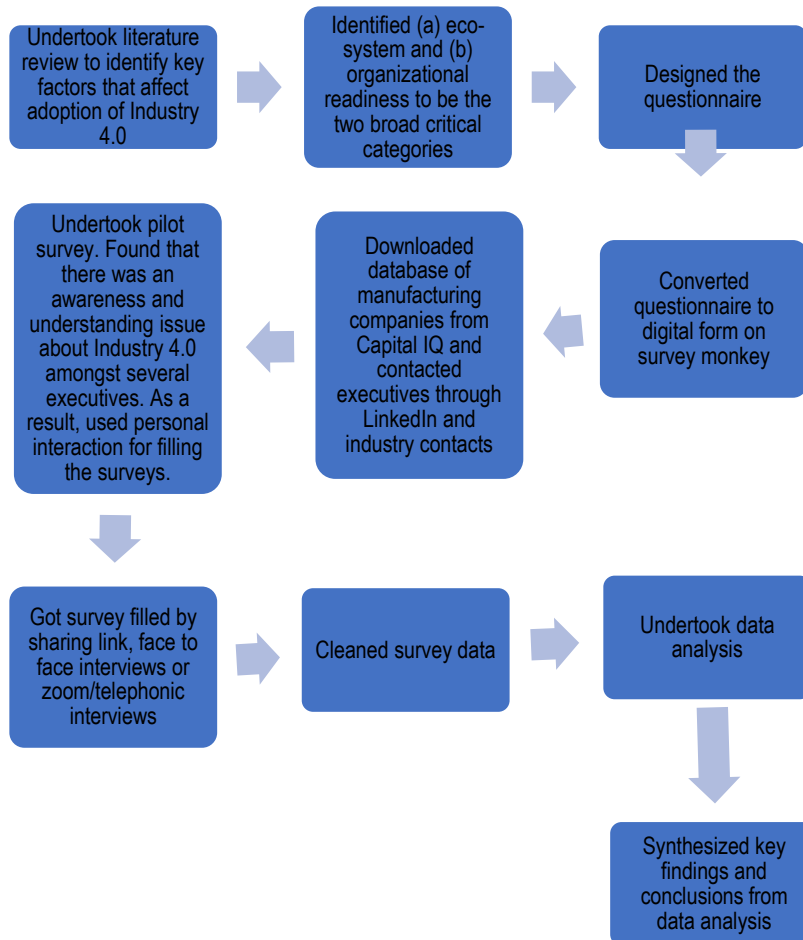
## **Section 2: Findings from primary survey**

### **Methodology:**

We undertook a survey of 90 manufacturing firms in India to assess their (a) perception on the state of the Indian eco-system to facilitate adoption of Industry 4.0 in the manufacturing sector, and (b) firm's organizational readiness for digital transformation in terms of leadership, commitment and

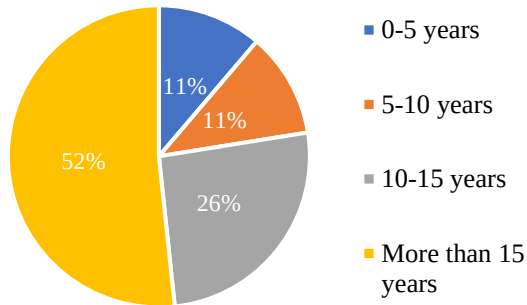
resources; organizational governance; motivations for digitisation; barriers to digitisation; quality of physical infrastructure; and communication. The survey was undertaken through telephonic interviews, face to face meetings, and zoom calls. Questions were designed to obtain the scores on a Likert's scale from 1-5.

**Figure 9: Methodology for primary survey**

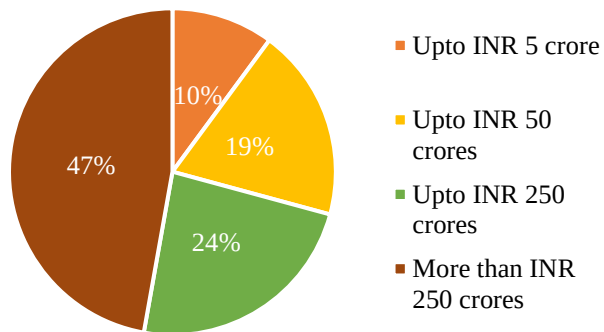


**Demographic profile of the respondents:**

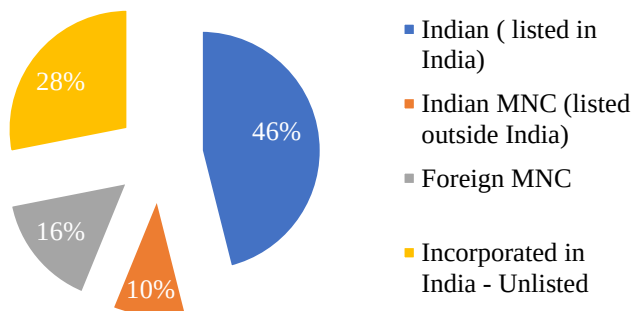
**Maturity of the organisation**



**Turnover of the organisation**



**Ownership structure**



## **Research findings**

An analysis of data collected through the primary survey yielded the following insights:

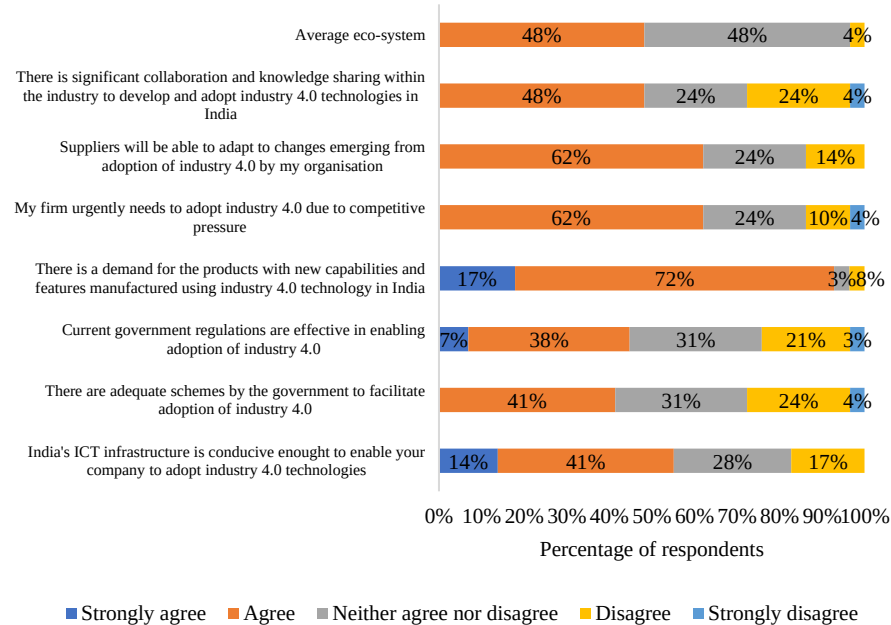
### **ECO-SYSTEM**

**Our respondents agreed that India has several eco-system characteristics required for digital transformation and adopting Industry 4.0**, as agreed by 48% of the manufacturing sector executives surveyed (Figure 10), and 'neither agreed nor disagreed' by another 48% of the executives. The eco-system includes ICT infrastructure, adequate competitive pressure, collaboration and knowledge sharing within the industry and a perceived ability of suppliers to adapt to changes resulting from adoption of Industry 4.0 technologies.

Most importantly, there is also a strong perception around relevant demand with 89% of the executives surveyed 'agreeing' or 'strongly agreeing' that there is a demand for products with new capabilities and features manufactured using Industry 4.0 technologies in India. This is likely a result of the young demographic profile of the country where the large youth population demands and is quick to embrace new technology.

**Figure 10: Perception on state of eco-system for adoption of Industry 4.0 in India**

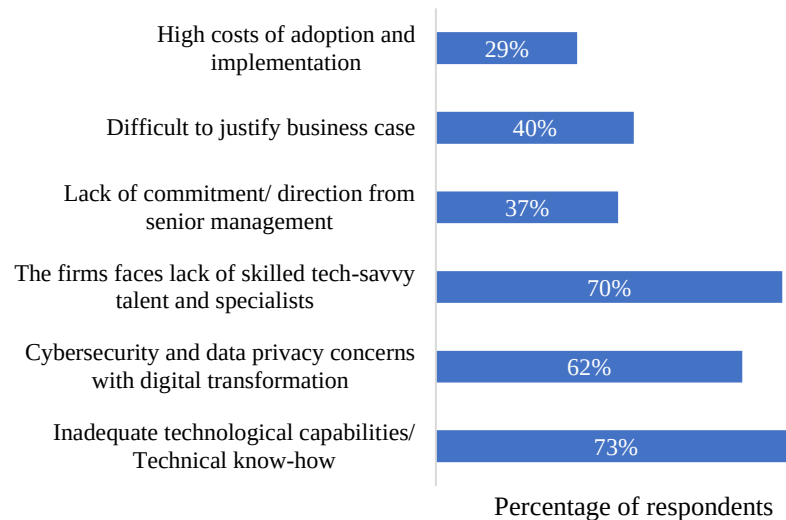
## Impact of Digital Transformation Strategies on Performance of Manufacturing...



**However, the presence of a fairly conducive eco-system is not translating into Industry 4.0 adoption on the ground.** As discussed above, India is far behind countries such as the United States, China, South Korea, Japan and Brazil. Key reasons for this include:

- **Relatively weak government support to enable adoption of Industry 4.0:** Only 41% of the manufacturing executives surveyed agreed that there are adequate schemes by the government to facilitate adoption of Industry 4.0 (Figure 10). Further, only 45% of the executives found the existing government schemes to be really effective on ground. This is likely a result of Industry 4.0 focussed government initiatives being fairly recent in India.
- **Lack of technological know-how and tech-savvy talent:** Inadequate technological capabilities and tech-savvy talent emerged as top barriers hindering adoption of Industry 4.0 in the manufacturing sector in India (Figure 11).
- **Concerns around cyber security:** 62% of the manufacturing sector executives surveyed cited lack of adequate cybersecurity infrastructure as one of the top 3 bottlenecks for digital transformation (Figure 11).

**Figure 11: Percentage of respondents identifying a barrier as one of the top 3 bottlenecks in adopting Industry 4.0 technologies and undertaking digital transformation in their firm**



## **ORGANIZATIONAL READINESS**

At the organization level, the most critical learning from the primary survey is that there is a **significant lack of awareness and understanding about Industry 4.0 amongst manufacturing firms in India**. While the problem is much more acute in case of MSMEs, as also highlighted in the stakeholder discussion section above, it is prevalent amongst large and listed firms as well.

While conducting the primary survey, our research team came across several executives in both small and large firms who had very limited understanding about Industry 4.0 technologies and their application in manufacturing. As a result, we eventually had to alter our survey methodology from only sharing the link to our survey form to conducting personal interactions for filling the survey for several executives.

