Identify the enablers of fostering domestic electronics manufacturing ecosystem: Context and Perquisites

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By

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Under the Supervision of

Dr. Ram Singh

DECLARATION

I, Sajal Vats , a student of IIFT Delhi , declare the following:

This dissertation, titled " Identify the enablers of fostering domestic electronics manufacturing ecosystem: Context and Perquisites," is an original and independent work carried out by me under the guidance of Dr. Ram Singh, at IIFT Delhi.

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ABSTRACT

The electronic market in India has witnessed profound transformations over recent decades, poised at the intersection of exponential technological growth and a burgeoning digital revolution. This research paper embarks on a comprehensive exploration of India's electronic market, examining the roles played by key producers and importers, addressing the sustainability of imports, and spotlighting the significance of the Digital India initiative and the development of a robust domestic manufacturing ecosystem. This multidimensional analysis endeavours to provide insights into the critical enablers and challenges shaping India's journey towards technological self-reliance.

India's Electronic Market:

India's electronic market is a dynamic and multifaceted landscape, fueled by a population increasingly reliant on electronic devices and services. The country's rapid digital transformation has catapulted it into a global technology hub, with ever-expanding consumer and industrial demands. The study provides an overview of the electronic market's evolution, underscoring the need to enhance domestic capabilities to meet surging demands effectively.

Key Producers:

Key producers in India, including multinational giants such as HP, Dell, Lenovo, Acer, and Asus, have recognized the potential of the domestic market and established manufacturing facilities within the country. These companies play an instrumental role in driving India's electronics manufacturing, contributing to both local production and export potential. Their manufacturing units not only cater to the domestic market but also serve as export hubs, contributing to the "Make in India" initiative, which seeks to promote indigenous manufacturing and create employment opportunities.

Key Importers:

Concurrently, India remains a significant importer of electronics, relying on international players to meet its vast consumer and industrial needs. The import landscape includes electronics giants like Apple, Samsung, and Xiaomi, who cater to various segments of the Indian market, underscoring the global dimensions of the electronic trade.

Unsustainable Imports:

Despite India's substantial reliance on electronic imports, concerns surrounding the sustainability of this model have gained prominence. Unsustainable imports not only strain the country's trade balance but also pose challenges related to intellectual property, environmental concerns, and supply chain vulnerabilities, as exposed during global crises like the COVID-19 pandemic.

Importance of Digital India:

The Digital India initiative, launched by the Indian government, serves as a catalyst for the country's digital revolution. This ambitious program seeks to digitize governance, improve connectivity, and empower citizens with digital literacy. The research underscores the pivotal role of Digital India in propelling the growth of India's electronic market and in ensuring that technological advancements benefit every stratum of society.

Importance of Domestic Manufacturing Ecosystem:

Recognizing the limitations and vulnerabilities associated with import-heavy electronics consumption, the development of a robust domestic manufacturing ecosystem has gained prominence. This ecosystem involves not only assembling products but also fostering a culture of innovation, investing in research and development, nurturing local supply chains, and improving the ease of doing business.

This research paper endeavors to paint a comprehensive picture of India's electronic market, aligning key producers, importers, sustainability concerns, the Digital India initiative, and the significance of a domestic manufacturing ecosystem. By identifying critical enablers and challenges within this complex ecosystem, the study aims to provide a roadmap for India's transition towards self-reliance in electronics production, securing its place as a global technology leader and enhancing economic resilience.

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Introduction and Methodology

Introduction

The global electronics industry stands as a symbol of innovation and progress, with its products permeating every facet of modern life. In an era driven by technology, the ability to harness and control electronics manufacturing has become a strategic imperative for nations worldwide. India, home to a burgeoning consumer market and a burgeoning digital transformation drive, has recognized the pivotal importance of fostering a robust domestic electronics manufacturing ecosystem.

This research paper delves into the critical imperative of identifying and understanding the enablers that can bolster the growth of a domestic electronics manufacturing ecosystem in India. With a burgeoning population and rapidly increasing technological demands, India seeks to reduce its reliance on electronics imports and establish itself as a formidable player in the global electronics market.

The dynamics of this endeavor are multifaceted, ranging from policy interventions and regulatory frameworks to infrastructure development, skill enhancement, and fostering a culture of innovation. The core objective is to ascertain the critical factors that contribute to the success of a domestic electronics manufacturing ecosystem and the unique challenges that India must overcome to achieve self-sufficiency.

By analyzing these enablers, we aim to provide valuable insights into the path India must tread to build a thriving and sustainable electronics manufacturing ecosystem. This research, therefore, serves as an exploration of not only the challenges but also the opportunities that lie ahead in India's quest to become a self-reliant force in the global electronics arena.

Problem statement of the Thesis

The problem statement of the thesis, "Identify the enablers of fostering a domestic electronics manufacturing ecosystem," revolves around the significant challenges and obstacles that India faces in its endeavor to establish a self-sustaining and competitive electronics manufacturing ecosystem.

To elaborate further on this problem statement, we can break it down into several key aspects:

Heavy Reliance on Electronics Imports: India has traditionally been heavily reliant on imports to meet its electronic goods and technology demands. This over-dependence on foreign electronics not only drains the country's foreign exchange reserves but also makes it vulnerable to supply chain disruptions, as witnessed during global crises such as the COVID-19 pandemic.

Limited Domestic Manufacturing: The problem statement underscores the inadequacy of domestic electronics manufacturing capabilities in India. Despite a burgeoning consumer market and growing demand for electronic products, the country has struggled to establish a thriving manufacturing sector capable of meeting this demand.

Policy and Regulatory Challenges: Developing a robust domestic electronics manufacturing ecosystem involves navigating complex policy and regulatory landscapes. This includes issues related to taxation, intellectual property, trade policies, and investment incentives, among others.

Skills and Infrastructure Gap: The thesis addresses the skills and infrastructure gap that hinders the growth of domestic manufacturing. A well-trained workforce and state-of-the-art infrastructure are critical enablers for the electronics manufacturing sector.

Innovation and Technology Transfer: Achieving self-reliance in electronics manufacturing requires fostering innovation and technology transfer. India must focus on research and development, collaboration with global technology leaders, and creating an environment conducive to innovation.

Global Competitiveness: Lastly, the problem statement touches on the issue of global competitiveness. India aims not only to meet its domestic needs but also to become a competitive player in the global electronics market. Achieving this requires addressing the challenges comprehensively.

In essence, the problem statement encapsulates the multifaceted nature of the issues surrounding India's pursuit of a domestic electronics manufacturing ecosystem. It serves as the foundation for the research, highlighting the urgency and complexity of the task at hand and the need to identify the key enablers for success in this endeavor.

Objective of the Thesis

The main objective of the thesis revolves around “Finding enablers of fostering a domestic manufacturing ecosystem for import substitution of electronics (HS 8471) in India”. This objective can be elaborated as follows:

- **Understanding Import Substitution**: The primary focus of this objective is to comprehend the concept of import substitution in the context of electronics categorized under HS code 8471. Import substitution refers to the strategy of domestically producing goods that were previously imported, with the aim of reducing reliance on imports. In this case, the research zeroes in on the electronics sector, which has historically been a major contributor to India's import bill.

- **Analysing HS Code 8471**: The research aims to delve into the specific category of electronics covered under HS code 8471. This involves a detailed examination of the types of electronic products included in this category, such as computers and computer-related equipment, and understanding their significance in India's import landscape.

- **Identification of Enablers**: The core objective is to identify and analyze the critical factors or "enablers" that can facilitate the growth of domestic manufacturing in this specific electronics sector. These enablers may encompass a range of elements, including policy interventions, investment incentives, technological advancements, infrastructure development, skill enhancement, and more.

- **Promoting Self-Reliance**: The goal of finding these enablers is to pave the way for greater self-reliance in the production of electronics under HS code 8471. By substituting imports with domestically manufactured products, India can reduce its dependence on foreign suppliers and strengthen its economic resilience.

- **Economic Impact Assessment**: The research may also include an assessment of the economic impact of import substitution in this electronics sector. This could involve evaluating potential cost savings, job creation, and improvements in India's trade balance resulting from increased domestic production.

- **Global Competitiveness**: The objective may extend to assessing how a domestically manufactured electronics ecosystem can enhance India's global competitiveness. This involves benchmarking against international standards and evaluating the ability to export electronics products to other markets.

Methodology

A structured methodology is required for analyzing and understanding complex relationships among different elements or factors within a system.

Interpretive Structural Modeling (ISM)

ISM is a powerful analytical technique used for modeling complex systems, understanding relationships among various factors, and hierarchically structuring these factors based on their influence and dependence.

To accomplish the research objectives and application of ISM, following steps need to be implemented.

Step 1 Identification of enablers of electronics manufacturing ecosystem from the relevant literature and confirmed by the experts.

Step 2 Defining contextual interrelationships among the enablers by developing "structural self-interaction matrix (SSIM)"

Step 3 Establishing "initial reachability matrix" by converting SSIM into binary digits.

Step 4 Checking transitivity among the enablers and developing the "final reachability matrix".

Step 5 Determining the levels of the enablers by applying "level partition".

Step 6 Developing a "digraph" and "ISM based model" for the enablers of smart warehouse.

Step 7 Applying MICMAC analysis to segregate enablers of smart warehouse in to dependent, independent, autonomous and linkage categories.

- Identification of enablers of electronics manufacturing ecosystem

At the outset fifteen enablers of smart warehouse have been identified from the extensive review of literature. These fifteen factors evolved from the literature are confirmed with the experts from the electronics manufacturing ecosystem (shown in Table 1).

- Structural self-interaction matrix (SSIM)

In the second step a structural self-interaction matrix (SSIM) has been developed by collecting the data from the field experts. The movement of interactions between various enablers is categorized into two categories: "i" and "j". where group i represent vertically posted and group j represents horizontally posted enablers in a triangular form of matrix i.e., SSIM (see Table 2). This matrix has been responded by the above-mentioned experts to capture the interactions among the enablers by filling each cell with either of the four responses (i.e.. A. V. X and O). The meaning of these four responses provided by the experts in the SSIM chart are as follow:

A represents that group 'j' leads to group 'i'.

V represents that group 'i' leads to group 'j'.

X represents that group 'i' and group 'j' both leads to each other.

O represents that group 'i' and group 'j' are un-related.

- Initial Reachability Matrix

The SSIM converted to a binary form of square matrix that is known as the initial reachability matrix (shown in Table 3). This matrix indicates the transformation of all the responses of SSIM into binary digits. The responses A, V, X, and O shown in the SSIM have been substituted with 0 and 1, by following the below guidelines:

In case, the interaction between two enablers is 'V' under group I and j, then the (1. j) will be 1 and the (j, i) will be 0.

In case, the interaction between two enablers is 'A' under group I and j, then the (1, j) will be 0 and the (j, i) will be 1.

In case, the interaction between two enablers is 'X' under group I and j, then both (1, j) and (j. i) cells will be 1.

In case, the interaction between two enablers is 'O' under group I and j, then both (I. j) and (j, i) cells will be 0.

- Developing final reachability matrix through transitivity check

As ISM is a technique that is based on the experts' responses that is why consistency across the experts' responses in the form of interactions must be checked. For this ISM suggested to check the transitivity of the initial reachability matrix to trace any of the missed interaction between the enablers. The transitivity rule advocates that if enabler I leads to enabler 2 and enabler 2 leads to enabler 3, then enabler 1 should also lead to enabler 3.

Then interaction between enabler 1 and enabler 3 must be indicated as 1 in the initial reachability matrix. In this way transitivity will be explored between the enablers and initial reachability matrix will be transformed into final reachability matrix (see Table 4). The transitivity found between A1 and A9; A2 and A3; and so on have been highlighted in the Table 4.

- Determining levels through level partition

For the level partition, reachability, antecedent and intersection sets have been determined from the reachability matrix. The reachability set entails the enabler and the other enablers it may reach whereas antecedent ser entails the enabler and the other enablers that may help achieving it. The common enablers across the reachability and antecedent sets for the specific enabler are known as intersection set. Later the enablers (A2, A6, A11, A12, A13) having a common intersection set and reachability set have been positioned first at level 1 (see Table 5). Through the iterative process, total two levels compromises of different enablers have been evolved (shown in Table 5). These levels indicate the degree of dependency or independency among different enablers.

- Developing the digraph and ISM based conceptual model

Based on two levels evolved through level partition and the interactions represented in the SSIM, a hierarchical paradigm i.e., diagraph and conceptual model have been developed (see Figure 1 and Figure 2), reflecting the different contextual interrelationships among the enablers of the smart warehouse. The enablers (A2, A6,A11,A12, A13) that evolved at level 1, have been presented at the top of the model and the enablers (A1,A3,A4,A5,A7,A8,A9,A10,A14,A15) at 2nd level has been placed at the bottom of the model.

The linkage enablers are at the different levels in between reflecting that they depend on some enablers and drive the other enablers. ISM model helps in prioritizing the enablers at different levels, along with the understanding of the interactions among the enablers.

MICMAC Analysis

"Matrice d'Impacts Croises Multiplication Appliques a un Classement" or "Impact Matrix Cross-Reference Multiplication" or MICMAC analysis is used to develop a graphical data to segregate the enablers into different categories based on their respective dependence and driving powers, shown in Figure 3. The categories emerge from the MICMAC analysis are autonomous, linkage, dependent, and independent. The y-axis has driving power and x-axis has dependence power respectively and the different enablers have been placed in different quadrants. It provides a lucid picture of the characteristics of the enablers of smart warehouse.

Quadrant 1 represents the autonomous enablers having very low dependence and driving powers. In the result of MICMAC analysis, quadrant one does not hold any variable. Autonomous enabler indicates that it has some influence on the manufacturing ecosystem but has no direct or indirect interactions with the other enablers. The second quadrant comprises of dependent enablers that involve enablers with weak driving and strong dependency. The enabler shown in Figure 3 (A13) have very high dependencies on the other enablers.

The quadrant three of the MICMAC consists of the enablers having strong dependence and driving powers. These variables (A1,A2,A3,A4,A5,A6,A7,A8,A9,A10,A11,A12,A14,A15) act as linkages between the variables having weaker dependence and driving powers. The fourth quadrant comprises of independent enablers with strong driving power but very poor dependencies of other variables. In the result of MICMAC analysis, this quadrant has no variable. These variables drive the other variables at a very significant extent, and they do not depend upon the other enablers significantly.

Literature review

This review provides a concise overview of the existing scholarly works and research findings related to these enablers. It sets the stage for the reader by summarizing the key themes and insights from the literature.

The literature review revealed a comprehensive understanding of the enablers crucial for nurturing a vibrant domestic electronics manufacturing ecosystem in India.