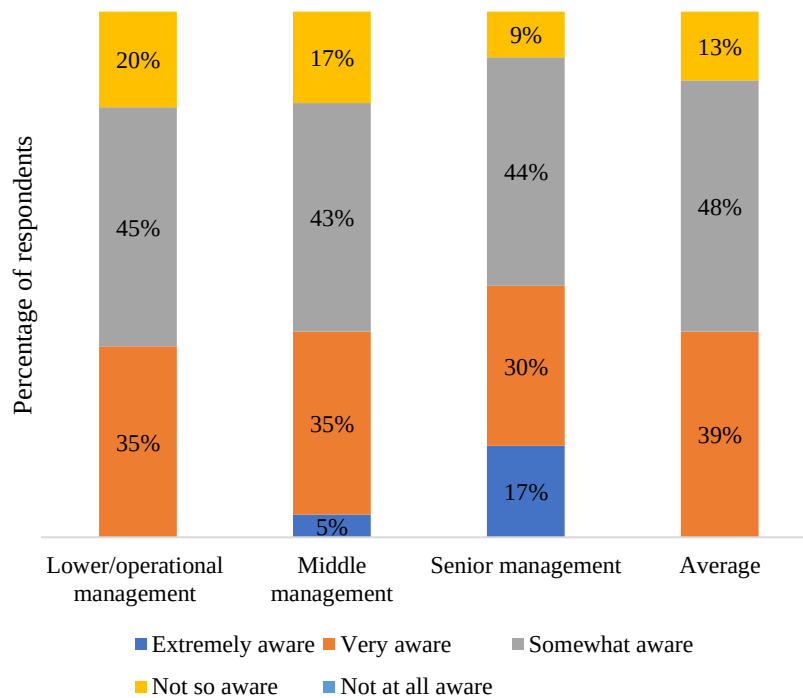
According to the primary survey undertaken, only around 35%, 39% and 47% employees have a good level of awareness and understanding about digital transformation and Industry 4.0 at the lower, middle and senior management level respectively. As is expected, the proportion of employees with a good understanding of Industry 4.0 is higher at the senior levels. This result leads

### Impact of Digital Transformation Strategies on Performance of Manufacturing...

to two key implications for adoption of Industry 4.0 in India's manufacturing sector:

- i. Limited awareness and understanding about Industry 4.0 at the senior level, (a) directly impacts a firm's ability to value its benefits and invest in digital transformation, and (b) will lead to the firm unknowingly setting much lower goals and aspirations in terms of digital transformation.
- ii. Even in firms which attempt digital transformation, the lack of multi-level readiness is likely to impede its success at the strategy as well as implementation phase. As discussed above, formation of a digital transformation strategy should be a down-up process (Andre Lipsmeier et al. / Procedia CIRP 88 (2020)).

**Figure 12: Level of awareness and understanding about digital transformation and Industry 4.0**



Further, interactions with company executives during the primary survey revealed that many executives consider basic digitalisation of human resource and accounting systems as significant advancements towards digital

transformation and Industry 4.0. As a result, we expect the relatively favourable results from the primary survey towards organizational readiness to be overestimates.

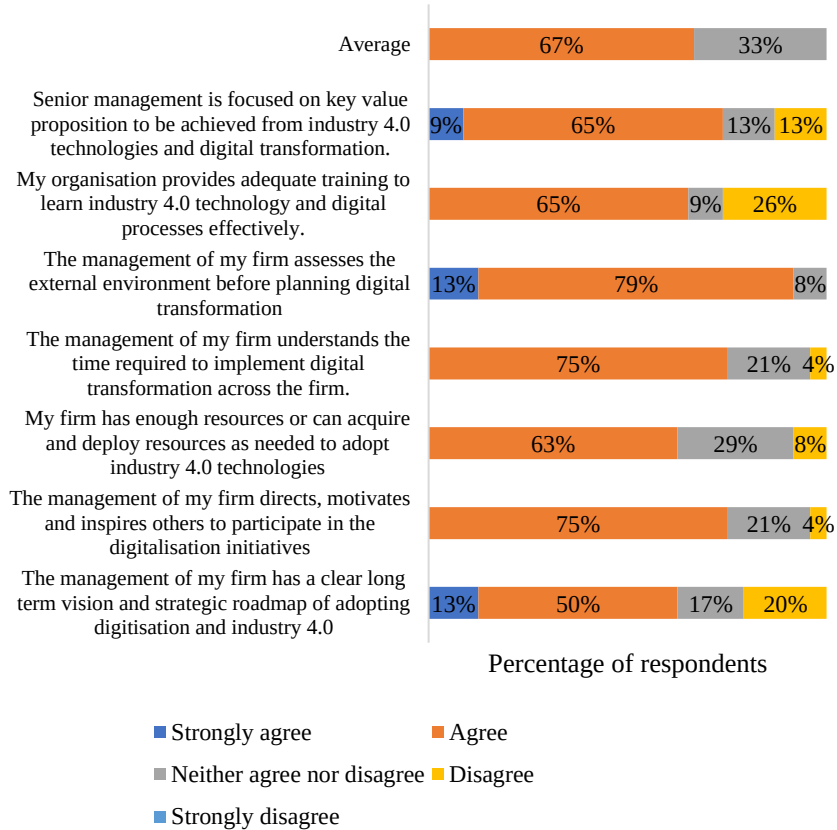
### **Leadership commitment and resources**

67% of the manufacturing sector executives surveyed agreed that their firms have the leadership commitment and resources required to undertake digital transformation and adopt Industry 4.0 technologies (Figure 13). The response was favourable towards embracing Industry 4.0 across a number of factors such as having a clear long term vision and strategic roadmap, top-down direction, motivation and inspiration, resources in terms of money and time, and evaluating the external environment (e.g. customers, competition, the economy, technology, political and social conditions).

Executives also rated their firms highly in terms of change management parameters of provision of adequate training to learn new technologies and the management's focus on deriving a key value proposition from digital transformation.

**Figure 13: Perception on level of leadership commitment and resources for adoption of Industry 4.0 in their firms**

## Impact of Digital Transformation Strategies on Performance of Manufacturing...



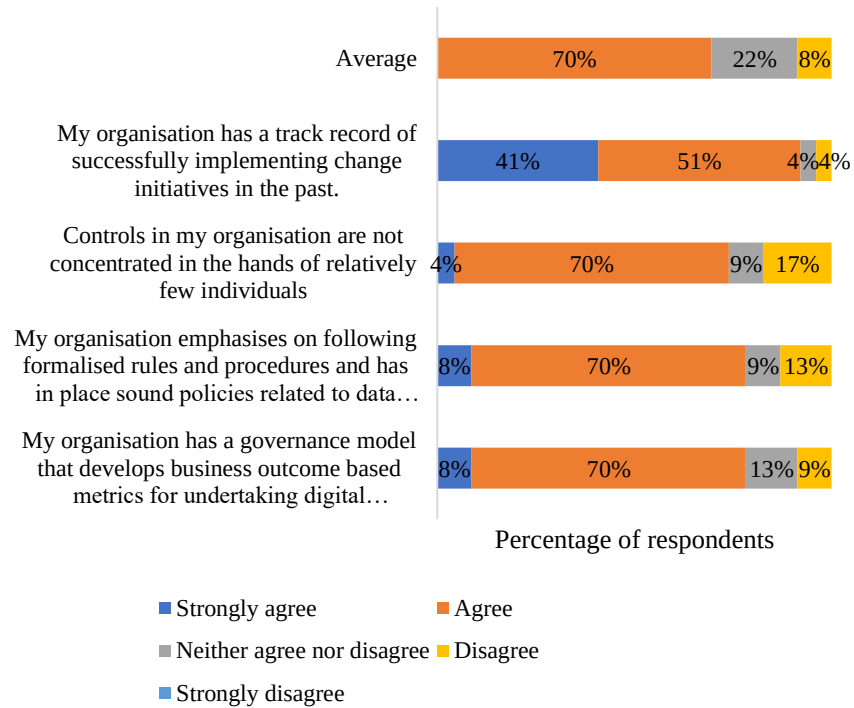
## Governance

70% of the manufacturing sector executives surveyed agreed that their firms have good governance to undertake digital transformation. Specifically, their firms

- Develop business outcome based metrics to track digital transformation,
- There are formalised rules and procedures in place to undertake digital transformation, and,
- Organisational control is not concentrated in the hands of a few people.

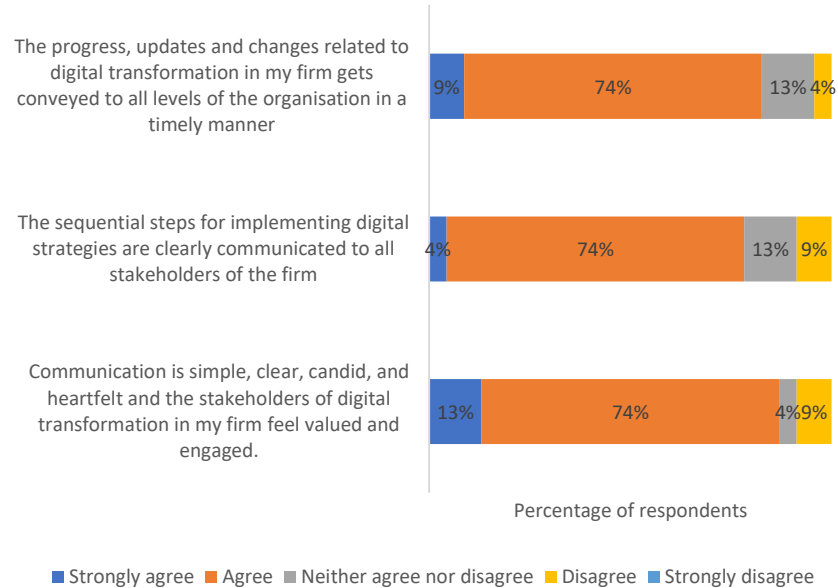
Further, 92% of the executives agreed that their firm has successfully implemented change initiatives in the past.

**Figure 14: Perception on organizational governance for adoption of Industry 4.0 in their firms**



Further, along with governance, communication regarding digital transformation initiatives across different levels in the organisation – in terms of strategy and implementation - is also perceived to be fairly good by the manufacturing sector executives interviewed.

**Figure 15: Perception on communication across the organisation for adoption of Industry 4.0 in their firms**



However, it is interesting to note here that despite the favourable leadership commitment, resources, governance and level of communication perceived above, the level of digital transformation and adoption of Industry 4.0 is quite low in the Indian manufacturing sector. In the paragraphs below we present some key reasons for this.

#### Legacy infrastructure at the firm level

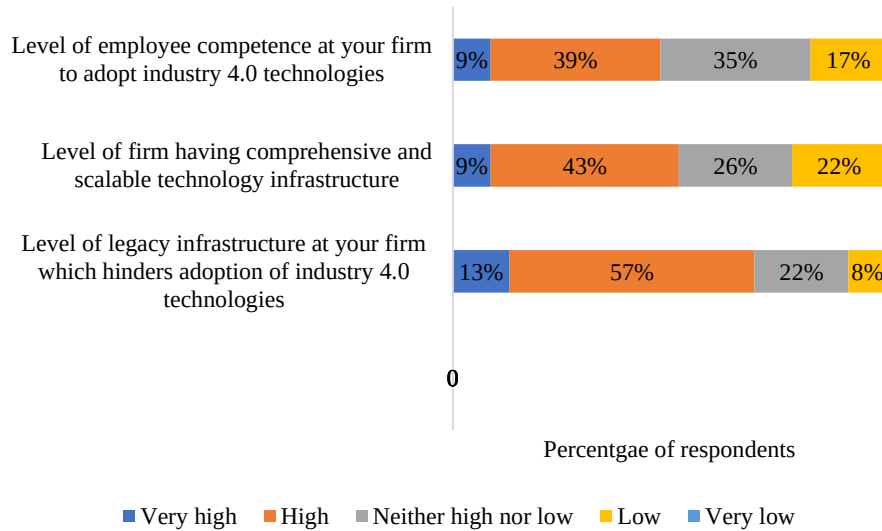
Manufacturing firms in India are grappling with legacy infrastructure which is a key bottleneck in adopting Industry 4.0. For instance, a firm may have old machinery that cannot be digitally connected and will necessarily have to be replaced if the firm wants to undertake digital transformation. This will lead to multiplication in costs and effort for the firm. 70% of the manufacturing executives surveyed agreed that there is a high level of legacy infrastructure in their manufacturing firms. Another challenge in terms of physical infrastructure in manufacturing firms in India is the lack of comprehensive and scalable technology infrastructure.

Further, as discussed above, employee skill is a significant challenge with only 48% of executives agreeing that employees in their organisation are

## Methodology and Research Findings

competent enough for digital transformation and adoption of Industry 4.0 technologies.

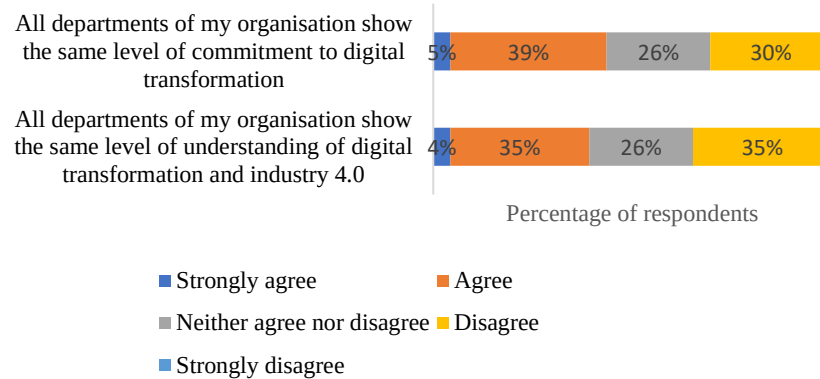
**Figure 16: Perception on quality of infrastructure for adoption of Industry 4.0 in their firms**



## Piecemeal digital transformation

Digital transformation is being implemented in silos in manufacturing firms in India. Only about 40% of the manufacturing sector executives surveyed agreed that the level of understanding and commitment towards digital transformation and Industry 4.0 is same across all departments in their an organisation. As discussed previously, this is a critical barrier in realizing cross-functional synergies (Andre Lipsmeier et al. / Procedia CIRP 88 (2020)), and is a key reason for value destruction while investing in digital transformation initiatives.

Figure 17: Piecemeal digital transformation



## Discussions and Conclusions

The perception survey of senior executives in India's manufacturing sector reveals that the prevalent eco-system is conducive to adoption of Industry 4.0 by manufacturing organisations in terms of ICT infrastructure, demand, competitive pressure and industry collaboration. However, certain key bottlenecks have limited digital transformation in the sector – (a) Government initiatives are fairly new and are still to show results on ground, (b) There is a significant gap in terms of technical knowhow and skill, and (c) Cyber security is a major concern at the national as well as firm level.

In terms of organizational readiness, senior executives in small as well as large firms in India's manufacturing sector lack awareness, understanding, and technical depth about Industry 4.0 technologies and their application in manufacturing. This likely results in lesser value assigned to Industry 4.0 by the senior management and/or setting of lower goals at the top. There is also lack of multi-level readiness which impedes strategy formulation and implementation for digital transformation.

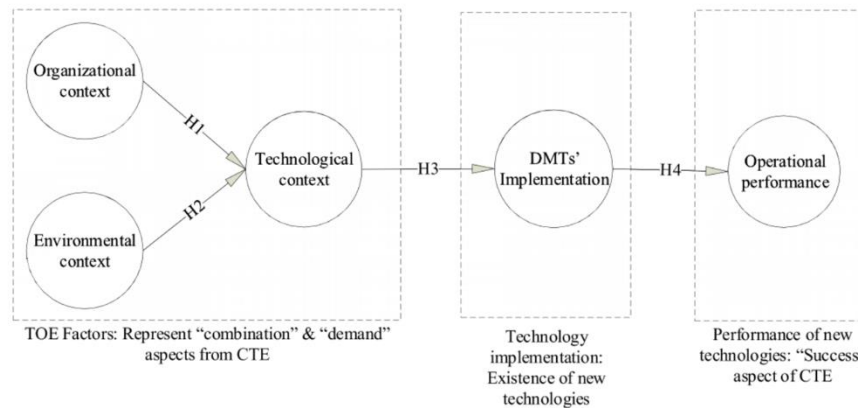
Further, executives have a highly favourable perception of leadership, commitment and resources, governance and communication in their manufacturing firms in the context of organizational readiness for digital transformation. This is likely to be an overestimation based on executives' perception of basic digitalisation initiatives implemented in the organization, misunderstood to be significant technological advancements. Nevertheless, the perceived organizational readiness has not translated into greater digital

transformation of manufacturing firms on ground due to issues around (a) prevalence of legacy infrastructure on the manufacturing floor, and (b) implementation of digital transformation in departmental silos, eroding cross-functional synergies and limiting value creation.

### TOE Framework Analysis

Using our perception survey scores we performed TOE framework analysis. A correlation analysis of **Organisational readiness score** measured by adding the **leadership commitment scores**, **governance scores** and **change management scores** (O) was conducted with **Technology readiness scores** (T) measured as quality of infrastructure for adoption of Industry 4.0 in their firms. We also performed a correlation between **Environmental context** (E) measured by adding up ecosystem variable scores and technological context scores.

Figure 18: TOE Framework Analysis



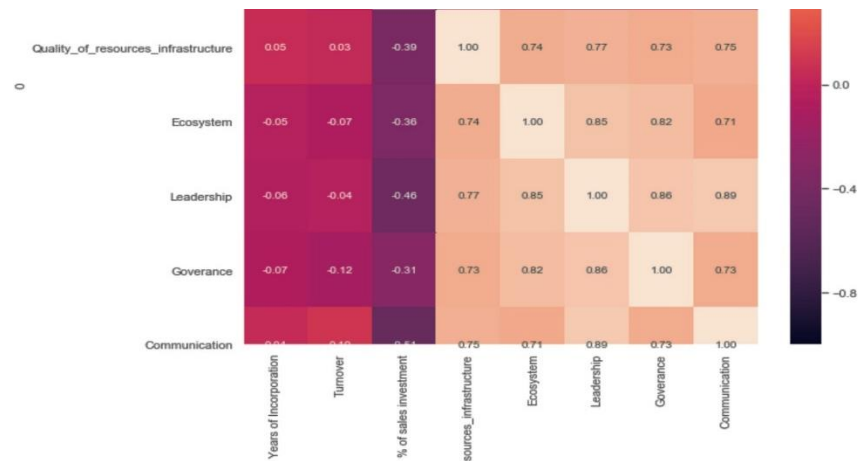
### Correlations Analysis of TOE Factors

As expected we found a strong positive correlation between Organisational context- leadership and change management 0.89 and Governance 0.73 with Technology context. In our second pair – Environmental context with technological context we found a significant positive relationship with a value of 0.71. This implies that favourable external ecosystem with strong leadership commitment, governance and overall positive change management climate can lead an organisation to be ready for adoption of digital manufacturing technologies (DMT) as shown in the charts below ( Figure 19). We note that organisational readiness and ecosystem does exist in the context of Indian

## Impact of Digital Transformation Strategies on Performance of Manufacturing...

manufacturing firms, however, there are other major impediments (as discussed in the above sections) which have impaired the successful implementation of digital transformation of manufacturing firms in India.

**Figure 19: Correlations Analysis of TOE Factors**



## Section 3: Findings from Secondary Data Analysis

### Data Collection

We took a sample of 25 manufacturing firms from each capital size - large, medium, small and micro scale from the Capital IQ Database using stratified sampling methodology. The manufacturing firms were identified using the list of industry codes.

We accessed key financial data related to the financial year 2019-2020 to do our cross-sectional productivity, profitability and valuation analysis. Our analysis focused on finding the financial impact of digitalisation on performance of firms.

We report sample statistics for the key variables used in our study in the charts below which describe several key characteristics of the sample of manufacturing firms classified into large, mid, small and micro-cap firms and by their primary activities.

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**Figure 20: Average Market Capitalisation, Revenue and Enterprise Value of Sample Firms - Size Wise**

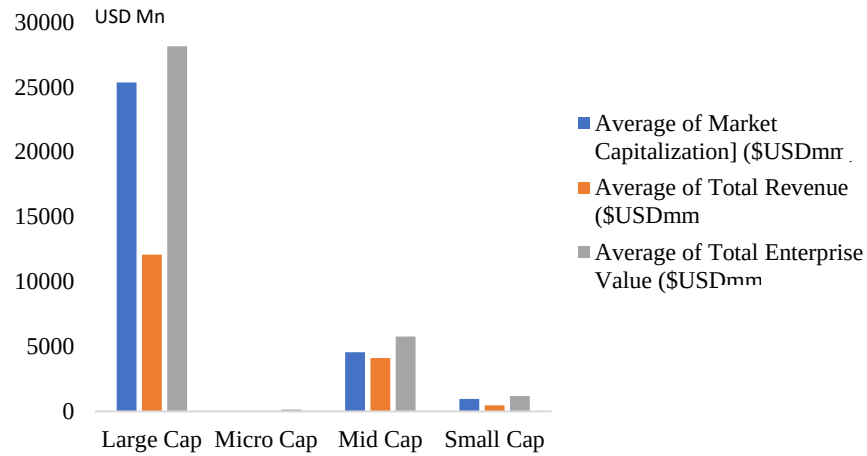


**Figure 21: Average of Profitability Margins and Operating Expenses of Sample Firms- Size Wise**

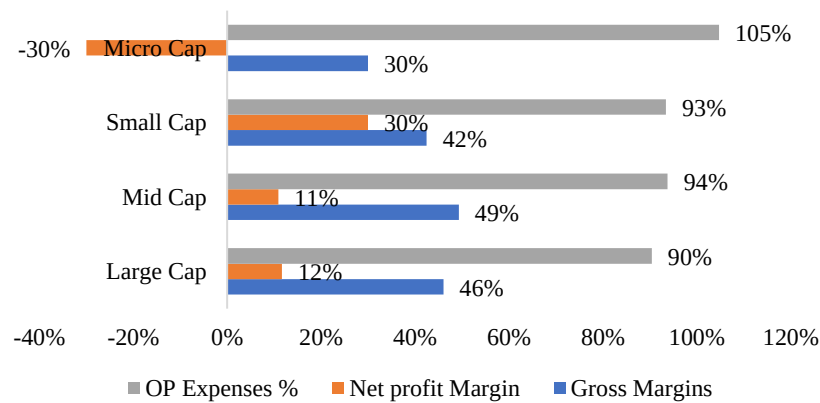
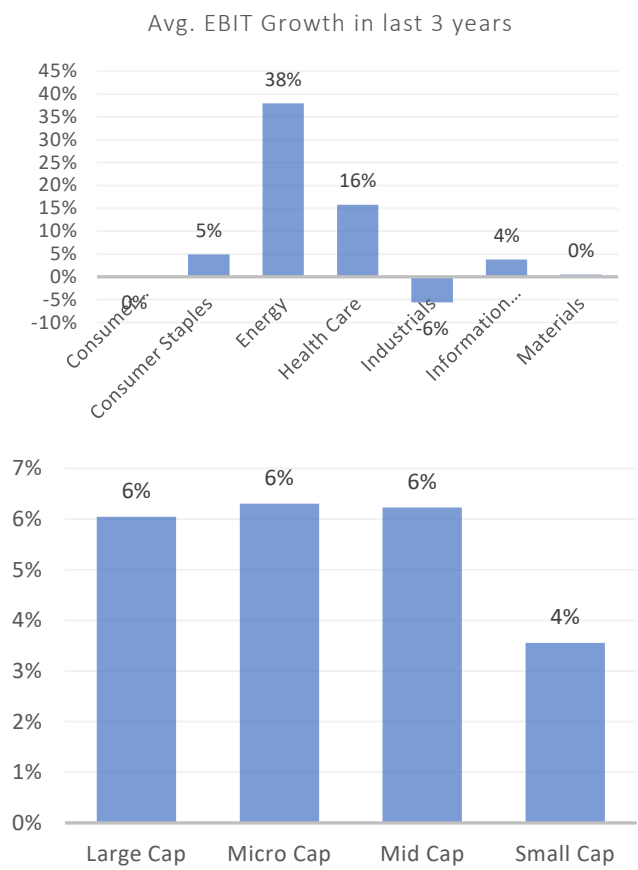
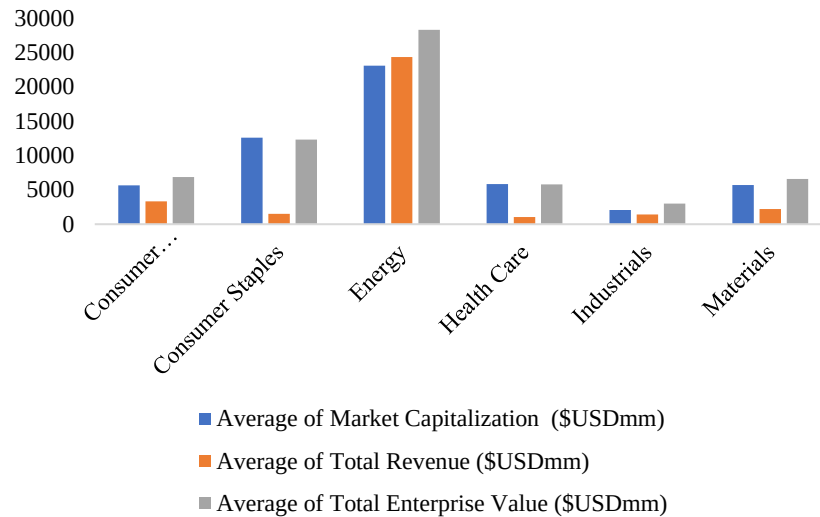


Figure 22: Average EBIT growth % in last 3 years Size wise and sector wise



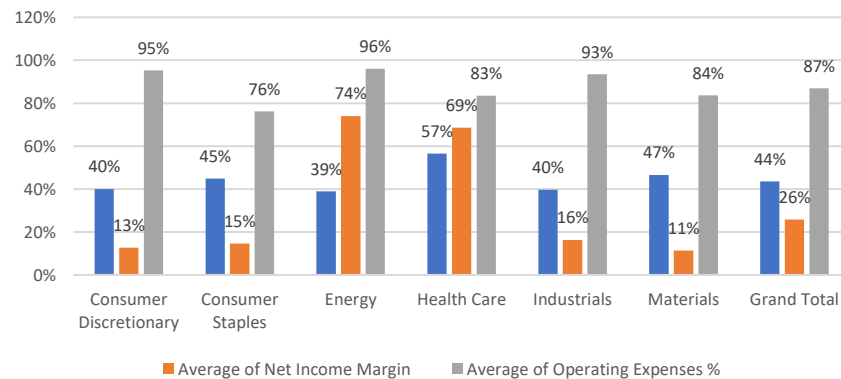
## Methodology and Research Findings

**Figure 23: Average Market Capitalisation, Revenue and Enterprise Value of Sample Firms-Sector Wise**



Total revenue of the sample companies has increased by 3% from 2017-2019 and EBIT has increased by 6%.