S.No	Enablers	Description of enablers	Sources from literature
A1	Industry Specific Incentives and Tax holidays (MAKE IN India)	Supportive policies and incentives, such as tax benefits and subsidies, play a pivotal role in attracting investments and promoting domestic manufacturing	India's electronic manufacturing sector: Smitha Francis, 2018
A2	Enabling Trade Policy and Facilitation	Adequate infrastructure, including reliable power supply, transportation, and industrial parks, is essential for setting up and running manufacturing facilities	Manufacturing sectors in India: Yash Mehta, John Rajan, 2017
A3	Technically Skilled Workforce	A well-trained and skilled workforce is crucial for efficient production and technological advancement	Technology and Labor Market: Rajarshi Majumder, 2018
A4	R &D Ecosystem and Investments	Investing in R&D facilities and innovation hubs fosters technology development and product innovation	What ails India's electronic manufacturing industry: Sunitha Raju, Raveendra Saradhi, 2021
A5	Facilitative Infrastructural Support	A robust supply chain, from raw materials to finished products, ensures a seamless manufacturing process	Supply Chain vulnerability assessment for manufacturing industry: Satyendra Kumar Sharma et al., 2021
A6	Access to Cheap Capital and Financing	Adequate access to financing options, venture capital, and funding mechanisms is necessary to support startups and SMEs	Prospects and Constraints of manufacturing growth in India: Sandeep Sarkar et al., 2019

A7	Intellectual Property Regime	Strong intellectual property rights (IPR) protection encourages innovation and secures technology investments	Intellectual Property Rights, Innovation, and Development: Lee Branstetter, 2017
A8	International Collaborations and Technology transfer	Collaborative research, partnerships with universities, and technology transfer agreements facilitate knowledge sharing and innovation	International technology transfer policies: Andrea Andrenelli et al., 2019
A9	Quality Consciousness and Compliance	Adhering to international quality standards and obtaining relevant certifications enhances product competitiveness	Quality infrastructure of India and its importance for inclusive national growth: D.K. Aswal, 2020
A10	Domestic demand and purchasing power	Understanding market demands and creating awareness among consumers about domestically manufactured electronics products	A study on consumer buying and their awareness towards country of origin: Gaurav Arora et al., 2017
A11	Export Promotion and Facilitation	Encouraging exports of electronics products promotes competitiveness and economic growth	Joining global production networks: Prema-chandra Athukorala, 2018
A12	Ease of doing business	Streamlining regulatory processes and reducing bureaucratic red tape makes it easier for businesses to operate	Electronics manufacturing entrepreneurs in a performance bonsai trap: Brajesh Mishra et al., 2023
A13	Sustainable Business practices	Incorporating sustainable and environmentally responsible manufacturing practices is increasingly important for global competitiveness	Current efforts on sustainable energy growth in the manufacturing sector to complement “Make in India” for making “Self-reliant India”: K.K. Pulicherla et al., 2022
A14	Digital Infrastructure and cybersecurity measures	Ensuring robust cybersecurity measures to protect intellectual property and sensitive data is critical	Government regulations in cybersecurity: Jangirala Srinivas et al., 2019
A15	Supply Chain Integration with Global Firms	Collaborating with global technology leaders, multinational corporations, and industry associations facilitates knowledge transfer and access to global markets	Is Co-invention expediting technological catch-up? : Elisa Giuliani et al., 2016

Brief description of the literatures

A1: (India’s electronic manufacturing sector: Smitha Francis, 2018)

The Indian electronics industry's heavy reliance on imports is a consequence of liberalized trade and investment policies. The absence of complementary industrial measures aimed at enhancing productivity and capabilities has exacerbated this issue. Efforts to attract foreign direct investment (FDI) have not yielded the desired outcomes. To foster domestic electronics manufacturing, a more comprehensive approach is needed, involving trade, FDI, technology, taxation, infrastructure, environmental protection, and education. It is crucial to increase public funding for research and development.

The Indian government has announced measures to promote domestic electronics manufacturing, primarily as part of the "Make in India" initiative. However, these efforts came after the National Policy on Electronics in 2012 highlighted the low levels of value addition in domestically produced electronic products.

Despite two decades of trade liberalization and favorable FDI policies, the gap between India's electronics demand and domestic production capabilities has continued to grow. The communication segment has been the largest contributor to industry growth, with consumer electronics accounting for the highest share of value addition. Import dependence, especially in telecommunication products, remains a significant concern.

The historical trajectory reveals a lack of effective industrial policies, a disconnect between the software export industry and the domestic hardware sector, and insufficient investment in technology forecasting, research, and education. Policy myopia, rolling back regulations meant to encourage technology transfer, and a focus on select segments have compounded the issue.

In summary, India's import dependence in the electronics industry is a result of liberalized trade and investment policies, the absence of complementary vertical industrial policies, and myopic approaches to industry development, causing a widening gap between demand and domestic production capabilities.

A2: (Manufacturing sectors in India: Yash Mehta, John Rajan, 2017)

The research investigates India's evolving manufacturing strategies and the factors influencing its manufacturing sector across different states. It identifies key factors like infrastructure quality, adherence to tax and labor laws, and environmental standards compliance, which contribute to better performance, particularly in states like Gujarat and Andhra Pradesh.

The International Monetary Fund (IMF) expresses concerns about the decelerating pace of economic reforms in India. However, recent developments, such as the passage of the GST bill, hold promise for the manufacturing sector by facilitating cost-effective goods flow across states and rejuvenating the logistics sector. Infrastructure development, including road and rail networks, is a key government focus to support manufacturing growth.

The paper underscores the role of new laws, especially concerning land and labor, coupled with infrastructure improvements, in positioning India as a burgeoning manufacturing hub. Historically, India shifted from an agriculture-based economy to a service-based one, with limited focus on the secondary sector. In recent years, the government has prioritized manufacturing, recognizing its employment potential and the availability of skilled labor.

The "Make in India" campaign, backed by robust infrastructure, labor-friendly laws, and a commitment to environmental standards, seeks to attract foreign and domestic investors in sectors like automobiles, electronics, machinery, chemicals, pharmaceuticals, and aviation. The defense sector is also gaining foreign investment interest. The government encourages domestic companies with strong leadership and manufacturing technology to compete on the global stage.

In summary, India is actively pursuing manufacturing growth with an emphasis on attracting foreign and domestic investment, infrastructure development, and a commitment to quality and sustainability.

A3: (Technology and Labor Market: Rajarshi Majumder, 2018)

This paper examines the profound influence of technological advancements on the Indian labor market, focusing on three key aspects: aggregate employment, the composition of the workforce in terms of skills, and wage disparity. Technological changes can significantly impact these dimensions, often transforming the nature of work and causing far-reaching effects.

1. Impact on Aggregate Employment: Technological innovation has a mixed impact on overall employment. At the industry level, industries characterized by high levels of technological change tend to experience moderate employment expansion. However, when observed at the regional level, areas with high technological change exhibit relatively lower employment growth. This suggests that while technology can create new job opportunities in certain industries, it might displace jobs in others, resulting in regional disparities in employment trends.

2. Skill Composition of the Workforce: Technological progress tends to be "skill-biased," meaning it increases the demand for highly skilled workers who can operate, program, and manage advanced machines and systems. Conversely, it reduces the demand for low-skilled workers in tasks that can be automated. As a result, the composition of the workforce evolves, with a growing need for workers with specialized skills. This can lead to skill gaps and challenges for those who lack the required skills.

3. Wage Disparity: The impact of technological change extends to wage inequality. In sectors and regions experiencing high technological progress, wage disparities tend to widen. Skilled workers often command higher wages due to their specialized knowledge and abilities to work with advanced technology, while low-skilled workers may face reduced demand and lower wages. This growing wage gap can contribute to rising income inequality, social tensions, and conflicts within India.

The paper suggests that the changing dynamics of the labor market, influenced by technological innovation, have contributed to increased inequality and social challenges in India. It underscores the need for policies and strategies that address these disparities and help bridge the skill gap, ensuring that the benefits of technological advancement are more equitably distributed across the workforce.

A4: (What ails India’s electronic manufacturing industry: Sunitha Raju, Raveendra Saradhi, 2021)

The electronics industry's success in manufacturing hinges on its technological prowess, which spans all components and a robust supply chain. However, with domestic value addition remaining below 25%, bolstering India's production capacity necessitates a focus on productivity-enhancing innovations at the firm level, particularly in design and development capabilities.

This empirical study investigates two pivotal factors influencing the technological orientation of India's electronics manufacturing industry under a liberalized regime: the impact of imports and firm productivity and the influence of exports and firm productivity. The analysis aims to identify the key drivers of production growth in the sector.

The findings of the econometric analysis underscore the limited technological capability of manufacturing firms. Notably, the import of raw materials plays a significant role for both domestically focused and export-oriented firms, whereas the import of capital goods is primarily relevant to export-oriented companies. Additionally, research and development (R&D) expenditure remains low but is statistically significant. These results collectively indicate that high levels of imports are driven by the unavailability of domestic alternatives and have substituted domestic R&D efforts, highlighting the relatively low technological capability of Indian firms. Furthermore, export-oriented firms tend to produce technologically advanced products, likely in response to the competitive pressures of the international market.

To complement these insights, the descriptive analysis examines the trade orientation of sample firms and their cost structure in shaping their market behavior. The research reveals a surge in firms engaging in domestic activities following liberalization, suggesting a primary focus on the rapidly expanding domestic market. Import engagement has notably increased, but export engagement has decreased, indicating that imports have mainly filled the gap in unavailable domestic inputs rather than facilitating export growth. An analysis of the cost structure points to a declining share of capital goods and R&D, both of which signify a lack of technological capability among firms. Moreover, an increasing number of firms are turning to trading, particularly importing finished goods.

In conclusion, to foster a favorable manufacturing environment, it is imperative to promote technological capability and encourage a shift toward export-oriented strategies among firms in the electronics manufacturing industry.

A5: (Supply Chain vulnerability assessment for manufacturing industry: Satyendra Kumar Sharma et al., 2021)

This research paper addresses the growing concern of supply chain vulnerability in today's business environment, particularly in the context of recent events like the COVID-19 pandemic. The primary aim is to investigate and prioritize the factors responsible for supply chain vulnerability. The study draws from an extensive review of existing literature and interviews with experts to identify 26 supply chain vulnerability factors.

The analysis employs the Analytical Hierarchy Process (AHP) to assess the relative criticality of these vulnerability factors. Among the 26 factors, "critical part supplier," "location of supplier," "long supply chain lead times," and issues related to "fixing process owners" and "mis-aligned incentives in supply chain" emerge as the most critical. The research highlights that not only the length and complexity of the supply chain but also the specific supply chain practices adopted by firms can increase vulnerability.

This research contributes to the development of a model for vulnerability factors that are internal to the supply chain and controllable. It provides professionals with valuable insights into mitigating strategies to enhance the resilience of supply chains. The study underscores the importance of recognizing and addressing vulnerability in supply chains, particularly as companies seek global competitiveness through supply chain management.

The research distinguishes between supply chain risk and supply chain vulnerability, emphasizing that risk represents outcomes, often negative, while vulnerability is the driving force that leads to such risks in supply chains. Supply chain vulnerability is shaped by various supply chain decisions that increase a supply chain's exposure to various disruptions.

The study also identifies a gap in the literature, noting that while there is substantial coverage of supply chain risk management, research specifically focused on supply chain vulnerability factors is limited. Developing a supply chain vulnerability model and assigning definitive weightages to criteria and sub-criteria can help managers identify critical factors and take targeted actions to minimize supply chain vulnerability.

In summary, this research addresses the pressing issue of supply chain vulnerability in the context of emerging economies, offering a framework for assessing and prioritizing vulnerability factors. The study aims to provide managers with a systematic approach to bolster supply chain resilience, especially in light of recent global disruptions like the COVID-19 pandemic.

A6: (Prospects and Constraints of manufacturing growth in India: Sandeep Sarkar et al., 2019)

The economic growth trajectory of India over the past three decades differs significantly from the international norm of sustained economic development. There are three key deviations:

1. Tertiary Sector-Led Growth: Unlike most countries, where manufacturing plays a pivotal role in driving economic growth, India's growth has been primarily led by the tertiary sector. This includes services and information technology, which have contributed significantly to both the overall value-added and employment, in contrast to manufacturing.

2. Dualism in Manufacturing: Within the manufacturing sector, India exhibits a persistent dualism. Employment in non-household manufacturing is heavily concentrated in two categories: small-sized establishments and large-sized ones. However, there is a conspicuous absence of a "middle" category. This gap is accompanied by a substantial productivity disparity between small-scale units (6-9 employees) and large-scale units (500 or more employees).

3. Impact on Manufacturing Exports:** The dominance of small-sized manufacturing units with low productivity has implications for India's manufacturing exports. The presence of a large number of small-sized, low-productivity firms may be linked to the poor performance of Indian manufacturing exports.

This paper argues that these phenomena are interconnected, pointing to a lack of dynamic growth in Indian manufacturing units. In light of this, the study aims to examine the constraints faced by the entire Indian manufacturing sector and the specific challenges encountered by different size classes of manufacturing units. This analysis draws from both secondary data and primary survey findings.

In summary, the Indian growth experience deviates from the global norm in terms of the dominance of the tertiary sector, the dualism in manufacturing, and the impact on manufacturing exports. The paper aims to explore the underlying constraints that contribute to these unique characteristics within the Indian manufacturing landscape.

A7: (Intellectual Property Rights, Innovation, and Development: Lee Branstetter, 2017)

For a significant duration, economic policymakers in developing nations have resisted calls to bolster their intellectual property rights (IPR) systems. Some have argued that the success of high-tech industries in Asian countries supports the notion that maintaining weak IPR systems during certain phases of economic development can serve as a form of infant industry policy, fostering the growth of innovative local companies. This essay delves into recent econometric findings regarding the impact of changes in IPR policies on industrial development and concludes that much of this evidence indicates that stronger IPR systems tend to expedite industrial growth.

The paper then scrutinizes whether the lessons learned from Asia's economic history genuinely contradict the econometric evidence. The perspective presented here is that Asia, in reality, does not differ substantially. The current challenges faced by Asian firms in technologically dynamic sectors imply that prolonged periods of industrial development under weak IPR systems can give rise to issues that manifest in the long term.

A8: (International technology transfer policies: Andrea Andrenelli et al., 2019)

This paper delves into the spectrum of international technology transfer (ITT) policies, which range from those aimed at creating a supportive environment for ITT to those that potentially compel ITT to varying degrees. The report identifies three main groups of policies affecting ITT:

1. Policies that Enhance Absorptive Capacity: These aim to maximize the benefits of ITT and technology-related promotion of Foreign Direct Investment (FDI). They typically do not raise concerns.

2. Policies Potentially Problematic: This group includes technology-related investment incentives and certain types of ITT-related outbound investment, particularly when driven by state industrial plans.

3. Policies Often Reported as Problematic: Concerns revolve around the use of registration, certification, and approval procedures that request proprietary information, technology-related performance requirements imposing local sourcing, and measures related to FDI restrictions.

The extent to which a measure can be seen as forcing technology transfer depends on several factors, including the presence of a quid pro quo relationship, discrimination, lack of transparency, and the role of the state in the economy. When these factors combine, a measure can transition from being considered safe or in a grey area to a source of concern along the ITT continuum.

The report emphasizes the significance of intellectual property rights (IPR) in preserving technology owners' interests. The protection and enforcement of IPR, along with ITT policies, are addressed in the context of the World Trade Organization (WTO) and International Investment Agreements (IIAs), including Bilateral Investment Treaties (BITs) and free trade agreements.

Lastly, the report explores ITT from the perspective of the private sector. Data from 93 multinational enterprises (MNEs) in high-technology sectors reveal that research collaborations and licensing agreements are common forms of direct technology transfer. These arrangements are influenced by technology transfer policies, showcasing their impact on business strategies.

In conclusion, the report offers a framework to help governments distinguish between policies that facilitate cross-border technology diffusion and those that may compel technology transfer for the benefit of competing firms. It underscores the need for balanced and transparent policies that support innovation and growth while protecting intellectual property rights.

A9: (Quality infrastructure of India and its importance for inclusive national growth: D.K. Aswal, 2020)

This paper explores the concept of quality infrastructure (QI) in India, which encompasses internationally recognized metrology, standards, and accreditation. The QI plays a fundamental role in ensuring the accuracy and precision of measurements, which are traceable to SI units, and serves as the underlying system for conformity assessment, including calibration, testing, certification, and inspection. It is depicted as an invisible force that connects various key elements responsible for economic growth and the quality of life, often referred to as the four helices: government, universities, science and technology institutions, civil society and media, and enterprises.

The paper highlights the existing capabilities of India's QI institutions, such as the National Physical Laboratory (the National Metrology Institute), the National Accreditation Board for Testing and Calibration Laboratories, and the Bureau of Indian Standards. It discusses mechanisms for enhancing these institutions' individual capabilities and fostering synergy among them.

Emphasizing the need for a robust QI facility, the article points out its significance in various areas, including regulatory implementation, industrial growth, international trade, food safety, environmental monitoring, sustainable energy, affordable healthcare, and attracting foreign investments. India's ambition to become a $5 trillion economy by 2024, given its growing population, necessitates exponential growth in all GDP-contributing sectors and a significant increase in export rates.

The paper also references the Quadruple Helix (QH) model, which examines the interactions between government, university/science and technology (S&T), industries, and civil society/media. The QH model extends the Triple Helix (TH) model by including civil society and media, facilitating effective communication of innovation to the public. The quality infrastructure plays a vital role in ensuring strong and multidirectional interactions among the four helices, contributing to economic growth. Developed nations have well-established QI systems, resulting in strong S&T and industrial policies and high GDP.

A10: (A study on consumer buying and their awareness towards country of origin: Gaurav Arora et al., 2017)

In an era of globalization and widespread production practices, the concept of "country-of-origin" has gained significant importance. Many consumers tend to associate certain beliefs with the country of origin when considering a product, using it as a cognitive cue. This research paper aims to investigate consumer awareness regarding the country-of-origin in the context of consumer electronics.

The research focuses on a dual concept of country-of-origin, considering consumers' awareness of both the "Country-of-Brand Origin" and the "Country-of-Manufacture" for electronic products. The former pertains to the country where the brand of the product is headquartered, while the latter refers to the country where the product is manufactured. The study specifically covers four consumer electronic products: TVs/LEDs, refrigerators, washing machines, and air conditioners.

Data was collected from 199 respondents in five different areas of the National Capital Region in India, using a structured questionnaire. The paper also provides insights into the buying penetration of these four consumer electronic products among consumers.

The primary finding of this research reveals that a majority of consumers demonstrate awareness regarding the Country-of-Brand Origin of the electronic products they use. However, when it comes to awareness regarding the Country-of-Manufacture, consumers tend to be less informed compared to their knowledge of the Country-of-Brand Origin.

A11: (Joining global production networks: Prema-chandra Athukorala, 2018)

This paper investigates India's experience with export expansion within the context of global production sharing, which involves the dispersion of various stages of production processes across different countries. It compares India's performance to that of East Asian countries, primarily focusing on China. The study aims to address several key questions:

1. How does India's manufacturing sector integrate into global production sharing compared to East Asian economies like China?

2. What are the implications of global production sharing for India's manufacturing performance and structural changes within the sector?

3. What policy options are available for effectively linking Indian manufacturing to global production networks?

The paper distinguishes between two major forms of production networks within global production sharing: buyer-driven and producer-driven. Buyer-driven networks are common in consumer goods industries like clothing and footwear, where international buyers and brand manufacturers play a key role in connecting producers with lead firms. Producer-centered networks are prevalent in industries such as electronics and automobiles, where multinational enterprises (MNEs) take the lead, and global production sharing occurs primarily through intra-firm linkages.

The analysis in this paper is based on detailed export data and categorizes products based on the Standard International Trade Classification. The goal is to assess India's export expansion and formulate relevant policies within the context of global production sharing.

The paper is structured as follows:

- Section 2 provides an overview of India's export performance before the economic reforms.

- Section 3 examines evolving patterns of global production sharing and assesses India's performance compared to East Asian countries.

- Section 4 discusses potential policy options.

- Section 5 summarizes the main findings and policy recommendations.

A12: (Electronics manufacturing entrepreneurs in a performance bonsai trap: Brajesh Mishra et al., 2023)

This study explores the state of India's domestic electronics industry, with a focus on its evolution post-economic reforms. The research examines the reasons behind the underperformance of the Indian electronics manufacturing sector. It highlights that despite various policy measures and regulatory reforms, Indian electronics entrepreneurs often remain as start-ups or micro, small, and medium-sized enterprises (MSMEs). The situation is likened to a bonsai tree, lacking the natural stages of business evolution.

The paper discusses India's strengths in areas such as telecom subscription, data usage, and software and IT-enabled services. However, despite the favorable policies like Digital India and Make in India, India's manufacturing exports, particularly in the electronics sector, have not significantly impacted global trade.

The analysis reveals that India's share in manufacturing exports, especially compared to dynamic East Asian economies like China, has remained modest. Economic liberalization in the 1990s did lead to the exceptional performance of certain sectors like IT and IT-enabled services. Still, the broader performance of the manufacturing sector has been lackluster, as highlighted by the declining self-sufficiency rate in the telecommunication equipment industry.

The study aims to understand the evolution of Indian domestic electronics manufacturing post-economic reforms and investigates the lack of natural transformational growth stages among Indian electronics manufacturers, particularly MSMEs and start-ups.

The research design is based on the survival strategy framework, with a phenomenological research approach to address the research objectives from the viewpoints of Indian domestic electronics manufacturers.

The study reveals key narratives, including "Make in India," "Made in India," "PMA strategy," "equitable market access strategy," "blue ocean strategy," "competitive positioning strategy," "importance of technical capability," and "importance of policy/regulatory arbitrage." These narratives highlight the challenges faced by Indian electronics manufacturers, including market barriers, niche area operation, and the impact of policies and regulatory arbitrage by multinational corporations (MNCs).

The study recommends stricter and honest implementation of the Preferential Market Access (PMA) policy for public procurement, along with measures to incentivize private organizations to adopt it voluntarily through subsidies and other benefits.

A13: (Current efforts on sustainable energy growth in the manufacturing sector to complement "Make in India" for making "Self-reliant India": K.K. Pulicherla et al., 2022)

In an effort to become a global manufacturing giant, India has launched the ambitious "Make in India" campaign. This article discusses the initiatives launched by the Indian government to create a sustainable economy and the opportunities for national and international startup organizations to reinforce the campaign. The focus is on improving India's manufacturing output and reducing dependence on foreign imports, aligning with initiatives like "Atmanirbhar Bharat," which translates to "Self-Reliant-Green" India.

The Department of Science & Technology plays a key role in establishing various programs to support infrastructure development, technological advancement, and green manufacturing practices. These programs aim to bridge the gap between "discovery research" and "commercially viable technologies" and target startups, MSMEs, young scientists, R&D labs, and traditional manufacturing units that have limited access to financial support.

The article emphasizes that manufacturing is a vital pillar of a sustainable economy and that India's current manufacturing output needs to increase significantly to make the country a global manufacturing giant. The "Make in India" campaign aims to produce as much as possible within India, using indigenous knowledge and resources.

To address the challenges of increased manufacturing output, the Indian government has also launched various Green India policies. These policies aim to reduce environmental impact and mitigate climate change concerns. The article highlights India's progress in reducing greenhouse gas emissions and its commitment to the Paris Agreement targets.

The paper discusses the need for India to achieve low carbon-emitting industrial growth and presents the National Action Plan on Climate Change (NAPCC) and the State Action Plan on Climate Change (SAPCC) to align with the "Make in India" campaign.

India's manufacturing output is compared to other countries, and the article emphasizes the importance of increasing manufacturing's contribution to GDP and generating job opportunities. The article also underscores the role of research and development in the "Make in India" campaign.

In summary, the article provides an overview of India's efforts to become a global manufacturing powerhouse through the "Make in India" campaign and highlights the importance of sustainable and green manufacturing practices. It outlines the role of the Department of Science & Technology in supporting these initiatives and the need to bridge the gap between research and commercial implementation.

A14: (Government regulations in cybersecurity: Jangirala Srinivas et al., 2019)

Cybersecurity is essential for safeguarding internet-connected systems, including hardware, software, and data, from cyberattacks. Cybersecurity regulations are necessary to compel organizations and companies to protect their systems and information from various cyber threats, such as viruses, phishing, Trojan horses, and more. This article emphasizes the importance of cybersecurity standards, the architecture of a cybersecurity framework, security threats, and measures. It also addresses the challenges of standardization in the field of cybersecurity.

The article discusses the need for regulations to manage cyber risks in critical sectors like national infrastructure and highlights the increasing threat of cyberattacks, which can have consequences for consumer confidence, public safety, and economic growth. It uses the example of Internet banking fraud to illustrate the real-world impact of cybersecurity threats.

The importance of cybersecurity standards is emphasized, as they enhance the efficiency and effectiveness of key processes, facilitate system integration and interoperability, and promote economic growth. The need for a minimum set of cybersecurity standards is recognized to help government departments adhere to and exceed these standards to enhance overall security.

The paper introduces the Security Policy Framework (SPF) and the national cyber security strategy to provide guidelines and obligations for security measures. It emphasizes the need for departments to implement security standards effectively to protect their information, technology, and digital services. Compliance with these standards is flexible to suit the department's specific context and needs.

Furthermore, the paper discusses the cybersecurity framework established in response to Executive Order 13636 to enhance the security of critical infrastructure against cyber threats. It serves as a useful guide for organizations seeking to improve their cybersecurity practices.

In summary, this paper covers cyberattacks, security requirements, and measures, the cyber security incident management framework, standardization challenges in cybersecurity, national strategies, government policies, and essential recommendations for both cybersecurity and cyber defense.

A15: (Is Co-invention expediting technological catch-up? : Elisa Giuliani et al., 2016)

Companies from emerging economies are expanding their global presence, and Europe has become a significant destination for a substantial portion of their foreign investments. This increasing internationalization offers these firms a chance to catch up technologically.

This research investigates instances where Brazilian, Indian, and Chinese inventors collaborate with inventors from the European Union (EU-27) between 1990 and 2012. The findings indicate that these collaborative inventions serve as an avenue for firms from emerging economies to enhance their technological capabilities, access cutting-edge knowledge, and secure intellectual property rights for these joint inventions.

This study contributes to our comprehension of how firms from emerging economies can bridge the technological gap.

India’s laptop market (8471)

8471: Automatic data-processing machines and units thereof; magnetic or optical readers, machines for transcribing data onto data media in coded form and machines for processing such data, n.e.s

India’s import of 8471

India's imports represent 2.4% of world imports for this product, its ranking in world imports is 10.
The average distance of supplying countries is 4514 km, and the market concentration is 0.34.

Bilateral trade at 6-digit	Exporters	Value imported in 2022 (USD thousand)	Trade balance 2022 (USD thousand)	Share in India's imports (%)	Quantity imported in 2022	Quantity unit	Unit value (USD/unit)	Growth in imported value between 2018-2022 (%, p.a.)
	World	11,090,347	-10,805,900	100	39,146	Tons	283,307	17
⊞	China	6,025,061	-6,006,619	54.3	21,280	Tons	283,133	20
⊞	Singapore	1,818,984	-1,796,137	16.4	6,349	Tons	286,499	13
⊞	Hong Kong, China	1,078,680	-1,068,369	9.7	3,813	Tons	282,895	22
⊞	United States of America	482,982	-414,243	4.4	1,699	Tons	284,274	7
⊞	Malaysia	403,006	-399,449	3.6	1,366	Tons	295,026	20
⊞	Taipei, Chinese	336,105	-333,980	3	1,265	Tons	265,696	25
⊞	Thailand	224,800	-220,274	2	580	Tons	387,586	-1
⊞	Viet Nam	146,518	-141,186	1.3	536	Tons	273,354	104
⊞	Netherlands	134,890	-122,581	1.2	495	Tons	272,505	54
⊞	Mexico	96,147	-95,528	0.9	314	Tons	306,201	-10
⊞	Ireland	89,365	-88,929	0.8	274	Tons	326,150	-11
⊞	Germany	51,629	-48,283	0.5	214	Tons	241,257	8
⊞	United Kingdom	42,682	-38,479	0.4	152	Tons	280,803	11
⊞	Korea, Republic of	26,515	-25,650	0.2	150	Tons	176,767	-6
⊞	United Arab Emirates	21,671	8,259	0.2	155	Tons	139,813	24
⊞	Japan	16,290	-12,765	0.1	96	Tons	169,688	1
⊞	Hungary	16,275	-15,035	0.1	43	Tons	378,488	29
⊞	Czech Republic	10,334	-10,315	0.1	37	Tons	279,297	24
⊞	France	9,646	-331	0.1	42	Tons	229,667	-8
⊞	Canada	9,423	-7,505	0.1	34	Tons	277,147	-8
⊞	Israel	7,497	-3,444	0.1	33	Tons	227,182	-12
⊞	Italy	6,092	-4,742	0.1	48	Tons	126,917	4
⊞	Belgium	4,639	-3,487	0	29	Tons	159,966	41
⊞	Indonesia	4,543	-3,364	0	44	Tons	103,250	12

India’s export of 8471

India's exports represent 0.1% of world exports for this product, its ranking in world exports is 40
The average distance of importing countries is 6531 km and the export concentration is 0.1