**Figure 24: Average of Profitability Margins and Operating Expenses of Sample Firms- Sector Wise**



Our study revolves around two variables- **Digital Investments and Digital Activities** for measuring the extent of digitalisation. Average digital investment in computer software and intangibles assets has been approximately USD 8 million in 2016 to 2018 in our sample companies.

For digital activities, we used a proxy for digital activities by counting the digital terms in the firm’s disclosures, analyst presentations and conference calls. We reviewed prior literature, numerous articles and glossaries to build a list of digital terms related to digital transformation and Industry 4.0. For doing the word analytics we used R and Python programming and confirmed our results with the Lexos online software.<sup>109</sup> An example of textual analysis is provided in the Figure 25 below.

Figure 25: Example of Digital Words Cloud

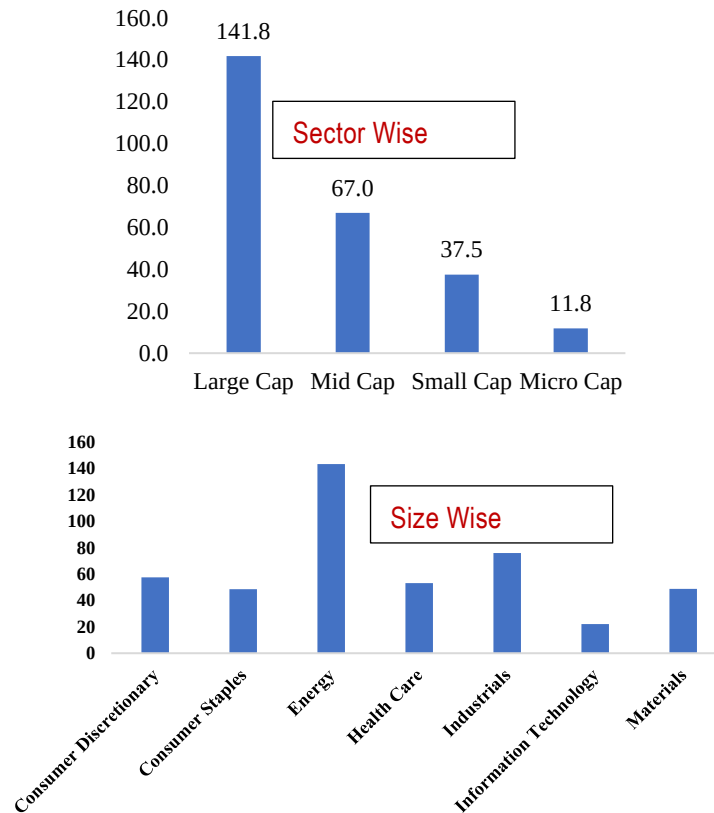


Table 7: Digital Words for Text Analytics

|                         |                    |
|-------------------------|--------------------|
| Data analytics          | Cyber              |
| Automation              | Security           |
| Artificial intelligence | Platforms          |
| Big data                | Digital            |
| Cloud Computing         | Robots             |
| Digitalisation          | Internet of Things |
| Machine learning        | Technology         |

<sup>109</sup> <http://lexos.wheatoncollege.edu/word-cloud>

Figure 26: Average Digital Words frequency of Sample Firms Size wise and Sector Wise



From the chart above, we can see that in large cap companies there is higher digital activity as compared to other groups of firms. The median word frequency of large cap companies is 83 while the mid cap firms have a median score of just 50, small cap have a median score of 33 and micro-cap have a median score of only 9. **This means that in India MSME companies do not yet talk about their digitisation or digital transformation in company strategy statements published in media reports and annual documents. This implies that digitalisation is not yet their main focus.**

We have used digital investments and digital activity to study the impact of various factors of financial performance. The objective of our research is to evaluate the impact of digital transformation on the economic and financial aspects of the manufacturing firms. We conducted correlation and regression analysis by using E-Views Software, presented in the sections below:

## Impact of Digital Transformation (investment and activity) on Performance

Before we examined the impact of digitalisation on financial performance and explored a causal relationship between them, we performed correlation analysis to understand whether a relationship exists between digitalisation and financial variables such as productivity (sales), profitability and market value. We chose these variables after extensive review of literature. Correlation analysis was followed by a regression analysis to evaluate whether any causal relationship exists between them.

### Hypothesis 1: Higher adoption of technology is related with increase in productivity (sales)

We analysed the impact of digital transformation on productivity by using sales as a measure of productivity. This concept is borrowed from the Cobb Douglas Production Function framework (Brynjolfsson 1996). We performed correlation between last financial year's revenue with proxy for digital activities (Sum of Word Frequencies). We found a positive significant correlation between sales revenue and the digital activities. We also performed correlation with digital investments measured by capitalised or purchased software and found 0.38 as positive correlation, which is not highly significant.

**Table 8: Correlation Scores between Digital Activities, Investments and Revenue**

|               | <i>Digital Activities</i> | <i>Digital Investments</i> |
|---------------|---------------------------|----------------------------|
| Total Revenue | 0.70                      | 0.38                       |

Above results show that productivity (sales) and digital activities are positively correlated. This correlation can point in either direction that digital activities and digital investments lead to increase in revenue or it can also mean that companies having higher revenues invest more in digitalisation as correlation does not establish causal relationship. The causal relationship can be analysed by performing a regression analysis. Since, there are more than one variables that lead to increase in sales we controlled those variables and used multiple regression technique. Data and analysis are presented in the next section on regression analysis.

## Methodology and Research Findings

### Hypothesis 2: Higher adoption of technology is related with improved profitability ( EBIT)

We analysed the co-movements of digital activity with the EBIT by using correlation technique. We found a significant correlation of 0.74 between EBIT and the digital activity and an insignificant positive correlation of 0.21 with digital investments. Prior studies such as Hitt et al. 2002 and Aral et al. 2006 have used this measure to analyse the impact of ERP on firms.

**Table 9: Correlation Scores between Digital Activities and Profitability Ratios**

|                           | <i>Digital Activities</i> | <i>Digital Investments</i> |
|---------------------------|---------------------------|----------------------------|
| <i>EBIT growth</i>        | -0.05                     | 0.03                       |
| <i>GP Margins</i>         | -0.07                     | 0.01                       |
| EBIT [CY 2019] (\$USD Mn) | 0.75                      | 0.21                       |
| Return on Assets          | 0.02                      | 0.02                       |
| Operating Expenses        | 0.68                      | 0.03                       |

When we performed correlation analysis of digital activities and digital investments with EBIT growth we could not find any correlation, as shown by close to zero numbers in the above table. This could be attributed to long payback period required for digitalisation before the positive results can be observed. We also performed correlations with Gross Margins and ROA but could not find any significant correlation with digital activity and the margin. We presume that there are various factors that contribute to gross margins and the factors vary from industry to industry, the economic situation, competitive pressures and demand from consumers. Prior studies have proved that if firms adopt digitalisation due to competitive pressures, it is hard to reap benefits in the short term.

### Hypothesis 2: Higher adoption of technology is related with improvements in Market Capitalisation.

Another important financial performance metric is the total market value of the firm which serves as an alternative to accounting profit measures to analyse the financial performance. Various studies have used different constructs of market value which is defined as stock market valuation of a firm divided by

### Impact of Digital Transformation Strategies on Performance of Manufacturing...

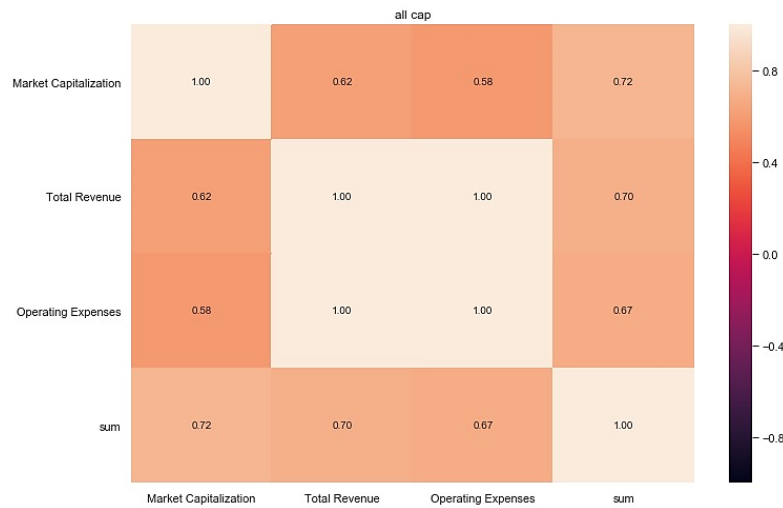
calculated book value, intangible assets and technological assets (Hall 1993; Hirschey 1982). Therefore, market value can be used as a reasonable measure to estimate the value of tangible as well as large intangible assets such as value added by human capital or organisational capital or value of improved information systems. Even though it is difficult to measure these intangible assets, market value is able to capture some insights into the impact of information technology-related intangible assets.

We performed correlation analysis of digitalisation variables with the market capitalisation and found positive correlations. Digital Activity was found to be more positively correlated than digital investments with market capitalisation.