Bilateral trade at 6-digit	Importers	Value exported in 2022 (USD thousand)	Trade balance 2022 (USD thousand)	Share in India's exports (%)	Quantity exported in 2022	Quantity unit	Unit value (USD/unit)	Growth in exported value between 2018-2022 (%, p.a.)
	World	284,447	-10,805,900	100	1,210	Tons	235,080	9
⊞	United States of America	68,739	-414,243	24.2	281	Tons	244,623	28
⊞	Russian Federation	31,698	31,407	11.1	140	Tons	226,414	74
⊞	United Arab Emirates	29,930	8,259	10.5	106	Tons	282,358	10
⊞	Singapore	22,847	-1,796,137	8	98	Tons	233,133	-3
⊞	China	18,442	-6,006,619	6.5	75	Tons	245,893	11
⊞	Netherlands	12,309	-122,581	4.3	48	Tons	256,438	52
⊞	Hong Kong, China	10,311	-1,068,369	3.6	45	Tons	229,133	-21
⊞	France	9,315	-331	3.3	48	Tons	194,063	-11
⊞	Bangladesh	6,811	6,783	2.4	33	Tons	206,394	38
⊞	Bhutan	6,475	6,461	2.3	24	Tons	269,792	50
⊞	Viet Nam	5,332	-141,186	1.9	15	Tons	355,467	50
⊞	Thailand	4,526	-220,274	1.6	15	Tons	301,733	50
⊞	United Kingdom	4,203	-38,479	1.5	18	Tons	233,500	-1
⊞	Israel	4,053	-3,444	1.4	21	Tons	193,000	6
⊞	Malaysia	3,557	-399,449	1.3	11	Tons	323,364	-31
⊞	Japan	3,525	-12,765	1.2	13	Tons	271,154	45
⊞	Germany	3,346	-48,283	1.2	15	Tons	223,067	4
⊞	South Africa	2,606	2,565	0.9	13	Tons	200,462	22
⊞	Philippines	2,577	-1,753	0.9	8	Tons	322,125	-12
⊞	Taipei, Chinese	2,125	-333,980	0.7	8	Tons	265,625	8
⊞	Nepal	2,031	1,997	0.7	9	Tons	225,667	3
⊞	Canada	1,918	-7,505	0.7	8	Tons	239,750	3
⊞	Botswana	1,653	1,651	0.6	16	Tons	103,313	50
⊞	Italy	1,350	-4,742	0.5	7	Tons	192,857	42

Number of importing companies in India, broken down by product categories, for HS 8471

Product category	Number of importing companies available in Trade Map▼
Computers, peripherals, and software	106
Computer peripheral equipment, nspf, and parts, nspf	38
Printers (computing)	34
Importers-exporters, industrial machinery	22
Personal computers (PC)	14
Computer and software stores	12
Input peripherals	12
Data storage devices for computing	11
Optical disc drives (ODD)	10
Monitors/display screens	9
Computer storage devices, and parts, nspf	8
Computers, and parts, nspf	8
Industrial computers	8
Integrated computer systems	7

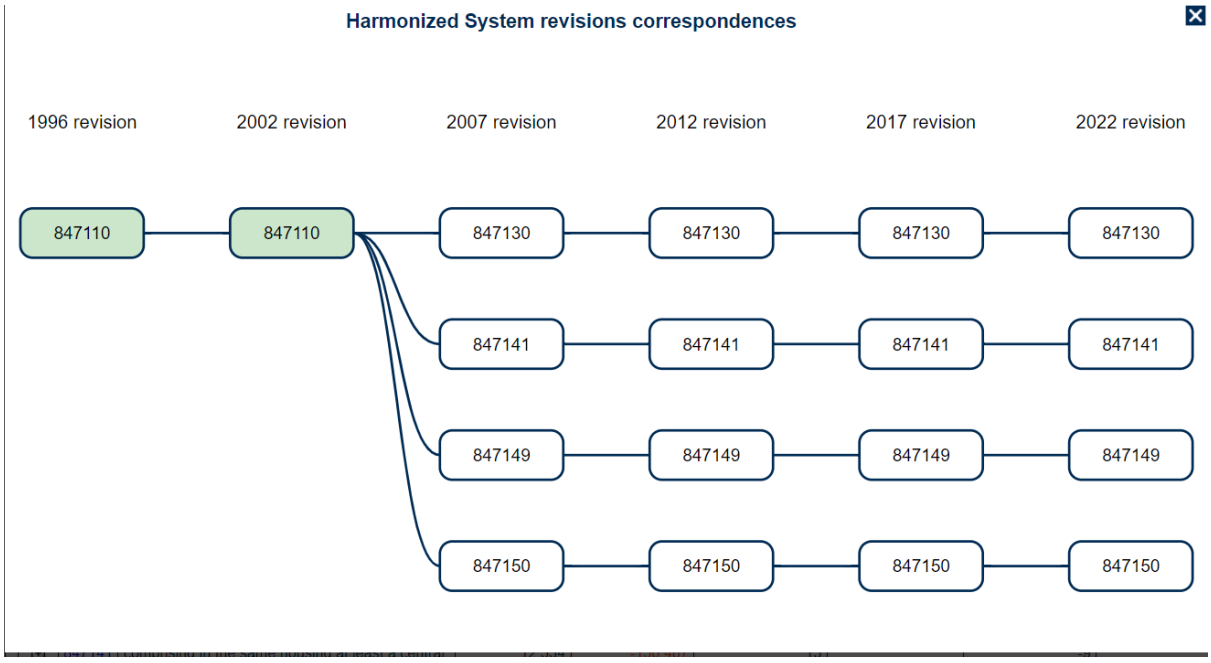
Number of exporting companies in India, broken down by product categories, for HS 8471

Product category	Number of exporting companies available in Trade Map▼
Computers, peripherals, and software	127
Importers-exporters, industrial machinery	51
Computer peripheral equipment, nspf, and parts, nspf	48
Printers (computing)	35
Integrated computer systems	31
Computer and software stores	14
Monitors/display screens	12
Personal computers (PC)	12
Data storage devices for computing	11
Optical disc drives (ODD)	11
Computer storage devices, and parts, nspf	9
Computers, and parts, nspf	9
Input peripherals	9
Industrial computers	6

Analysis at the 6 digit level of HS 8471

Product: 847110 Analogue or hybrid automatic data processing machines

This 6-digit code was further revised into four 6-digit codes as per latest revision



Import data

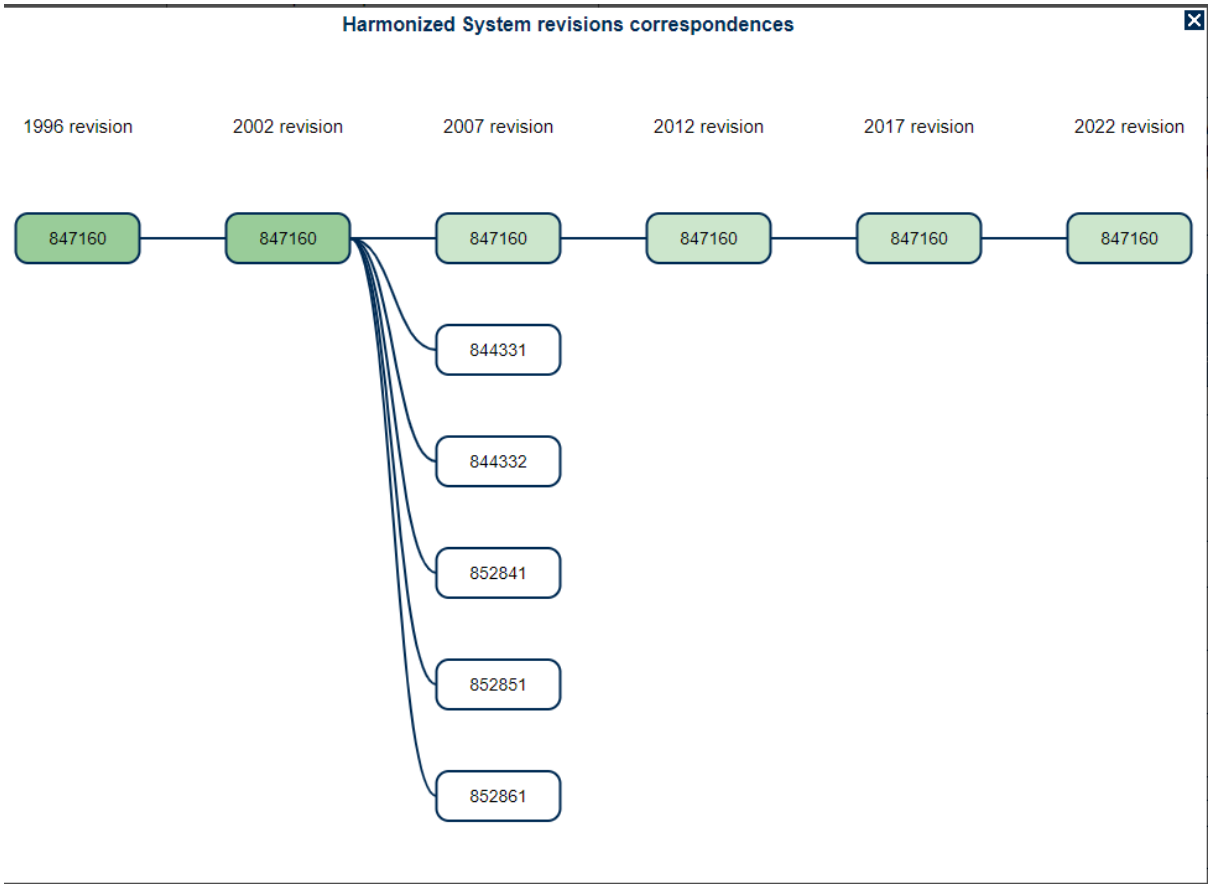
HS8	Code	Product label	imported value 2022, USD thousand▼	Trade balance 2022 in USD thousand	Annual growth in value between 2018-2022, %, p.a.
		Total	9,766,748	-9,558,716	
⊞	847130	Data-processing machines, automatic, portable, weighing <= 10 kg, consisting of at least a central processing unit, a keyboard and a display (excl. peripheral units)	6,894,061	-6,829,676	25
⊞	847150	Processing units for automatic data-processing machines, whether or not containing in the same housing one or two of the following types of unit: storage units, input units, output units (excl. those of heading 8471.41 or 8471.49 and excl. peripheral units)	2,562,050	-2,455,370	9
⊞	847141	Data-processing machines, automatic, comprising in the same housing at least a central processing unit, and one input unit and one output unit, whether or not combined (excl. portable weighing <= 10 kg and excl. those presented in the form of systems and peripheral units)	163,021	-150,487	33
⊞	847149	Data-processing machines, automatic, presented in the form of systems "comprising at least a central processing unit, one input unit and one output unit" (excl. portable weighing <= 10 kg and excl. peripheral units)	147,616	-123,183	7

Export Data

HS8	Code	Product label	exported value 2022, USD thousand▼	Trade balance 2022 in USD thousand	Annual growth in value between 2018-2022, %, p.a.
		Total	208,032	-9,558,716	
⊞	847150	Processing units for automatic data-processing machines, whether or not containing in the same housing one or two of the following types of unit: storage units, input units, output units (excl. those of heading 8471.41 or 8471.49 and excl. peripheral units)	106,680	-2,455,370	28
⊞	847130	Data-processing machines, automatic, portable, weighing <= 10 kg, consisting of at least a central processing unit, a keyboard and a display (excl. peripheral units)	64,385	-6,829,676	1
⊞	847149	Data-processing machines, automatic, presented in the form of systems "comprising at least a central processing unit, one input unit and one output unit" (excl. portable weighing <= 10 kg and excl. peripheral units)	24,433	-123,183	23
⊞	847141	Data-processing machines, automatic, comprising in the same housing at least a central processing unit, and one input unit and one output unit, whether or not combined (excl. portable weighing <= 10 kg and excl. those presented in the form of systems and peripheral units)	12,534	-150,487	15

Product: 847160 Input or output units for automatic data-processing machines, whether or not containing storage units in the same housing

This 6-digit code was further revised into six 6-digit codes as per latest revision



Import Data

HS8	Code	Product label	imported value 2022, USD thousand▼	Trade balance 2022 in USD thousand	Annual growth in value between 2018-2022, %, p.a.
		Total	1,776,456	-1,720,649	
⊞	852852	Monitors capable of directly connecting to and designed for use with an automatic data processing machine of heading 8471 (excl. CRT, with TV receiver)	619,058	-606,519	14
⊞	844331	Machines which perform two or more of the functions of printing, copying or facsimile transmission, capable of connecting to an automatic data-processing machine or to a network	500,090	-491,351	5
⊞	847160	Input or output units for automatic data-processing machines, whether or not containing storage units in the same housing	325,768	-305,422	12
⊞	844332	Machines which only perform one of the functions of printing, copying or facsimile transmission, capable of connecting to an automatic data processing machine or to a network	251,691	-240,525	1
⊞	852862	Projectors capable of directly connecting to and designed for use with an automatic data processing machine of heading 8471 (excl. with TV receiver)	70,444	-67,486	-12
⊞	852842	Cathode-ray tube monitors "CRT" capable of directly connecting to and designed for use with an automatic data processing machine of heading 8471 (excl. with TV receiver)	9,405	-9,346	25

Export Data

HS8	Code	Product label	exported value 2022, USD thousand▼	Trade balance 2022 in USD thousand	Annual growth in value between 2018-2022, %, p.a.
		Total	55,807	-1,720,649	
⊞	847160	Input or output units for automatic data-processing machines, whether or not containing storage units in the same housing	20,346	-305,422	-2
⊞	852852	Monitors capable of directly connecting to and designed for use with an automatic data processing machine of heading 8471 (excl. CRT, with TV receiver)	12,539	-606,519	34
⊞	844332	Machines which only perform one of the functions of printing, copying or facsimile transmission, capable of connecting to an automatic data processing machine or to a network	11,166	-240,525	-8
⊞	844331	Machines which perform two or more of the functions of printing, copying or facsimile transmission, capable of connecting to an automatic data-processing machine or to a network	8,739	-491,351	22
⊞	852862	Projectors capable of directly connecting to and designed for use with an automatic data processing machine of heading 8471 (excl. with TV receiver)	2,958	-67,486	-25
⊞	852842	Cathode-ray tube monitors "CRT" capable of directly connecting to and designed for use with an automatic data processing machine of heading 8471 (excl. with TV receiver)	59	-9,346	-24

Product: 847170 Storage units for automatic data-processing machines

Import Data

HS8	Code	Product label	imported value 2022, USD thousand▼	Trade balance 2022 in USD thousand	Annual growth in value between 2018-2022, %, p.a.
⊞	847170	Storage units for automatic data-processing machines	854,155	-817,440	1

Export Data

HS8	Code	Product label	exported value 2022, USD thousand▼	Trade balance 2022 in USD thousand	Annual growth in value between 2018-2022, %, p.a.
⊞	847170	Storage units for automatic data-processing machines	36,715	-817,440	-2

Product: 847180 Units for automatic data-processing machines (excl. processing units, input or output units and storage units)

This 6-digit code was further revised into two 6-digit codes as per latest revision.

Import Data

HS8	Code	Product label	imported value 2022, USD thousand	Trade balance 2022 in USD thousand	Annual growth in value between 2018-2022, %, p.a.
		Total	4,761,291	-3,756,462	
⊞	851762	Machines for the reception, conversion and transmission or regeneration of voice, images or other data, incl. switching and routing apparatus (excl. telephone sets, telephones for cellular networks or for other wireless networks)	4,654,176	-3,657,894	-3
⊞	847180	Units for automatic data-processing machines (excl. processing units, input or output units and storage units)	107,115	-98,568	-1

Export Data

HS8	Code	Product label	exported value 2022, USD thousand	Trade balance 2022 in USD thousand	Annual growth in value between 2018-2022, %, p.a.
		Total	1,004,829	-3,756,462	
⊞	851762	Machines for the reception, conversion and transmission or regeneration of voice, images or other data, incl. switching and routing apparatus (excl. telephone sets, telephones for cellular networks or for other wireless networks)	996,282	-3,657,894	13
⊞	847180	Units for automatic data-processing machines (excl. processing units, input or output units and storage units)	8,547	-98,568	6

Product: 847190 Magnetic or optical readers, machines for transcribing data onto data media in coded form and machines for processing such data, n.e.s.

Import Data

HS8	Code	Product label	imported value 2022, USD thousand▼	Trade balance 2022 in USD thousand	Annual growth in value between 2018-2022, %, p.a.
⊞	847190	Magnetic or optical readers, machines for transcribing data onto data media in coded form and machines for processing such data, n.e.s.	36,561	-25,754	-4

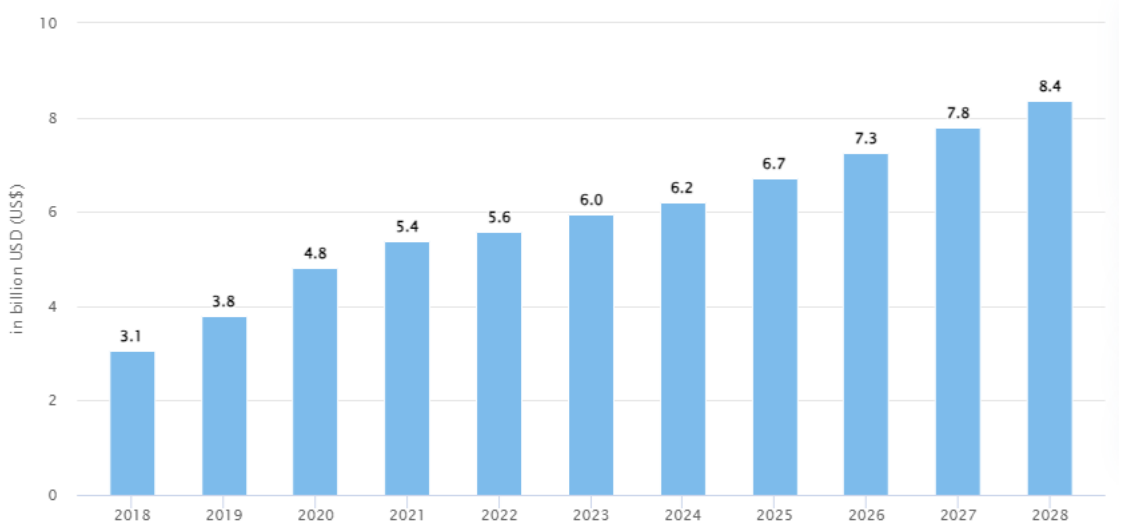
Export Data

HS8	Code	Product label	exported value 2022, USD thousand▼	Trade balance 2022 in USD thousand	Annual growth in value between 2018-2022, %, p.a.
⊞	847190	Magnetic or optical readers, machines for transcribing data onto data media in coded form and machines for processing such data, n.e.s.	10,807	-25,754	5

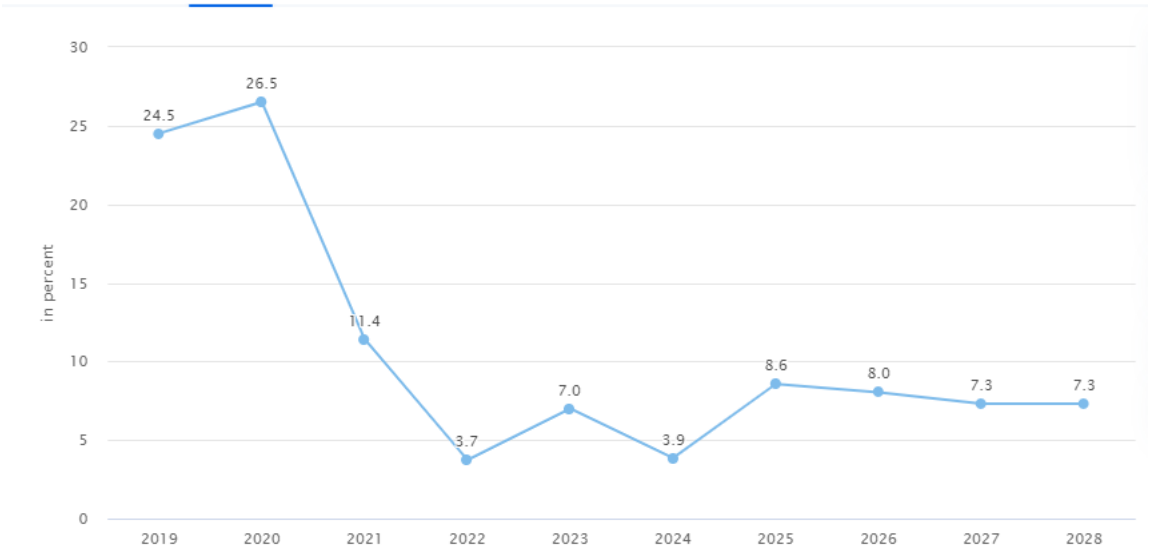
Trends in the laptop market in India

- Revenue in the Laptops market amounts to ₹0.5tn in 2023. The market is expected to grow annually by 9.18% (CAGR 2023-2028).
- In global comparison, most revenue is generated in China (₹1,898.0bn in 2023).
- In relation to total population figures, per person revenues of ₹343.00 are generated in 2023.
- In the Laptops market, volume is expected to amount to 13.9m pieces by 2028. The Laptops market is expected to show a volume growth of 3.9% in 2024.

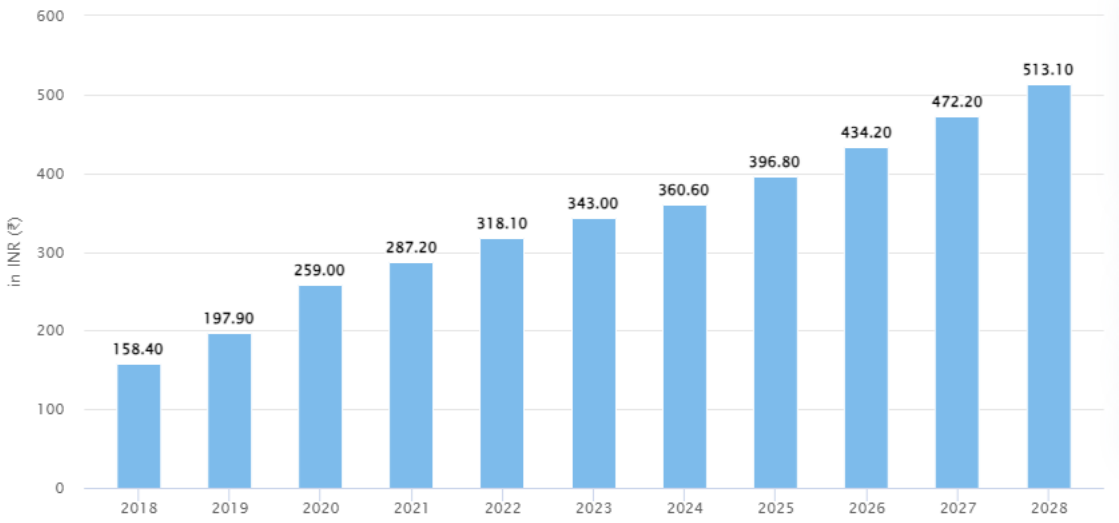
Revenue generated in the Indian Laptop Market



% Revenue change in the Indian Laptop Market

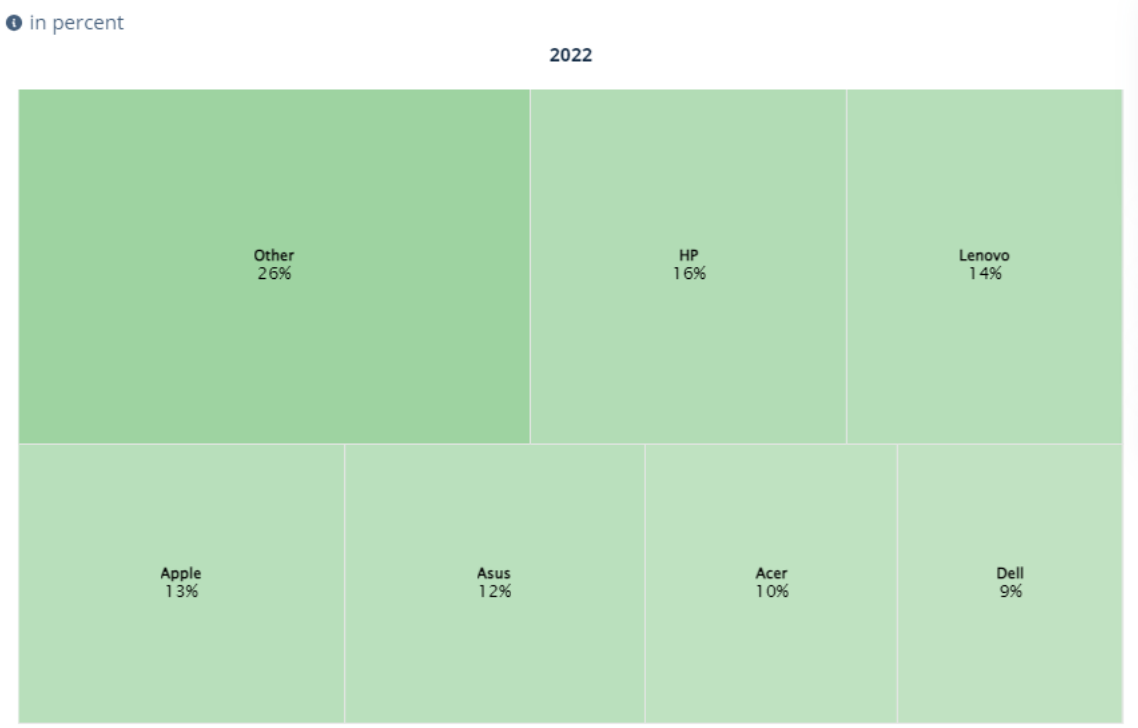


Average per capita revenue generated

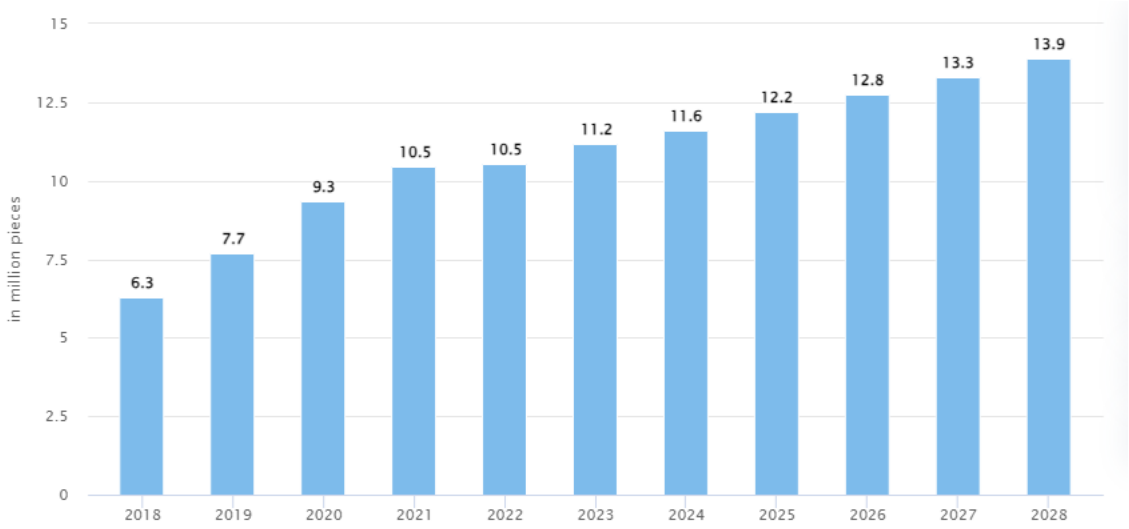


Key Players

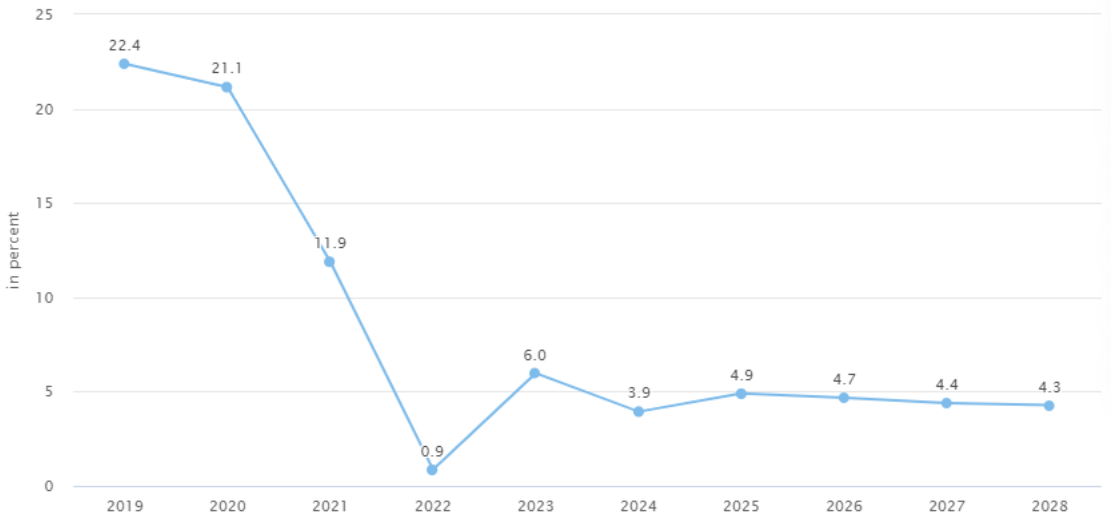
Brand share (%)