**Table 10: Correlation Scores between Digital Activities and Market Capitalisation (log)**

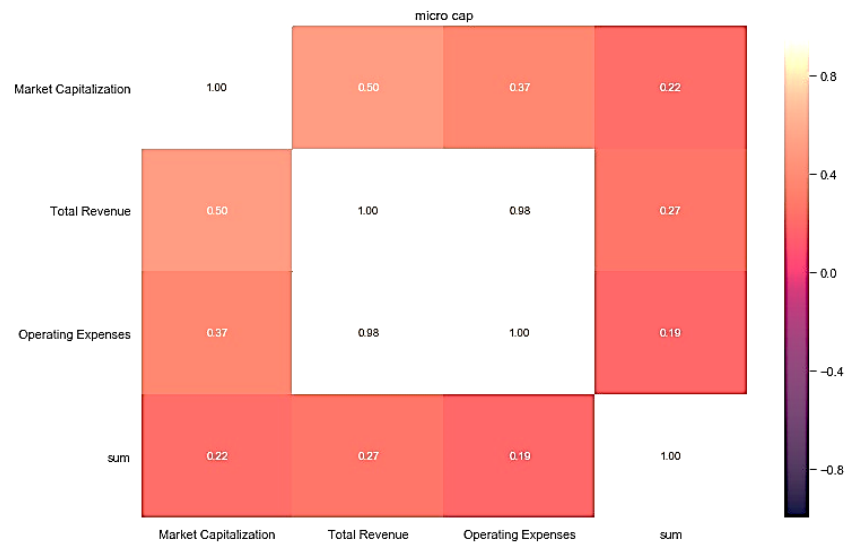
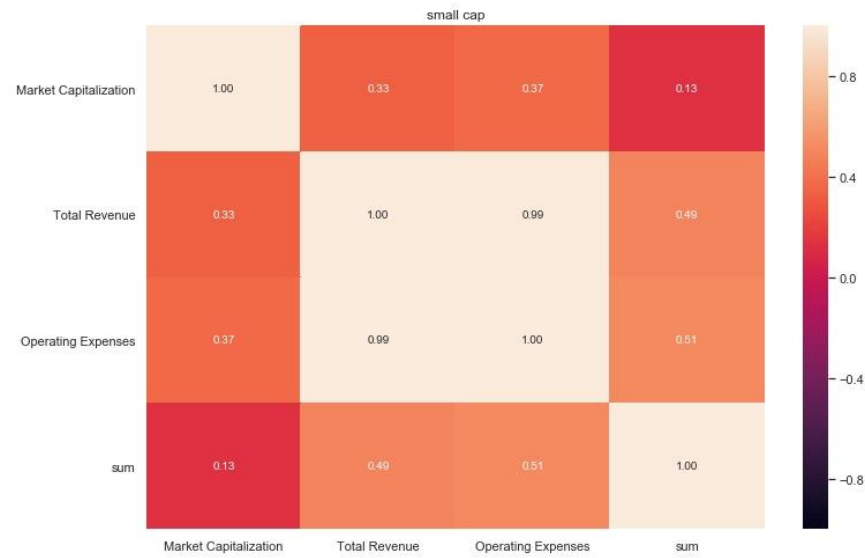
|                       | <i>Digital Activities</i> | <i>Digital Investments</i> |
|-----------------------|---------------------------|----------------------------|
| Market Capitalization | 0.72                      | 0.17                       |

**Figure 27: Correlation Scores between Digital Activities and Market Capitalisation (log)**

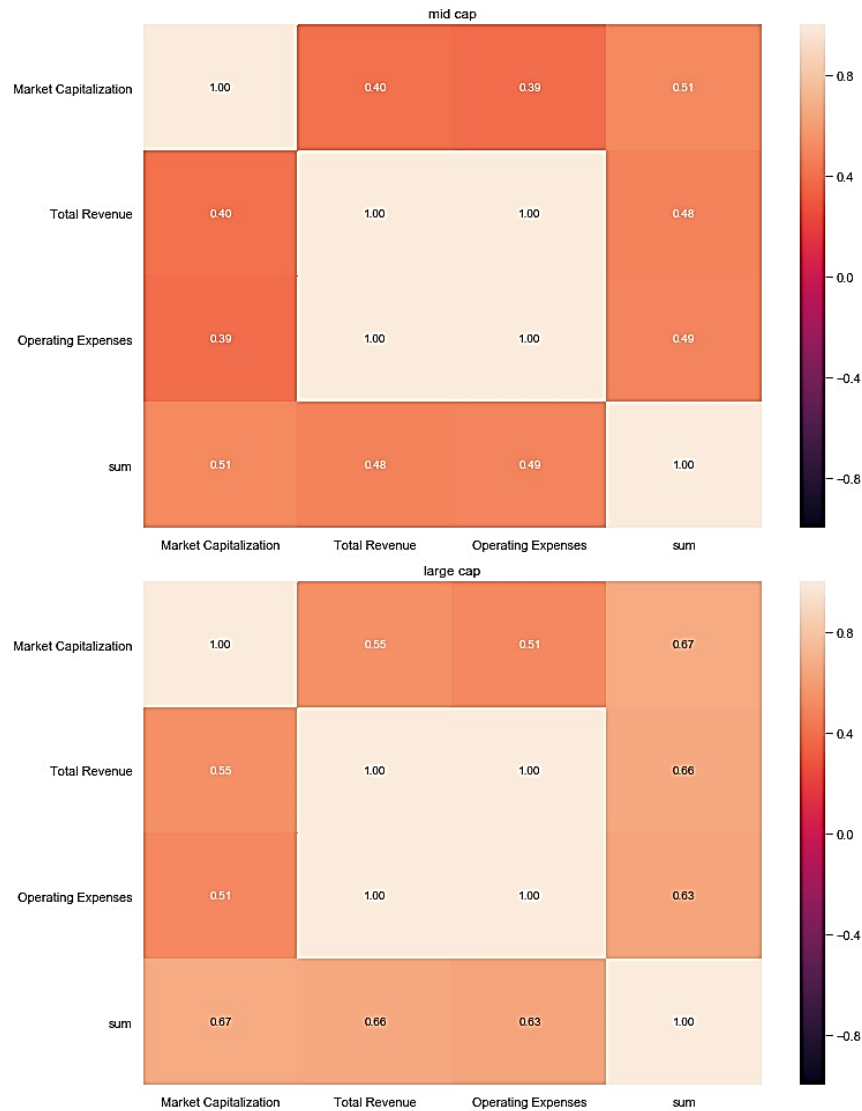


## Methodology and Research Findings

### Correlation Scores between Digital Activities and Market Capitalisation (Size Wise)



## Impact of Digital Transformation Strategies on Performance of Manufacturing...



In addition to all firms taken together, we also performed correlation analysis on different categories of manufacturing firms. We found that large-cap companies have the strongest correlation with the digital activity as compared to micro-cap having the least. This implies that large firms exhibit more digital activity than the mid, small or micro firms. This can be explained with the fact that large companies have more resources to invest in digital activities.

## Regression Analysis

### Impact of digitalisation on Productivity (Sales)

Earlier researchers such as Brynjolfsson et al. (2017)<sup>110</sup> and Cockburn et al. (2017)<sup>111</sup> have suggested that digitalisation leads to growth and productivity of firms. When we performed regression analysis of Sales (log of sales) as a dependent variable with digitalisation (Digital Activities) as an independent variable while controlling for other contributing variables such as number of labourers, material, asset growth, etc., our results were consistent with the correlation results giving us a significant value of  $R^2$  - 67%. Our model was tested with F values and it showed a good fit with a F value of 40.3. However, **our P values were higher than 0.05 at 95% confidence intervals and we found that digital activities are insignificant in contributing towards sales.** Given these results we could not accept our hypothesis that digital activities positively impact revenues of the firm.

However, on reversing the values of Y and X variables, we found that companies which have higher sales adopt higher digitalisation activities. Even though **the  $R^2$  was low at 0.43 ( low significance) but P value was 0.002 which suggested that we could not reject the hypothesis and can conclude that companies that have higher revenues adopt more digital transformation activities.** This could be true as higher sales revenues generate better cash flows leading to higher digital investments.

We performed similar regression analysis for profitability and market values also. In the first instance, when Y was a profit ratio or market value we could not find a causal effect of digital activity on the financial profitability or market value. However, in the next runs, when we used digital activity as the Y variable, we found  $R^2$  value of **0.76 and P values lower than 0.05** suggesting that companies which have higher market capitalisation and better profitability are adopt digitalisation at a higher rate.

Our empirical regression analysis implied that firms with large revenues, better resources and access to cash flows adopt more digitalisation. Our hypotheses

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110 Brynjolfsson, Erik, Daniel Rock, and Chad Syverson. Artificial intelligence and the modern productivity paradox: A clash of expectations and statistics. No. w24001. National Bureau of Economic Research, 2017.

111 O'Doherty, John P., Jeffrey Cockburn, and Wolfgang M. Pauli. "Learning, reward, and decision making." Annual review of psychology 68 (2017): 73-100.

that digital transformation impacts financial performance could not be proved given P values > 0.05, explaining that digital activities are an insignificant contributor towards financial performance. But reverse analysis was true that that better financial performance leads to better digital adoption.

## **Findings and Conclusions**

The above analysis shows that the profile of firms that adopt digital activity are larger, profitable and have better sales revenues. Moreover, we report positive, though not so statistically significant, associations between digital activity and total revenues, which is consistent with prior studies that attributed the results to the performance pressure channel. Studies have shown that when market pressures force the firms to go digital, digitalisation does not necessarily result in improved sales. This is because in case of high market competition it is very difficult for the firms to increase their market shares through digital activities as price is the main consideration. This is also consistent with our panel interview results and surveys we conducted that firms which adopt digitalisation due to competitive pressures and on piecemeal basis without being customer centric or focusing on customer value proposition or understanding the rippling effects on different areas of the value chain may find it difficult to generate more sales due to digitalisation.

Next, we hypothesised that digitalisation increases firm value. Our p values made us reject this hypotheses. On the other hand, when we reversed our regression equation, we found that firms which have higher market capitalisation are more likely to adopt digitalisation. This suggests that firms show early signs of going digital as they receive higher valuations in the market. According to value creation theories, firms command better valuations in the market if they provide value proposition to customers and provide better quality products for their customers. Therefore, considering this theoretical concept we can presume that firms will command higher valuations indirectly if they focus their digitalisation strategies on value proposition and serve their customers well by using technologies. In case of manufacturing firms, this is possible through digitalising the products, innovating and re-designing the product with tech capabilities and solutions for the customers.

Next, we examined the impact of digitalisation on profitability. We could not prove our hypothesis here also. This is consistent with prior literature that firms will realise improvements in profitability and returns only in the long term as the payback of digitalisation could be very long and there are challenges of

## **Methodology and Research Findings**

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integration between various complementary technologies both inside and outside the firm (Bresnahan and Greenstein 1996).<sup>112</sup> Prior studies have also found that margins of firms decline significantly in the short term after the firms engage in digital activities. This could be due to the fact that digital investments are costly in the short term and that benefits of digitalisation are eroded by competitive pressures if the motivation to go digital was only technology push or competition. Companies have to recruit and hire talent and spend a lot of resources on their process redesigning and development of human capital which leads to increase in operating costs, resulting in reduced profitability.

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112 Bresnahan, Timothy, et al. "Technical progress and co-invention in computing and in the uses of computers." *Brookings Papers on Economic Activity. Microeconomics* 1996 (1996): 1-83.

## Chapter 6

# Digital Transformation and Implementation Case studies

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To understand the digital transformation approaches and benefits in depth and appreciate the multi-dimensional issues in natural practical environment we also adopted case study approach. The purpose of case analysis is to understand both the context, process and benefits of digital transformation, and how they influence each other.

### **Data Collection**

For case study analysis, we collected data by conducting interviews and also through secondary data sources like annual reports and capital IQ. Financial data for the past four years from 2016-2020 was used and conducted interviews formally and informally. Interview conversations were documented in the form of notes as a data collection strategy. The meetings were conducted face to face and over zoom. We also collected data through annual reports, press releases, media reports and strategy communications.

### **Case selection and description**

We looked for two manufacturing companies in the same sector which have been very successful in their digital transformation and implementation of digitalization strategies. Hero motor Corp and Tata Motors both fitted this requirement. We chose two companies so that we could compare their drivers, process, and benefits achieved.

### **Methodology**

In the section below we have provided synopsis of our case analysis for Hero MotoCorp and Tata Motors. We also conducted textual analysis on annual reports, press releases and media reports to understand the strategic intentions and communications by the company about digitalization or Industry 4.0. Then we studied the co-movements of frequency digital strategy words such as ( AI, ML, Big Data, Cloud Computing etc ) with the financials of the company to interpret the impact of digital strategies on the company's financial performance.

## Digital Transformation Implementation at Hero Motors

The Chief Information Officer of Hero MotoCorp- Mr. Vijay Sethi :

“Digital Transformation is not a one-time intervention – it is a journey”

The largest two-wheeler manufacturer embarked on its journey of digital transformation in 2016 and took the first-mover advantage to race ahead to its business rivals in the era of Industry 4.0. Hero Motors won an award for "Manufacturing Innovator of the Year" for adopting digitalization. It undertook a project to break the barriers between the physical and digital world and was named as one of the top ten Gartner's Strategic Technology Trends 2017.<sup>113</sup>

Key objectives behind Hero Motor's digitalization strategy were to improve quality, boost productivity, and cost reduction so that they could offer high quality products with better value to their customers. Their digital journey started in April 2016 with the launch of their "Digital Twin" project at Vadodara, Gujarat. They thrived to remodel traditional manufacturing approach to a digital one, which is one of its kind in India. They redesigned their Vadodara manufacturing facility using digital tools to incorporate needed changes and enhanced capabilities before actually going in for physical implementation and making investments. Digital Twin enabled them to examine their processes and resources in a virtual context for enhanced productivity, cost effectiveness, risk assessments and risk mitigation prior to actual implementation.