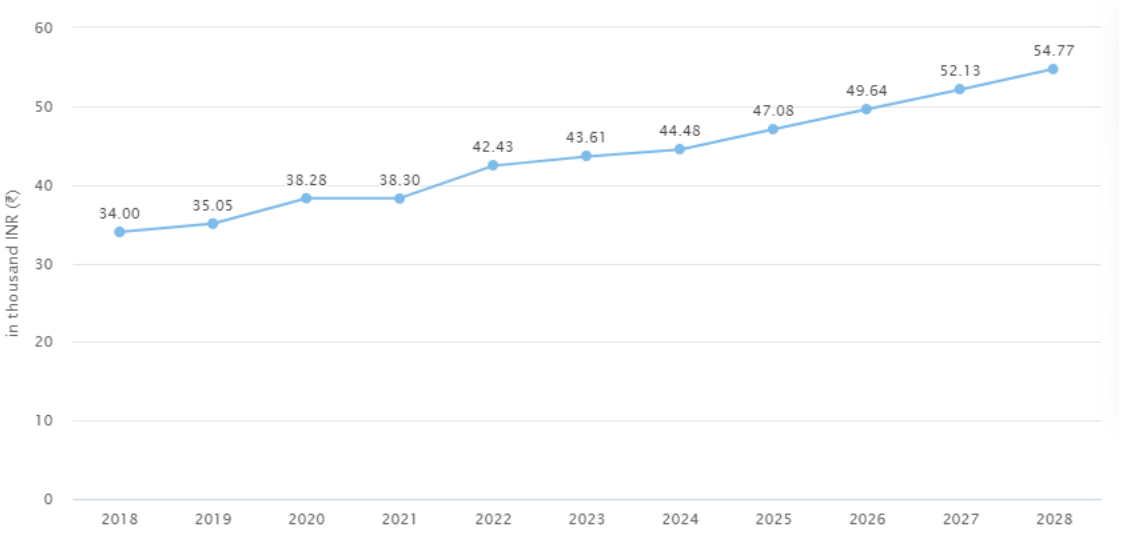
Sales Volume



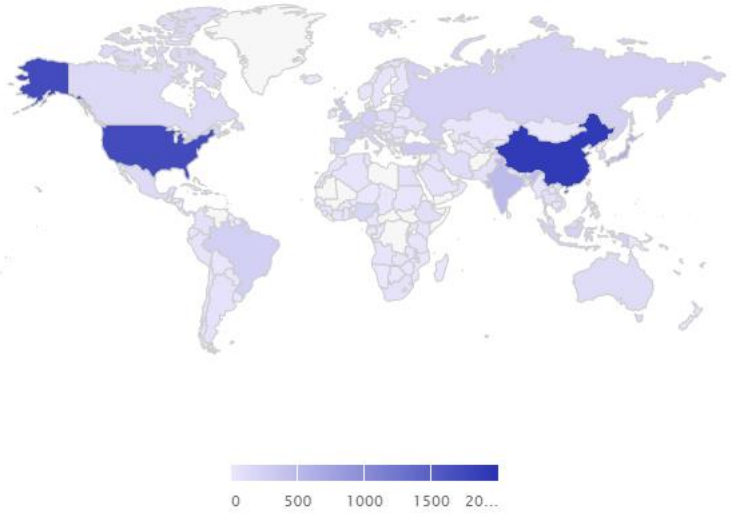
% growth in Sales volume



Average price per unit



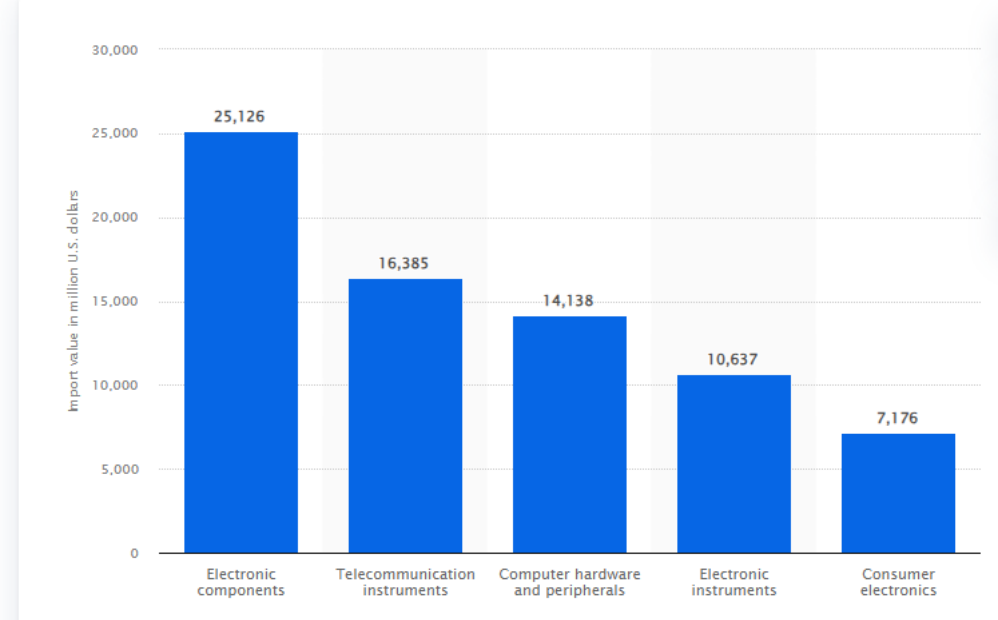
Revenue comparison on a global level



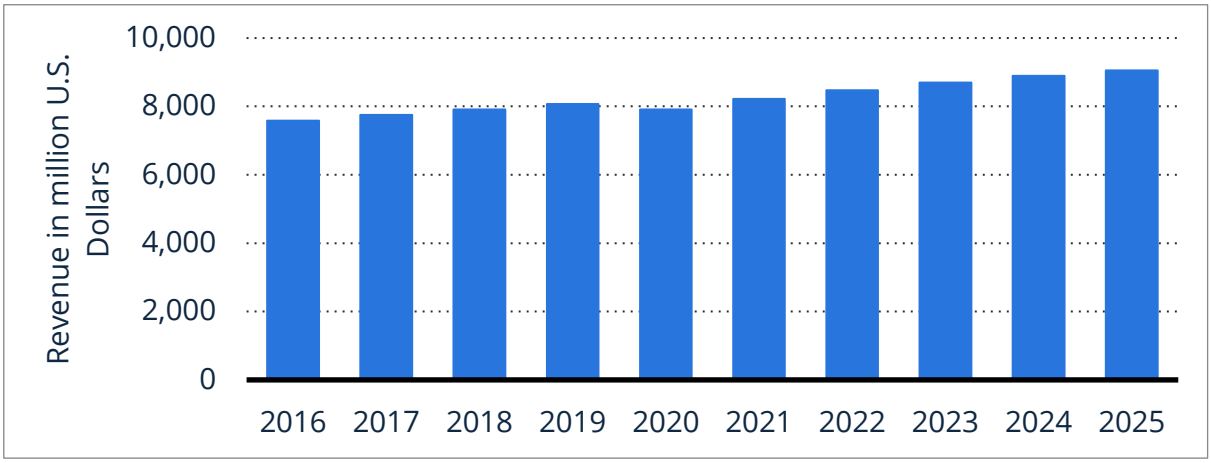
Top 5 (2023) in billion INR (₹)	
1. China	1,898.0
2. United States	1,727.0
3. Japan	632.4
4. India	486.9
5. Turkey	309.5

India’s Electronic imports

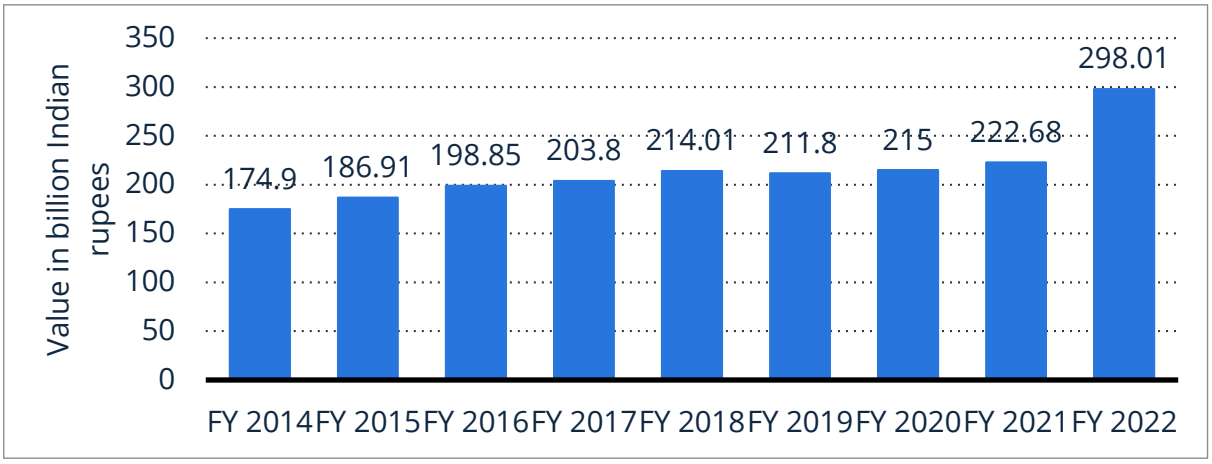
Value of electronics imported to India in FY23



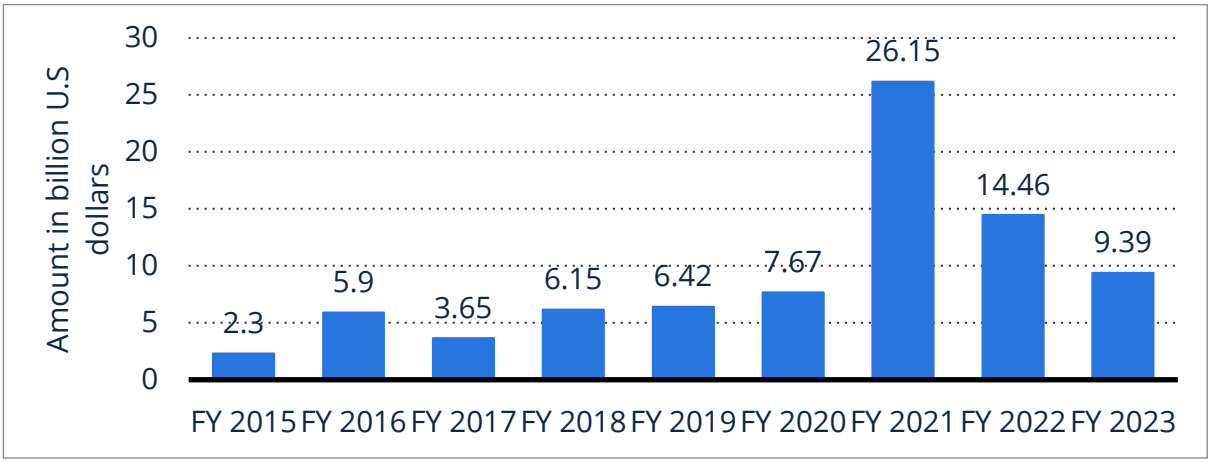
Revenue of the laptop and tablet industry in India 2016-25



Value of computer hardware production in India 2014-22

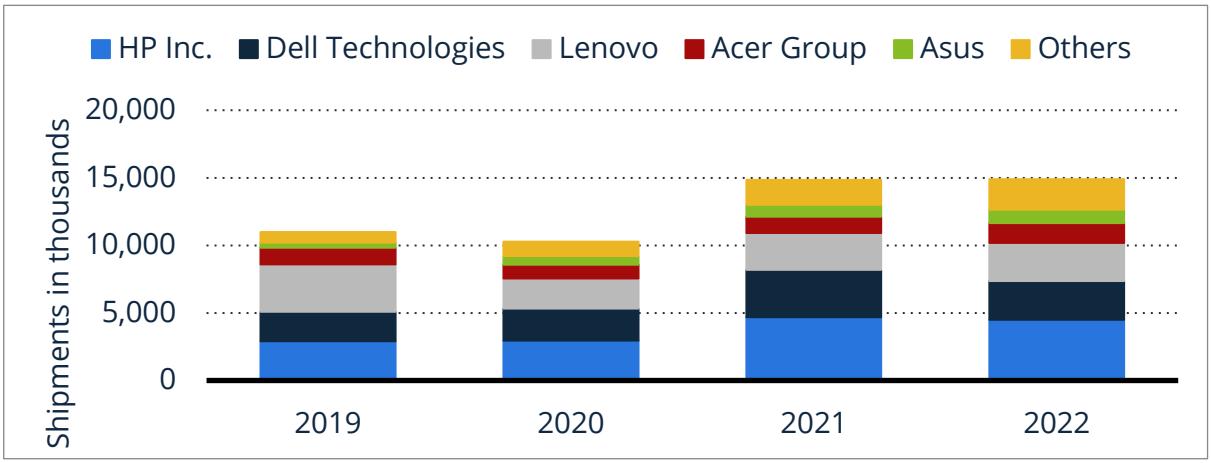


Amount of FDI equity inflows for computer hardware and software sector in India from FY 2015-23