Going Digital is about creating or unlocking value for the business by making advancements in technology. Whether making new business models or exploring new areas, delivering better customer experiences across the value chain, re-engineering the ways of working in an organization including collaboration and decision making, digitalization provides the new ways for doing business. It is not just about using technology but also about changing mindsets of the various stakeholders including employees especially about

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113 Jha, S. (2017, March 14). How Vijay Sethi is driving the Digital Twin project at Hero Moto Corp. *Economic Times*. Retrieved from <https://cio.economictimes.indiatimes.com/news/strategy-and-management/how-vijay-sethi-is-driving-the-digital-twin-project-at-hero-moto-corp/57625617> (last accessed 2021, January 09)

### **Impact of Digital Transformation Strategies on Performance of Manufacturing...**

using data to make better and faster decisions, changing the organizational processes, policies, and ways of dealing with the customers.

Digital transformation initiatives at Hero Motors focused on SMAC (Social, Mobile, Analytics & Cloud) and changing their processes and other systems. The data related to temperature, humidity, vibration rates, rate of spinning, quality parameters was captured using IoT sensors. Hero Motors also set up digital cockpits in their factories where large TV screens and monitors display real time data streaming from the IoT sensors installed in the machines. This helps them to assess the health of their machines and apply predictive maintenance. Besides IoT, the company has also adopted other technologies like Artificial Intelligence, Machine Learning, Robotic Process Automation (RPA) and Augmented Reality (AR)/Virtual Reality (VR).

As a part of this transformation, they also modernized their IT infrastructure and applications and gave a huge thrust on enhancing competence levels of their teams. While that was the basic step, they progressed by making it more structured. Improving customer experience was the central theme of their strategy. Focusing on this theme impacted other business processes and capabilities - sales, operations, service, planning, etc positively and caused rippling effects internally and externally. They looked at all the possible technology solutions and interventions that could help them achieve those objectives. They emphasized on using machine learning for thoughtful maintenance, operational efficiency and forecasting demand. Hero Motors also leveraged 3D Manufacturing in prototyping, simulations and testing on one end.<sup>114</sup>

The SAAS-based integrated talent management platform is a long-thought strategy for spotting rising competencies and embedding them to this acquisition framework. With an increase in the youthful workforce in the organisation, they realized the easy use of social media to grasp more employees and collaborations where they could also seek an expert opinion on the side. The experience of buying bikes from Hero Motors is getting

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114 Jha, S. (2017, March 14). How Vijay Sethi is driving the Digital Twin project at Hero Moto Corp. *Economic Times*. Retrieved from <https://cio.economictimes.indiatimes.com/news/strategy-and-management/how-vijay-sethi-is-driving-the-digital-twin-project-at-hero-moto-corp/57625617> (last accessed 2021, January 09)

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### Digital Transformation and Implementation Case studies

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innovative through an online B2C marketplace. Hero Xperience app is offering after-sales services that will track service coupons, due dates, maintenance and would also monitor the bike performance over a period of time. A new addition of a Xperience club and Hero Bikers Community would soon be available, where one can mention associates/buddies and win exciting goods. All of their inspiring advertisements as well as their plants – GPC, CIT , etc are glorifying instances of them getting digital.

The management played an important role in building a digitally robust house of MotoCorp, polishing the people to their fullest potential so that they could connect with the technology and be able to use and communicate the information generated by the smart machines. The leaders promoted creativity and innovation, created space for employees to bring about new ideas to the table for improving business and service models via many initiatives like Innovation Cell, Idea Contest, Scenario Planning etc. Employees were encouraged to use social platforms to build creativity, research, and engagements. They implemented “mySuccess” - to digitize talent management processes; engage, enable and empower the right people at the right time to be future leaders.<sup>115</sup>

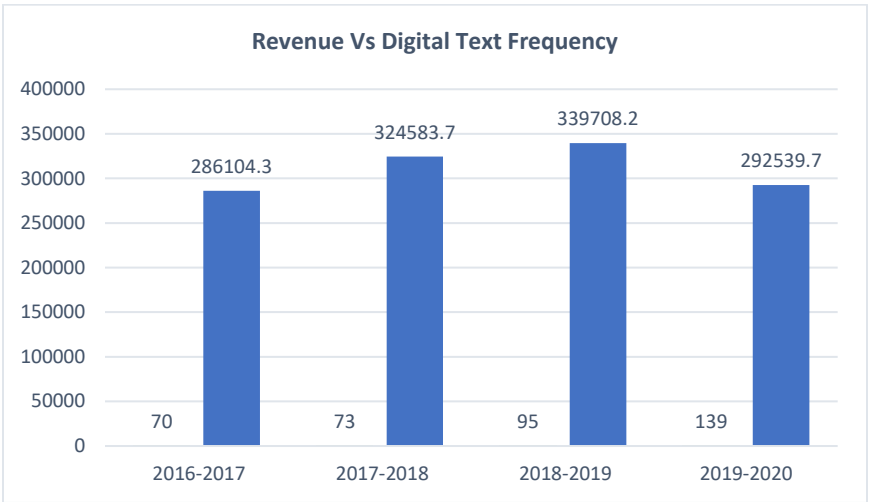
All these technology interventions along with change management initiatives landed the company in a splendid phase of high growth. Our corporate disclosures and communication textual analysis showed that company used more Industry 4.0 related words incrementally ( 70 words in 2016 to 139 words in 2020). The sales of the company increased from INR Million 286,104.3 in the year 2016 to 292,539 in 2020 resulting in a compounded annual growth rate of 8.9%. The gross profit margin initially declined from 2017 to 2019 from 32.5% to 30% but then again increased in 2019-2020 to 31.50%. Earnings before interest and tax (EBIT) margins of the company declined from 14% approximately to 11% over the period . Hero Motocorp has been continuously investing in both tangible and intangible assets. Huge investment was done in BSVI infrastructure, a new plant capitalisation at Chittoor-Andhra Pradesh and company continued to invest in innovation and technology. Changes in key financial metrics are depicted in the following charts.

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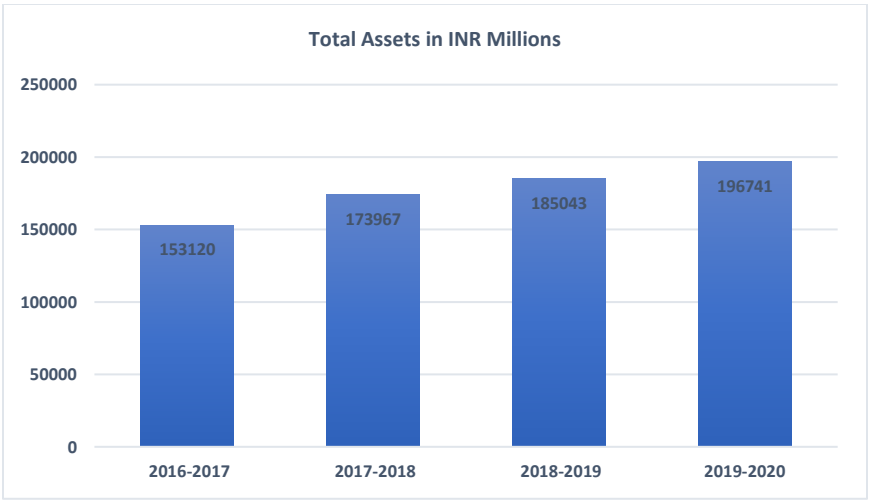
115 Key Technology Mega-Trends Transforming Our World. *CMR*. Retrieved from <http://cmrindia.com/key-technology-mega-trends-transforming-our-world/> (last accessed 2021 January 09)

Figures 28-31 : Key Financial Data of Hero Motors over 2016-2020

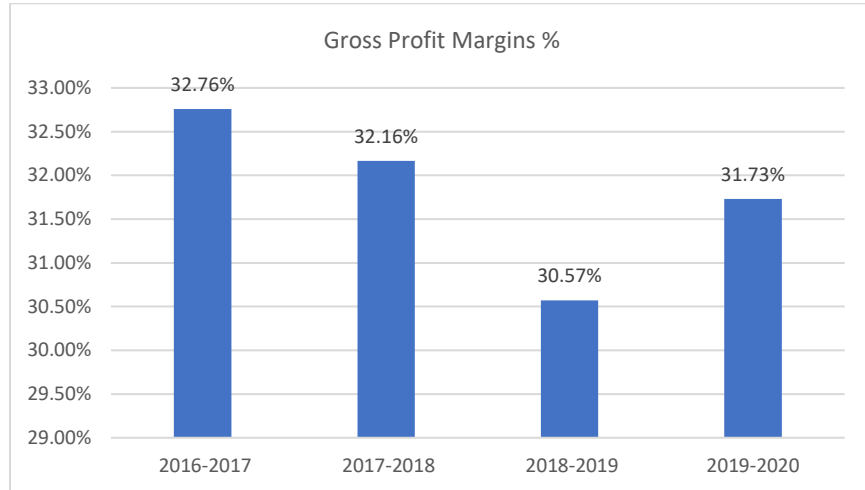
Figures 28



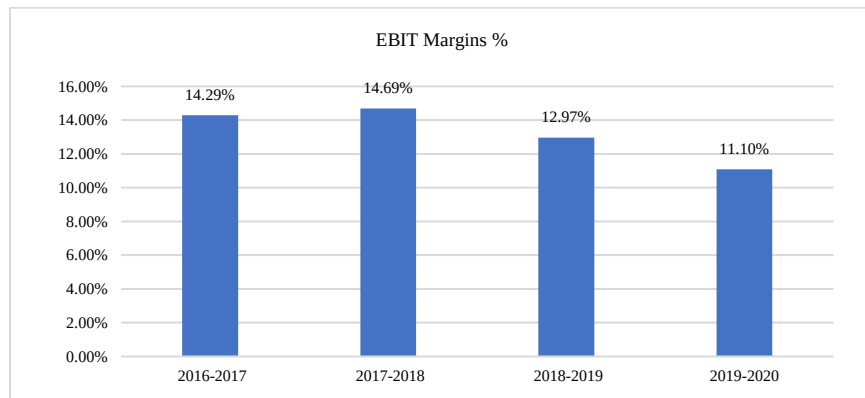
Figures 29



**Figures 30**



**Figures 31**



Decline in EBIT margins can be accounted to increase in operating costs. When digital transformation systems are implemented initially company has to incur not only fixed investments but also has to increase the recurring expenditures. Operating expenses have gone up due to transition from the manual and traditional systems to the new automatic, cyber security and database management systems. Employee costs also have increased due to higher training costs and new hiring. It is usually expected that these expenses reduce over a period of time as the systems set in and are well established.

According to a report prepared by the World Economic Forum (WEF) & Accenture impact of digital transformation on financial performance of firms is

### **Impact of Digital Transformation Strategies on Performance of Manufacturing...**

difficult to measure due to long payback period and short term and intangible benefits. The study has suggested that companies must, therefore, understand the limitations of the financial metrics inherited from the pre-digital era and think about alternatives. Impact of digital transformation should be measured by focusing on the non-financial metrics such as company's Digital IQ, Improvements in Productivity, Employee Engagement levels, Social Impact created, Quality of Decision Making etc.

Thus, on non-financial metrics basis, Digital Initiatives at Hero MotoCorp have resulted in the following benefits: <sup>116</sup>

- Reduced human intervention in the quality testing process
- Round the clock continuous testing cycles.
- Reduced deviations in the testing plan and system controlled automation.
- Increase in manpower productivity ( direct and indirect ) by 20% with the use of Simplify (ECSR), Automation, Cycle time optimisation/benchmarking.
- Reduced turn-around time.
- Higher quality assurance and proactive scheduling. Zero-tolerance on quality
- Better monitoring of the test equipment.
- Reduced Total Productive Maintenance (TPM) enabled reduction of 16 losses.
- Higher accuracy, higher efficiency and faster decision making.
- Flexibility and agile manufacturing led to better asset utilisation on multi-models.
- LEAP was launched for fixed cost optimisation and has focused on material cost reduction with a target of ~50 bps of annual savings.
- Safe and enabling working environment of all manufacturing plants.