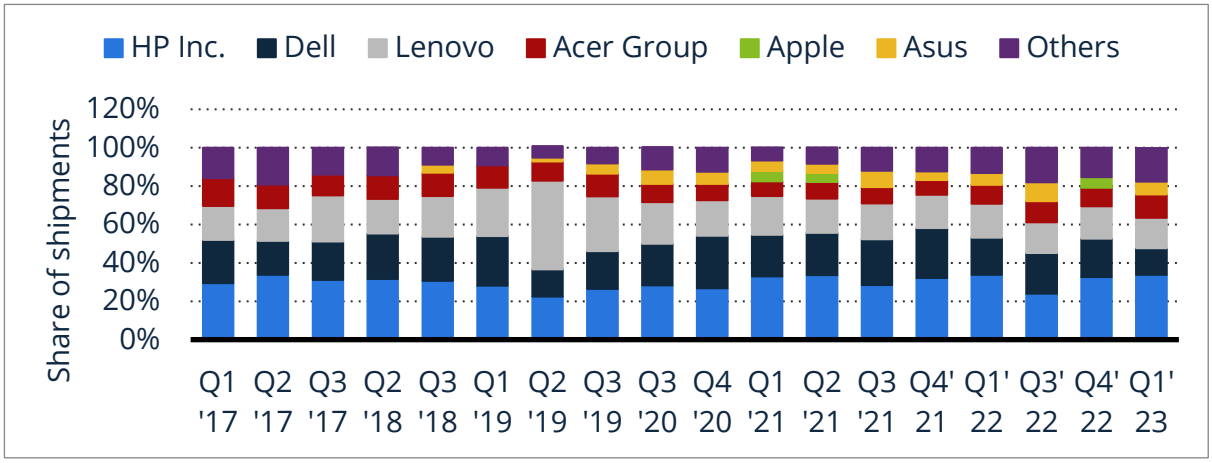


Number of personal computer shipments in India from FY 2019-22, by company

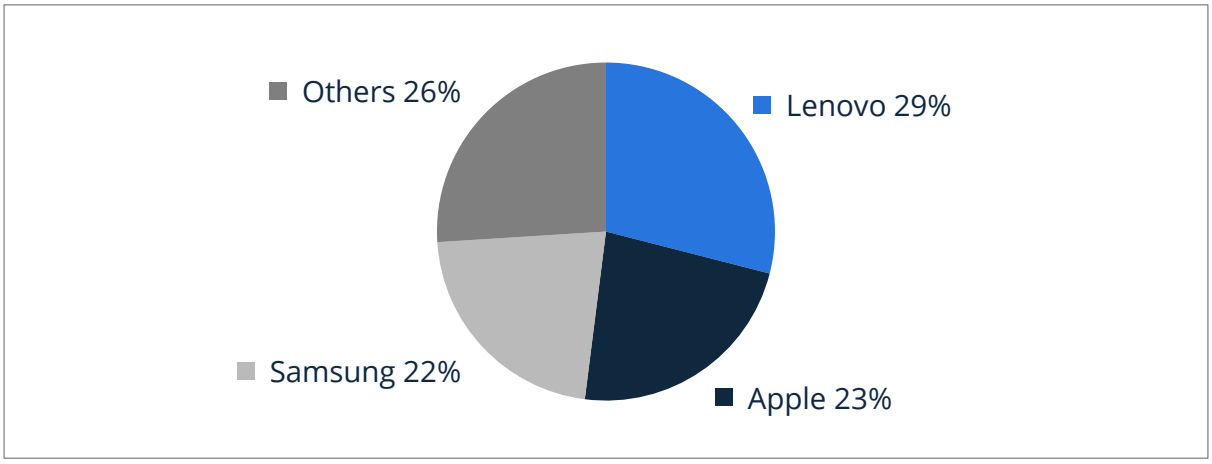
PC: Desktops, notebooks, and workstations excluding tablets



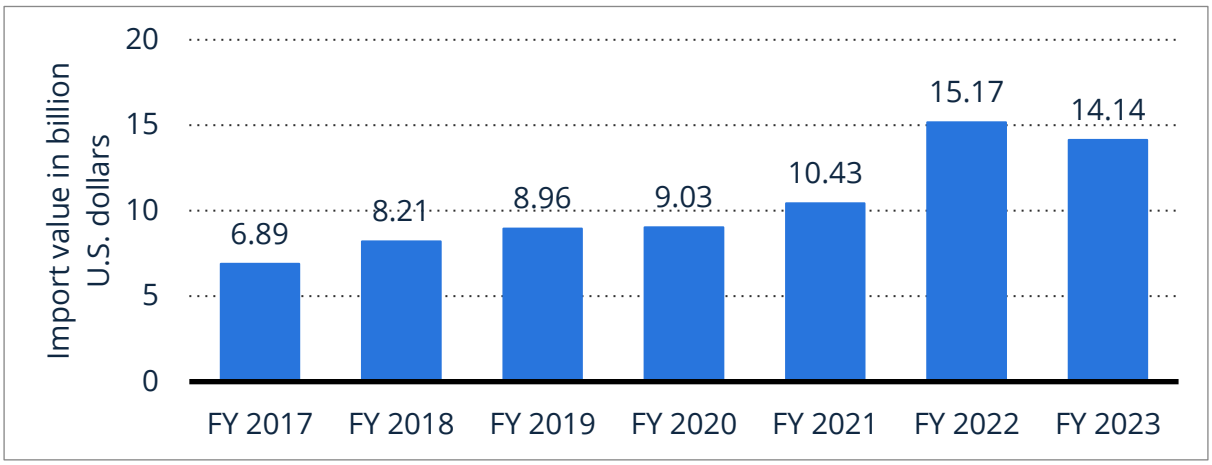
Market share of PC shipments in India Q1-2017 to Q1-2023, by vendor



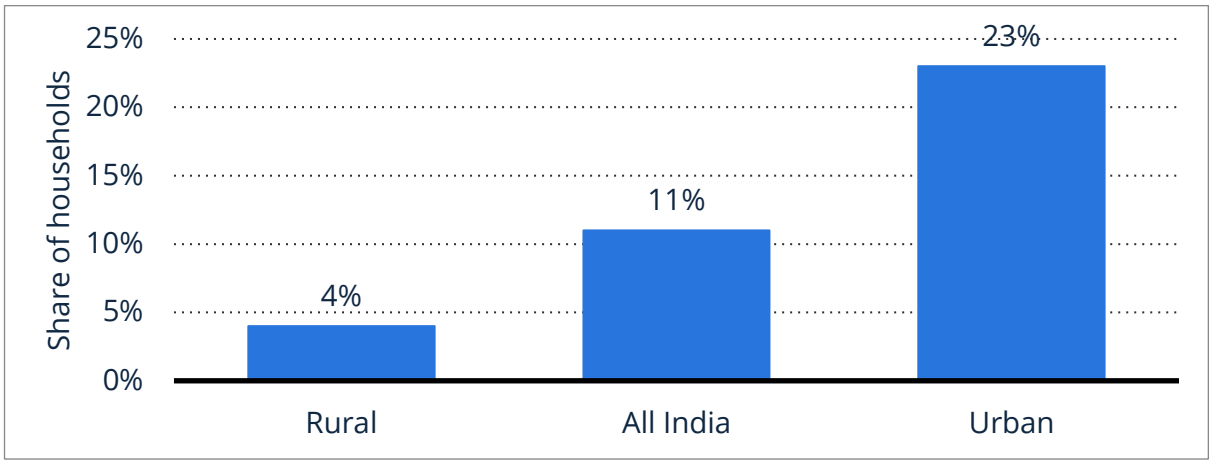
Market share of tablet shipments in India in 2022, by vendor



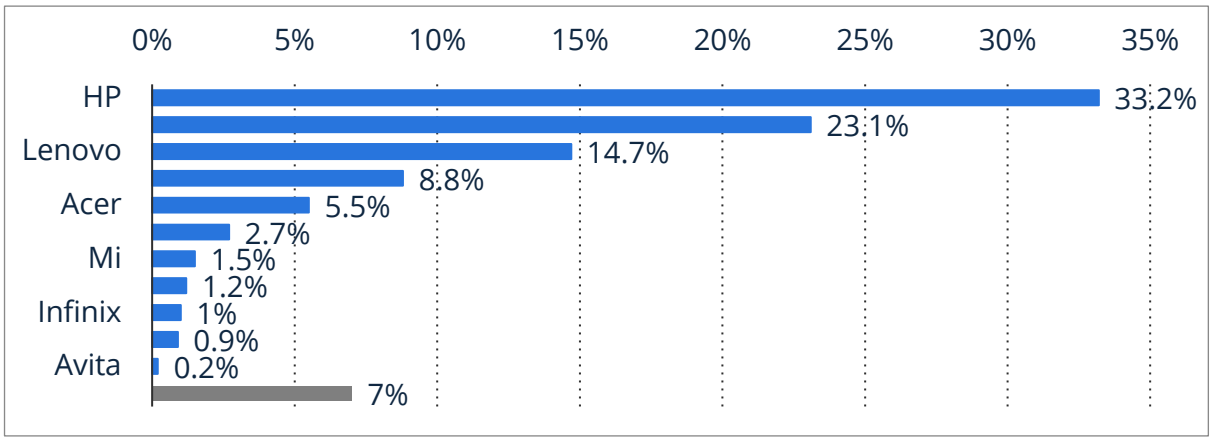
Value of computer hardware imported to India FY 2017-2023



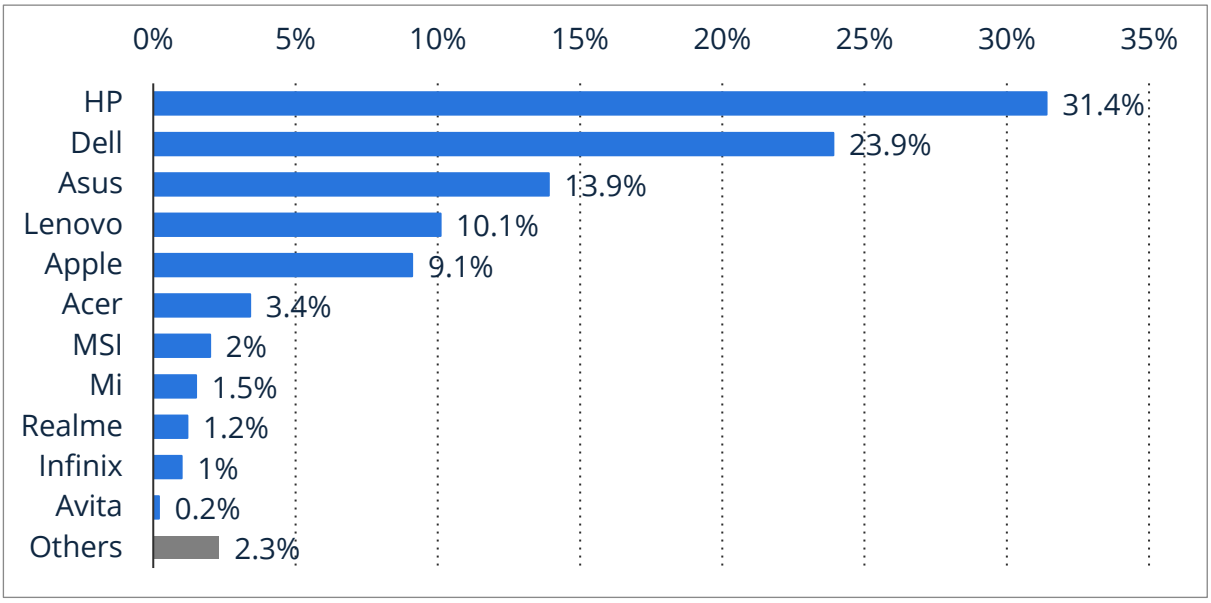
Share of households with access to computers India 2019, by region



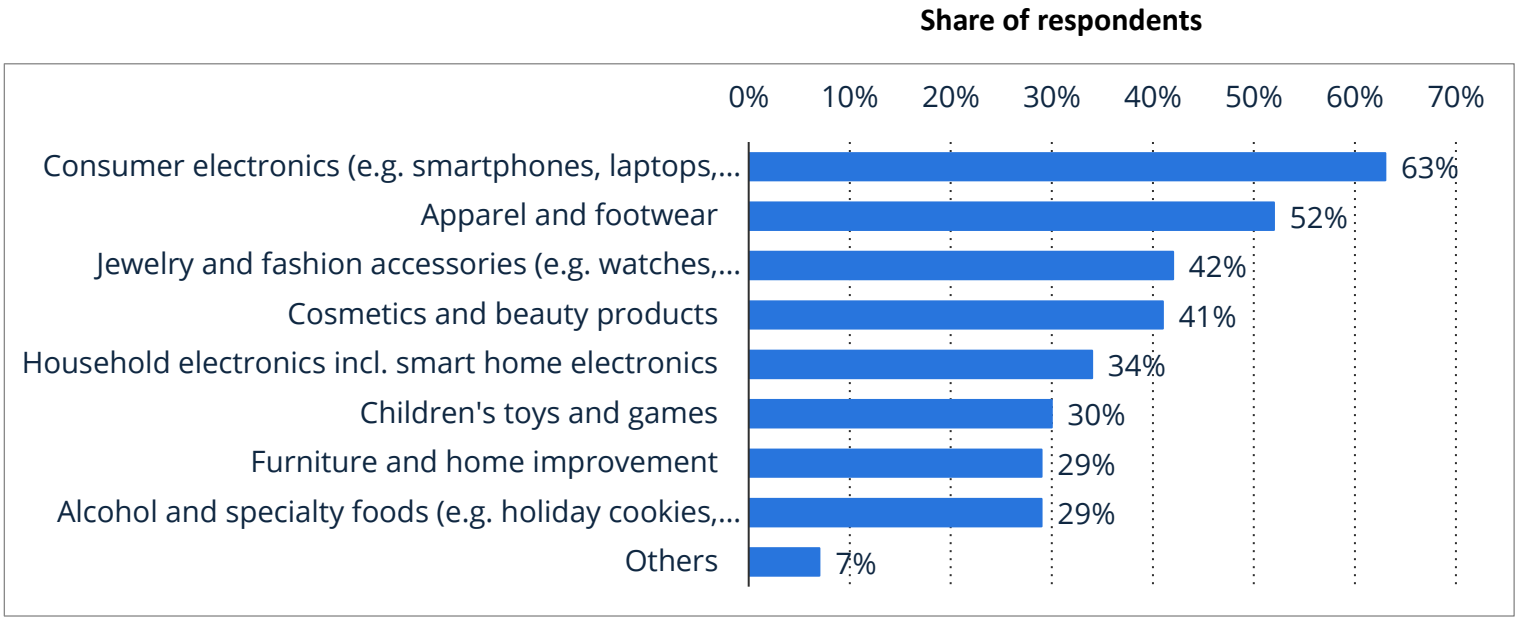
Laptop ownership in India 2023, by brand



Laptop future purchase preference in India 2023, by brand



Popular items among holiday shoppers India 2022



Fostering ecosystem for domestic manufacturing

In recent years, the global landscape for electronics manufacturing has undergone significant transformations. Countries in East Asia have risen as manufacturing giants, dominating the production of consumer electronics and high-tech components. China, Taiwan, and South Korea have become synonymous with electronic manufacturing excellence. In contrast, India, with its large market and tech-savvy workforce, has not realized its full potential in the electronics manufacturing sector.

This article delves into the critical issue of fostering an ecosystem for Indian domestic electronics manufacturing. It explores the challenges, opportunities, and policy measures needed to transform India into a global electronics manufacturing hub.

Challenges in Indian Electronics Manufacturing

The electronics manufacturing sector in India faces several challenges that hinder its growth and global competitiveness:

1. Supply Chain Gaps: The electronics manufacturing supply chain in India is fragmented and lacks integration. Critical components and materials are often imported, leading to supply chain vulnerabilities and dependencies on foreign markets.

2. Lack of Infrastructure: The absence of specialized electronic manufacturing zones with world-class infrastructure puts India at a disadvantage. The establishment of electronics manufacturing clusters is essential to attract global players.

3. Skilled Workforce: While India boasts a large pool of skilled engineers and IT professionals, the electronics manufacturing sector requires specific skill sets. Bridging the gap between academic qualifications and industry requirements is vital.

4. Regulatory Challenges: Cumbersome bureaucratic procedures, ambiguous regulations, and complex tax structures deter foreign and domestic investments in electronics manufacturing.

5. Intellectual Property Protection: Effective protection of intellectual property rights is crucial to attracting foreign investors and fostering innovation.