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116 Hero MotoCorp Ltd Management Discussions. *IIFL Securities*. Retrieved from <https://www.indiaonline.com/company/hero-motocorp-ltd-split/management-discussions/237> (last accesses 2021, January 09)

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## Digital Transformation and Implementation Case studies

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It's evident from Hero Motors' transformation journey that success of transformational changes depends on involvement at all levels and departments, commitment from the top, employee engagements and fostering an environment of creativity and innovation. <sup>117</sup>More than the transformational changes, the focus should be clearly on how we create value for the customers and the stakeholders. The digital transformation team at Hero Motors ensures that their several IT/tech initiatives align with their business value propositions. The IT team works with the business managers and understands their improvement needs and challenges. Hero Motors also focuses on enhancing the competence of their team and building their tech skills by conducting training and workshops. They periodically review their policies every six months to adapt to the internal and external environment changes.

With the inclusion of everyone into the process and making it as a 'We' instead of 'I', it promotes the transparency and trust with the customers, shareholders, investors giving so much credibility in the market.

### Digital Transformation Implementation at Tata Motors

"The Internet of Everything makes the world more efficient." Jagdish Belwal, CIO, TATA Motors

TATA Motors is an Indian listed automotive manufacturing company having operations worldwide and headquartered in Mumbai, India. It is a subset of TATA group. Its product 'Tata Tiago' won 'Compact Car of the Year' Overdrive Award in 2016 Tata Motors is committed to stay at the top in times of transition and work with alternate firms within the Tata ecosystem to help create a viable atmosphere for adoption of electrical vehicles.

Tata motors, like Hero Motocorp started their digital transformation journey in 2016. They spent 8-10% spend of their annual research and development towards advanced and rising technologies. On an average, Tata Motors has been hiring over five hundred cadres each year since 2016, where most of the hiring happens through universities and institutions for the purpose of innovation and implementation of digital technologies.

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117 Jorapur, S. (2016, August 12). Digital transformation journey of Hero MotoCorp. *peplematters*. Retrieved from <https://www.peplematters.in/article/hr-technology/digital-transformation-journey-of-hero-motocorp-13866> last accesses 2021, January 09)

## **Impact of Digital Transformation Strategies on Performance of Manufacturing...**

Research and development activities at Tata Motors are aimed at new product development, sustainable technologies focusing on environment and safety of vehicles. The company targets to reduce cycle time of product development besides improving quality of their products and creating varied models through the use of highly scalable digitalised technologies, virtual testing and validations. The company has created global design studios for product conceptualisation. Their business objectives, targets and KPIs are aligned with digital transformation KPIs. The company has made significant investments in their assets to enhance their capabilities and have implemented technologies like computer aided and knowledge based engineering, digital mock up and virtual build to reduce the time and improve quality. They also used in-house based knowledge-based engineering framework, (KNexT), the information of engineering processes is captured within the style of rules and reused.<sup>118</sup> These applications perform complicated operations with automation, thereby eliminating the manual errors and providing faster results. Tata motors has implemented vehicle electronics initiatives and driver information technologies with IT enabled services. The company collects and analysis data for failure prediction to the end customer.

Digital initiatives taken by Tata Motors also include mastering of product data and processed using 3D digital designing and creative solutions in collaboration with global partners. The company implemented a unified Product Lifecycle Management (PLM) system for each passenger and business vehicle across various countries and locations. <sup>119</sup>Today, PLM is employed 100% for all new vehicle development programs with progressive modification management method. delivering insights into engineering changes of car information at every unleashed milestone, facilitating project groups to review changes visually. In this, integrated approach of 3D mental image, issue management and alternate comparison was useful to accurate design reviews, distinguish critical areas of focus and facilitate the cognitive process for absolute decision making. Tata Motors has digitized multiple business processes by changing either paper based or email-based processes into laid out online applications using first in-house developed platform. <sup>120</sup>

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118 News and Stories | Tata group. (2020). Retrieved 9 December 2020, from <https://www.tata.com/newsroom>

119 News and Stories | Tata group. (2020). Retrieved 9 December 2020, from <https://www.tata.com/newsroom>

120 Digital Product Development Systems team anchors the digital transformation efforts at Tata Motors. *Express Computer*. Retrieved from

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## Digital Transformation and Implementation Case studies

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The company has also developed and tested the TAL BRABO – robotic solutions in over 50 work streams which can be used by sectors like Light, Aerospace, Automotive and other Engineering, Precision Machining, Software Testing, Electronics, etc to simplify manufacturing, improve quality and productivity.

They did not stop at that. To meet the customers' aspirations of driving high-tech care and to embrace digital technology-driven innovation and disruption company partnered with Microsoft. Through this collaboration Tata Motors got access to artificial intelligence (AI), advanced machine learning, and the Internet of Things (IoT) capabilities on the global hyper-scale Azure cloud, to extend the digital to the physical world creating safe digital driving and owning experience for the buyers.<sup>121</sup> The company also partnered with Cisco for better connectivity and teleconferencing products. Tata Motors recognizes the impact of the Internet of Everything (IoE) on every segment of value chain. As a result, TATA Motors is providing better service to its customers.<sup>122</sup>

With the transformations moving towards Industry 4.0, TATA Co. and CII in collaboration have set up a centre for digital transformation named 'Vision'. TACNet 2.0 (Tata Motors AutoMobility Collaboration Network 2.0)<sup>123</sup> facilitates a centre of automobility innovation through partnerships for brand new technologies and business models. It enables the business to interact with start-ups and tech companies by sparking innovative solutions within automotive technologies, quality scheme and exploring synergies.

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<https://www.expresscomputer.in/amp/interviews/digital-product-development-systems-team-anchors-the-digital-transformation-efforts-at-tata-motors/31458/> (last accessed 2021, January 09)

121 (2017, February 16). Tata Motors and Microsoft India collaborate to redefine the connected experience for automobile users. *Microsoft*. Retrieved from <https://news.microsoft.com/en-in/tata-motors-and-microsoft-india-collaborate-to-redefine-the-connected-experience-for-automobile-users/#:~:text=Tata%20Motors%20will%20leverage%20Microsoft's,a%20highly%20personalized%2C%20smart%20and> (last accessed 2021, January 09)

122 <https://economictimes.indiatimes.com/tech/ites/tata-communications-and-cisco-partner-on-fully-managed-contact-centre-solution/articleshow/71195068.cms?from=mdr>

123 Sangani, P. (2019, September 19). Tata Communications and Cisco partner on fully managed contact centre solution. *Economic Times*, Retrieved from <https://www.google.com/amp/s/www.theweek.in/news/biz-tech/2019/09/18/tata-motors-launches-tacnet-to-startups-for-digital-auto-solutions.amp.html> (last accessed 2021, January 09)

### **Impact of Digital Transformation Strategies on Performance of Manufacturing...**

The main challenge for the company was to change the legacy infrastructure running on previous heavy investments. With multiple legacy systems across locations, their modernization needed prioritization and therefore needed a dedicated effort and time window for each project. Concurrent modernization might have resulted in failure and disruption. To achieve their digital objectives, Tata Motors focused on multi stakeholder management model, compliances and IT security.

The company acknowledges the anxiety of employees so to unfreeze the employee resistance it focused on employee engagement by providing them training and coaching and encouraging their participation in innovation challenges. They conducted digital and online skills assessment, to identify educational priorities for every role, with intervention through customized exercises and courses. By enhancing the talents of its staff on future technologies, this company has been ensuring a smooth transition towards adoption of latest technologies and development of new products.

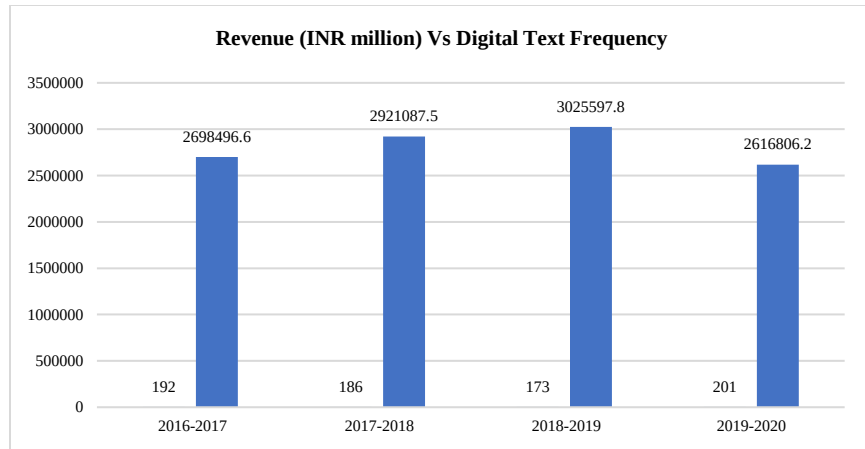
The company followed a unified strategy and there has been a strong commitment and support of the senior management. The Digital development Systems team has been in place for implementing the digital development roadmap to assist in creating a platform for Digital Transformation over many years. Tata Motors has made its mark by bringing a culture of digital transformation that's agile, progressive and makes the business more economical, productive, artistic and innovative.

Our textual analysis of corporate disclosures and communication showed that company used more Industry 4.0 related words incrementally (192 words in 2016 to 201 words in 2020). Technology interventions at Tata Motors along with change management led to positive improvements in their turnover levels. The sales of the company increased from INR Million 26,98,496 in the year 2016 to 30,25,597 in 2019 but declined in the year 2020 due to COVID to INR million 2616806. The company's compounded annual growth rate of 5.8 % for the period 2016-2019. The gross profit margin averaged at 43% higher than the industry average of 35%. We noticed similar impact on EBIT margins as in the case of Hero Motors. It declined 7% in 2016 to 1.25% in 2019. The company has been continuously investing in both tangible and intangible assets. Total asset turnover declined from 1.1x to 0.8x and Return on assets also showed the same declining trend from 4.8% to 0.7% in 2019. Changes in

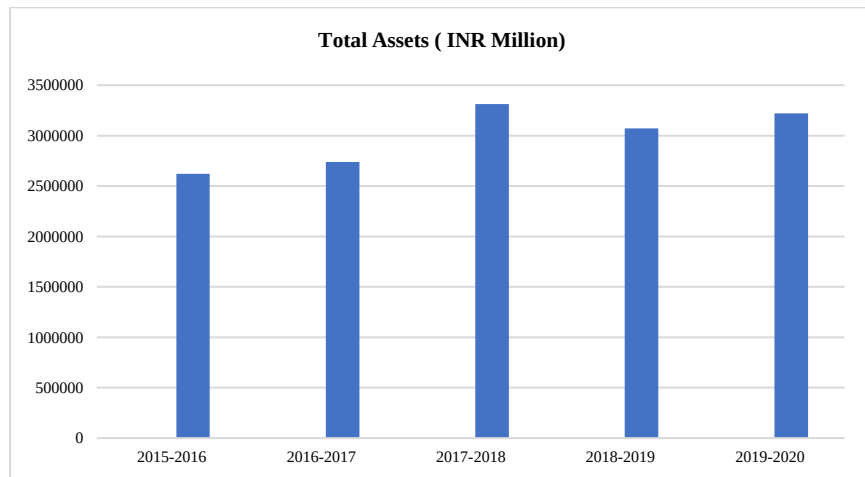
key financial metrics are depicted in the following charts. <sup>124</sup>

**Figures 32-35 : Key Financial Data of Tata Motors over 2016-2020**

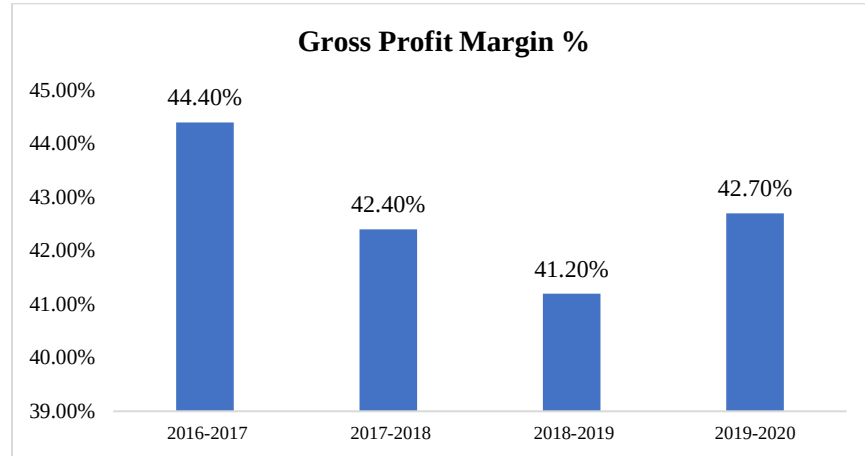
**Figures 32**



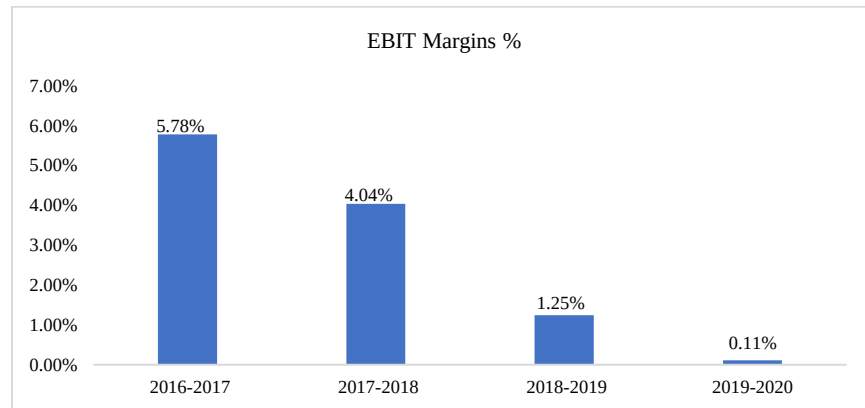
**Figures 33**



Figures 34



Figures 35



Digitalisation helped the company to improve its inventory management and production of engines on time to ensure smooth supply of engines to the assembly line. The technologies also helped in providing early warning signals for potential failures. It achieved mapping of energy consumption, time quality-related data processing and analytics to monitor and improve quality at every opportunity.

**Analysis and Conclusions:** Analysis of financial performance of both the companies over a period 4 years revealed that digitalisation impacted total revenue in absolute terms and gross profit margins positively however, return on assets and EBIT margins declined. The positive impact on sales could be attributed to the improved product designs, customer centric innovation and

### **Digital Transformation and Implementation Case studies**

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digitalisation strategies. The stable/ positive impact on gross profits is due to improvement in productivity, reduction of costs and efficiency of production. This is in line with the Deloitte Study (Deloitte ,2017) and (Cockburn Et Al 2017) which concluded that Industry 4.0 technologies enhance growth and productivity of manufacturing firms and lead to cost savings.

However, we evidenced decline in EBIT margins and Return on Assets. This is in contrast with some of the prior studies where researchers like Chen & Srinivasan (2019) concluded that digitalisation improves return on assets over a period of three years. Some other researchers on the other hand stated that improvements to firm performance will only realize in the long term due to the challenges involved in integrating new technologies (Bresnahan and Greenstein 1996). Consistent with this expectation, we can expect that the overall payback of digital transformation is a very long and it takes longer than three years to achieve an overall improvement in return on investments (ROI). Increased cost of investment (debt funding) and change management initiatives increased the operating costs could be possible reasons for the decline in ROA.

However, this should not be discourage companies from investing in Digital Transformations. Digital investments are costly in the short run but will hopefully pay off in the long run. We also noticed that that the intangible benefits are quite encouraging for both the companies as they have benefitted significantly in terms of their non-financial parameters and KPIs.

## Chapter 7

# Conclusions and Recommendations

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From all the analysis discussed in Chapter 6, we conclude that India is far behind in the adoption of Industry 4.0 in manufacturing, particularly amongst MSMEs which are still operating in industry 2.0. A number of government agencies are working on the Industry 4.0 eco-system in India since the last two years and are proactively organizing webinars and trainings. There is an urgent need for the government to reach out to the MSME sector to understand their requirements to help adopt Industry 4.0. There is an urgent need to handhold the MSME sector in India and motivate them through a push from Original Equipment Manufacturers (OEMs), regulatory pressure, demonstrating benefits to sales and profit, and so on. Financial support schemes for MSMEs will be key in their transition from industry 2.0 to Industry 4.0.

India must build Industry 4.0 across the value chain to be able to grow its manufacturing sector and capture the opportunity presented by the current geo-political developments around China. Our respondents agreed that India has several eco-system characteristics required for digital transformation and adopting Industry 4.0 are present and government has been taking initiatives. However, the presence of a fairly conducive eco-system is not translating into Industry 4.0 adoption on the ground. The manufacturing sector in India needs to have an export focus to develop Industry 4.0.

A dedicated digital transformation project is key for embracing Industry 4.0 at the firm level. The most critical learning from the primary survey is that there is a significant lack of awareness and understanding about Industry 4.0 amongst manufacturing firms in India. Further, it is important for manufacturing firms in India to set up dedicated Digital Transformation Projects with clear Key Performance Indicators (KPIs) across departments and levels. Companies should consider both quantitative and qualitative advantages of digital transformation in their business case. Currently, there is a huge skill set gap for embracing digital transformation and Industry 4.0 in terms of leaders and availability of human resources who are capable of implementing the same. There are also concerns around cyber security. Manufacturing firms in India are grappling with legacy infrastructure which is a key bottleneck in adopting Industry 4.0. Digital transformation is being

## Conclusions and Recommendations

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implemented in silos in manufacturing firms in India. The adoption in larger firms also has been seen on a on a piece meal basis.

It is interesting to note here that despite the leadership commitment, resources and governance structure and **level of communication perceived above, the level of digital transformation and adoption of Industry 4.0 is quite low in the Indian manufacturing sector**. This implies that favourable ecosystem and external environment with strong leadership commitment, governance and overall positive change management climate can lead an organisation to be ready for adoption of digital manufacturing technologies (DMT). It is also important for the manufacturing firms to have cross-functional teams, job rotation, and collaboration among functional departments to enhance the coordination to achieve effective implementation and create value by adoption of technologies. Integration of such management practices and technologies cumulatively enable successful implementation.

On study of co-movements we found that digital activities are correlated with sales, profitability and market valuations suggesting that firms which have higher market cap, revenues and profitability adopt digital strategies more than those who do not have these factors. Our empirical analysis for evaluating the causal relationship - impact of digital transformation on financial performance did not yield desired results. We could not establish a predictive relationship between digitalisation and financial performance. This could be due to the fact that Industry 4.0 technologies have not yet diffused widely and is a very recent phenomenon. Full effects of these technologies can be realised after a long period as the payback period is very long and their implementation requires development and implementation of complementary innovations. The transformation also requires adjustments to costs, hiring and development of human capital, reengineering of processes which can increase overall costs affecting profitability negatively. Another reason could be competitive pressures. If the firms adopt technologies as a response to cope up with tough competition they in fact lose value. Additional costs incurred on implementation may result in intangible benefits and capital which are not visible in the financial statements.<sup>125</sup> We believe that these benefits will be reflected in market values of firms in the coming future. However, going forward, these results should not discourage firms from adopting Industry 4.0.

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125 [https://www.nber.org/system/files/working\\_papers/w24001/w24001.pdf](https://www.nber.org/system/files/working_papers/w24001/w24001.pdf)

### **Impact of Digital Transformation Strategies on Performance of Manufacturing...**

Our analysis and evidence does provide optimism for manufacturing companies. The breakthroughs of Digital Manufacturing Technologies are not visible immediately but they promise larger effects as deployed across the value chains. These technologies enable development of complementary technologies and innovations which can create opportunities for MSMES and other elements in the value chain.

Another important aspect will be development of non-financial KPIs and toolkits for measuring the impact of Industry 4.0 as these technologies result in non-financial benefits and development of intangible capital. In the long run, financial markets will value the intangible capital created by technologies. Overall, the reaping benefits of Industry 4.0 will not only require organisational readiness, leadership commitment, governance, but also adaptation and restructuring across value chain on society levels.

## Research Limitations

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The research undertaken has the following limitations:

- i. The level of awareness and understanding about digital transformation and Industry 4.0 is very low in India across all firm sizes and all levels of management. This created several challenges for primary research. Further, executives interviewed considered basic digitization of human resource and accounting systems as significant advancements towards digital transformation and Industry 4.0. As a result, favourable results from the primary survey towards organizational readiness at the firm level (e.g. strategy, leadership, resources, governance) are likely to be overestimates.
- ii. Given the very recent and still extremely low level of adoption of Industry 4.0 in India, it is very early for the study to be able to assess a definitive impact of digital transformation on financial performance in the manufacturing sector.

Another limitation of our study is that it is based on cross-sectional data. For studying the impact of digital technology strategies longitudinal study can be considered more suitable and can be used in future when more companies adopt Industry 4.0 and more years' data is available post implementation.

- iii. Further comparative research can be done for an analysis of digital transformation strategies in Indian manufacturing Companies with Companies in developed markets or Companies in Service sector with companies in manufacturing sector.

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# Appendix

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## Appendix A

### Questions for Roundtables

A. Industry

B. Government

C. Academia/ Experts/ Think Tanks

#### Industry

1. Is India ready for digital transformation and Industry 4.0 in manufacturing?
2. Where does India stand in the adoption of Industry 4.0 in manufacturing? How does it compare to developed countries?
3. Is there enough awareness in India about Industry 4.0?
4. Is the adoption rate different amongst large manufacturing firms and MSMEs?
5. What are the key reasons for low adoption of Industry 4.0 in India?
6. Does India have the right eco-system for embracing Industry 4.0 - technology, skilled manpower, government policy support, funding?
7. How does low adoption of Industry 4.0 play out in terms of India's competitiveness in the global market?
8. What are the organization level challenges in adopting Industry 4.0, particularly for MSMEs?
9. What are the characteristics of a successful digital transformation strategy for a manufacturing firm in India? Are there any observations of improvements in business performance?
10. Are CEOs of manufacturing firms in India ready to lead digital transformation? Do they have the mindset and commitment?
11. How do firms measure success of implementation of digital transformation strategies?
12. How is the strategy different for large and small firms?

### **Impact of Digital Transformation Strategies on Performance of Manufacturing...**

13. What are the firm-specific advantages and measures of success by adopting Industry 4.0 in manufacturing?

### **Government**

1. Where does India stand in the adoption of Industry 4.0 in manufacturing? How does it compare to developed countries?
2. Is Industry 4.0 in manufacturing a top agenda for the government?
3. What initiatives is the government undertaking to encourage digital transformation of the manufacturing sector - policy initiatives, collaboration with the private sector, setting up labs, technology import from developed countries, skill development, etc.?
4. How will the government ensure effective implementation of these initiatives pan India?
5. Is there room for regulatory pressure to adopt Industry 4.0?
6. Are government sector enterprises embracing Industry 4.0?
7. How is the government measuring success in Industry 4.0 in the manufacturing sector?

### **Academia/Experts/Think Tanks**

1. Is India ready for digital transformation and Industry 4.0 in manufacturing?
2. Where does India stand in the adoption of Industry 4.0 in manufacturing? How does it compare to developed countries?
3. Is there enough awareness in India about Industry 4.0?
4. Is the adoption rate different amongst large manufacturing firms and MSMEs?
5. What are the key reasons for low adoption of Industry 4.0 in India?
6. Does India have the right eco-system for embracing Industry 4.0 - technology, skilled manpower, government policy support, funding?
7. How does low adoption of Industry 4.0 play out in terms of India's competitiveness in the global market?
8. What kind of initiatives/ projects should be undertaken by the

government or through PPP to have successful adoption of digital transformation?

9. Are government initiatives such as Make in India aligned with digital transformation and Industry 4.0?
10. What are the characteristics of a successful digital transformation strategy for a manufacturing firm in India? How is the strategy different for large and small firms?
11. What are the organization level challenges in adopting Industry 4.0?
12. What are the firm-specific advantages and measures of success by adopting digitization and Industry 4.0 in manufacturing?

## **Appendix B**

Primary survey link: <https://www.surveymonkey.com/r/8ZG3S5T>