Opportunities in Indian Electronics Manufacturing

Despite these challenges, India holds enormous potential for electronics manufacturing. Several factors make India an attractive destination:

1. Large Consumer Base: India's booming middle class and increasing consumer demand for electronics products provide a vast domestic market.

2. Government Initiatives: The Indian government's "Make in India" campaign aims to boost domestic manufacturing. Initiatives such as "Digital India" and "Startup India" offer policy support and incentives.

3. Skilled Workforce: India's pool of engineers, researchers, and technology professionals can be harnessed for innovation and research in electronics manufacturing.

4. Rising Start-up Ecosystem: The thriving start-up ecosystem in India is fostering innovation and entrepreneurship in electronics manufacturing.

5. Green Manufacturing: Sustainable and eco-friendly manufacturing practices can provide a unique selling point for Indian electronics products.

Policy Measures for Fostering Electronics Manufacturing

To foster a conducive ecosystem for Indian domestic electronics manufacturing, several policy measures are essential:

1. Simplified Regulations: Streamlining regulatory processes, reducing bureaucratic red tape, and creating a single-window clearance system can attract foreign investments and facilitate ease of doing business.

2. Specialized Zones: The development of electronics manufacturing zones with state-of-the-art infrastructure and facilities can attract global electronics manufacturers.

3. Skill Development: Collaborating with academic institutions and industries to design specialized courses and skill development programs for electronics manufacturing will bridge the skills gap.

4. Research and Innovation: Promoting research and development activities in electronics manufacturing can enhance product quality and innovation.

5. Intellectual Property Rights: A robust intellectual property rights framework must be established to safeguard innovations and attract foreign investors.

6. Green Manufacturing: Encouraging sustainable and eco-friendly manufacturing practices can not only reduce environmental impact but also appeal to environmentally conscious consumers.

Role of Emerging Technologies

The integration of emerging technologies plays a pivotal role in fostering the ecosystem for Indian domestic electronics manufacturing:

1. Artificial Intelligence (AI): AI can optimize manufacturing processes, enhance quality control, and predict maintenance needs, leading to more efficient production.

2. Internet of Things (IoT): IoT can be employed to create connected devices, smart factories, and predictive maintenance systems, improving productivity and reducing downtime.

3. Robotics: The use of robotics in manufacturing can automate repetitive tasks, increasing efficiency and reducing labor costs.

4. 3D Printing: 3D printing enables rapid prototyping, customization, and the production of complex components with reduced waste.

5. Blockchain: Blockchain technology can enhance supply chain transparency, ensuring the authenticity and traceability of electronic components.

Global Collaboration

Collaboration with global electronics manufacturing giants can be instrumental in knowledge transfer and technology exchange. Partnerships with companies from East Asia and other manufacturing hubs can help India leapfrog the learning curve and accelerate its journey toward becoming a global electronics manufacturing hub.

The Role of Start-ups

Start-ups are integral to fostering an electronics manufacturing ecosystem. They bring innovation, agility, and disruptive ideas to the industry. The Indian government's "Startup India" initiative has created a favorable environment for entrepreneurial ventures in the electronics manufacturing sector. These start-ups can focus on niche areas, develop innovative products, and drive technological advancements.

Championing Green Manufacturing

The adoption of eco-friendly manufacturing practices is not just a moral imperative but also a market advantage. Consumers worldwide are increasingly conscious of the environmental impact of products they purchase. Indian manufacturers can differentiate themselves by implementing sustainable manufacturing processes, reducing waste, and minimizing energy consumption.

Creating an Integrated Supply Chain

A robust supply chain is the backbone of any successful electronics manufacturing ecosystem. It is imperative to reduce dependency on foreign suppliers for crucial components and materials. Creating a well-integrated supply chain within the country can enhance the resilience and competitiveness of Indian electronics manufacturers.

Promoting Export-Oriented Manufacturing

Exporting electronics products can significantly boost the Indian economy. The government should incentivize export-oriented manufacturing by offering tax breaks, export subsidies, and logistical support.

Fostering an ecosystem for Indian domestic electronics manufacturing is not just an economic imperative but also a strategic move to reduce dependency on imports and enhance national security. With the right policy measures, integration of emerging technologies, global collaboration, and a focus on green manufacturing, India can emerge as a formidable player in the global electronics manufacturing landscape. The growth of the electronics manufacturing sector will not only create jobs but also position India as a hub for innovation and technological excellence. It's time for India to seize the opportunity and establish itself as a global electronics manufacturing powerhouse.

Result and Discussion

To foster domestic electronics manufacturing systems, it becomes pivotal to understand the various enablers involved. Through the extensive review of literature incorporated with the expert's opinion, a total of fifteen enablers of the domestic manufacturing system have been identified in this study. This study exclusively analyzed the enablers of smart warehouse and their contextual interrelationships using ISM and MICMAC analysis.

The result helps prioritize and segregate the enablers, along with evaluating the interactions among them. Result revealed that all the identified enablers can be divided into two levels as per their relevance and contribution to the domestic manufacturing ecosystem.

Enablers A1(Industry specific incentives and Tax Holiday), A3(Technically skilled workforce), A4(R&D ecosystem and investment), A5(Facilitative infrastructural support), A7(Intellectual property regime), A8(International collaboration and energy transfer), A9(Quality consciousness and compliance), A10(Domestic demand and purchasing power), A14(Digital infrastructure and cybersecurity measures), A15(Supply chain integration with global firms) have the highest significance and hence are placed at Level 2.

Enabler A13(Sustainable Business Practices) is a dependent enabler which can be fostered via Government incentives, R&D support, CSR activities, and green supply chain management.

Rest of the enablers act as as linkage enablers which connect dependent enablers to potential independent enablers. Results further indicate that all enablers, except A6 and A13, have maximum driving power and therefore can influence multiple variables.

Finally, enablers in the Level 1 category, which get influenced by Level 2 category, include A2(enabling trade policy and facilitation), A6(Access to cheap capital and financing), A11(export promotion and facilitation), A12(ease of doing business), and A13(sustainable business practices). These enablers are critical as they enhance the efficiency of domestic manufacturing by reducing delays and costs, provide capital to invest in technology, and encourage investments via stable policy and enhanced market access.

Implications, limitations, and future scope

Implications:

The findings of this thesis hold significant implications for policymakers, industry stakeholders, and investors. Understanding the identified enablers is crucial for crafting targeted policies that can catalyze the growth of the domestic electronics manufacturing ecosystem. Policymakers can leverage insights to create a holistic framework that aligns industry-specific incentives, trade policies, and infrastructure development, fostering a conducive environment for sustainable growth.

Limitations:

While the study comprehensively explores various enablers, it may encounter limitations due to dynamic economic and geopolitical conditions. The effectiveness of identified enablers may vary over time, necessitating continuous evaluation and adaptation of policies. Additionally, regional variations and unforeseen global events could impact the applicability of certain enablers, requiring a nuanced approach to policy implementation.

Future Scope:

The research opens avenues for future investigations into the nuanced interplay among enablers and their evolving impact on the electronics manufacturing ecosystem. Further studies could delve into the effectiveness of specific policy interventions, the role of emerging technologies, and the impact of global trends on domestic manufacturing. Exploring adaptive strategies for sustained growth and resilience in the face of economic uncertainties presents an exciting avenue for future research in this dynamic field.

Conclusion

In conclusion, this thesis has meticulously examined the multifaceted landscape of enablers crucial for fostering a robust domestic electronics manufacturing ecosystem. Industry-specific incentives, well-crafted trade policies, and a skilled workforce lay the foundation for competitiveness and innovation. The emphasis on research and development, backed by supportive infrastructure and access to affordable capital, amplifies the industry's potential for growth and technological advancement. Intellectual property protection becomes imperative in ensuring sustained innovation, while international collaborations amplify the collective strength of the domestic electronics sector on the global stage.

Quality compliance, underpinned by adherence to international standards, not only bolsters the credibility of domestically manufactured electronics but also facilitates smoother access to international markets. The purchasing power of the domestic market emerges as a pivotal factor, driving demand and incentivizing manufacturers to scale up production. Export promotion, coupled with ease of doing business initiatives, encourages market diversification and attracts foreign investments, fostering a resilient and globally competitive manufacturing ecosystem.

Moreover, the integration of sustainability practices into the manufacturing processes is identified as an imperative enabler, aligning with global expectations for environmentally conscious production. Lastly, the significance of a robust digital infrastructure cannot be overstated, as it forms the backbone for modern manufacturing processes and facilitates the adoption of Industry 4.0 technologies.

In synthesizing these enablers, it becomes evident that a holistic and synergistic approach is necessary to propel the domestic electronics manufacturing ecosystem forward. Policymakers, industry leaders, and stakeholders must collaboratively work towards creating an environment where these enablers intersect, fostering an ecosystem that is not only resilient and competitive but also sustainable in the long term. The success of the domestic electronics manufacturing sector relies on the orchestrated orchestration of these key enablers, paving the way for a vibrant, self-sufficient, and globally acclaimed industry.

ISM Working

Structural Self-Interaction Matrix

I/J		Supply Chain Integration with Global Firms	Digital Infrastrucure and cybersecurity measures	Sustainable Business practices	Ease of doing business	Export Promotion and Facilitation	Domestic demand and purchasing power	Quality Consciousness and Compliance	International Collaborations and Technology transfer	Intellectual Property Regime	Access to Cheap Capital and Financing	Facilitative Infrastructural Support	R &D Ecosystem and Investments	Techincally Skilled Workforce	Enabling Trade Policy and Facilitation
		A15	**A14**	**A13**	**A12**	**A11**	**A10**	**A9**	**A8**	**A7**	**A6**	**A5**	**A4**	**A3**	**A2**
Industry Specific Incentives and Tax holidays (MAKE IN India)	**A1**	V	V	V	X	V	A	O	V	X	V	V	X	X	X
Enabling Trade Policy and Facilitation	**A2**	X	V	V	V	X	A	V	V	X	X	V	X	O	
Techincally Skilled Workforce	**A3**	X	X	V	X	X	A	X	A	O	O	X	A		
R &D Ecosystem and Investments	**A4**	X	V	V	V	V	O	V	X	X	O	X			
Facilitative Infrastructural Support	**A5**	X	V	V	X	V	O	V	A	A	O				
Access to Cheap Capital and Financing	**A6**	A	O	X	X	V	A	O	A	A					
Intellectual Property Regime	**A7**	X	X	V	V	V	V	V	X						
International Collaborations and Technology transfer	**A8**	X	V	V	V	V	V	V							
Quality Consciousness and Compliance	**A9**	X	O	V	V	V	O								
Domestic demand and purchasing power	**A10**	X	O	V	O	O									
Export Promotion and Facilitation	**A11**	X	A	V	V										
Ease of doing business	**A12**	X	X	V											
Sustainable Business practices	**A13**	A	A												
Digital Infrastrucure and cybersecurity measures	**A14**	X													

Initial Reachability Matrix

Names	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15
A1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1
A2	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1
A3	1	0	1	0	1	0	0	0	1	0	1	1	1	1	1
A4	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1
A5	0	0	1	1	1	0	0	0	1	0	1	1	1	1	1
A6	0	1	0	0	0	1	0	0	0	0	1	1	1	0	0
A7	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
A8	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1
A9	0	0	1	0	0	0	0	0	1	0	1	1	1	0	1
A10	1	1	1	0	0	1	0	0	0	1	0	0	1	0	1
A11	0	1	1	0	0	0	0	0	0	0	1	1	1	0	1
A12	1	0	1	0	1	1	0	0	0	0	0	1	1	1	1
A13	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0
A14	0	0	1	0	0	0	1	0	0	0	1	1	1	1	1
A15	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Final Reachability Matrix

Reference of the RStudio package used:

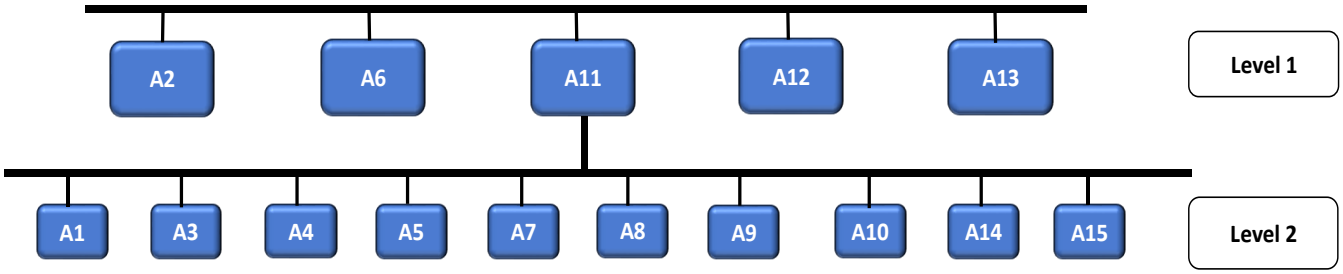
[AdarshAnand,GunjanBansal,(2017)"Interpretivestructuralmodellingforattributesofsoftwarequality",JournalofAdvancesinManagementResearch,Vol.14Issue:3,pp.256-269, https://doi.org/10.1108/JAMR-11-2016-0097]

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15		Driving Power
A1	1	1	1	1	1	1	1	1	*1*	*1*	1	1	1	1	1		15
A2	1	1	*1*	1	1	1	1	1	1	*1*	1	1	1	1	1		15
A3	1	*1*	1	*1*	1	*1*	*1*	*1*	1	*1*	1	1	1	1	1		15
A4	1	1	1	1	1	*1*	1	1	1	*1*	1	1	1	1	1		15
A5	*1*	*1*	1	1	1	*1*	*1*	*1*	1	*1*	1	1	1	1	1		15
A6	*1*	1	*1*	*1*	*1*	1	*1*	*1*	*1*	0	1	1	1	*1*	*1*		14
A7	1	1	*1*	1	1	1	1	1	1	1	1	1	1	1	1		15
A8	*1*	*1*	1	1	1	1	1	1	1	1	1	1	1	1	1		15
A9	*1*	*1*	1	*1*	*1*	*1*	*1*	*1*	1	*1*	1	1	1	*1*	1		15
A10	1	1	1	*1*	*1*	1	*1*	*1*	*1*	1	*1*	*1*	1	*1*	1		15
A11	*1*	1	1	*1*	*1*	*1*	*1*	*1*	*1*	*1*	1	1	1	*1*	1		15
A12	1	*1*	1	*1*	1	1	*1*	*1*	*1*	*1*	*1*	1	1	1	1		15
A13	0	*1*	0	0	0	1	0	0	0	0	*1*	*1*	1	0	0		5
A14	*1*	*1*	1	*1*	*1*	*1*	1	*1*	*1*	*1*	1	1	1	1	1		15
A15	*1*	1	1	1	1	1	1	1	1	1	1	1	1	1	1		15
Dependence Power	14	15	14	14	14	15	14	14	14	13	15	15	15	14	14		

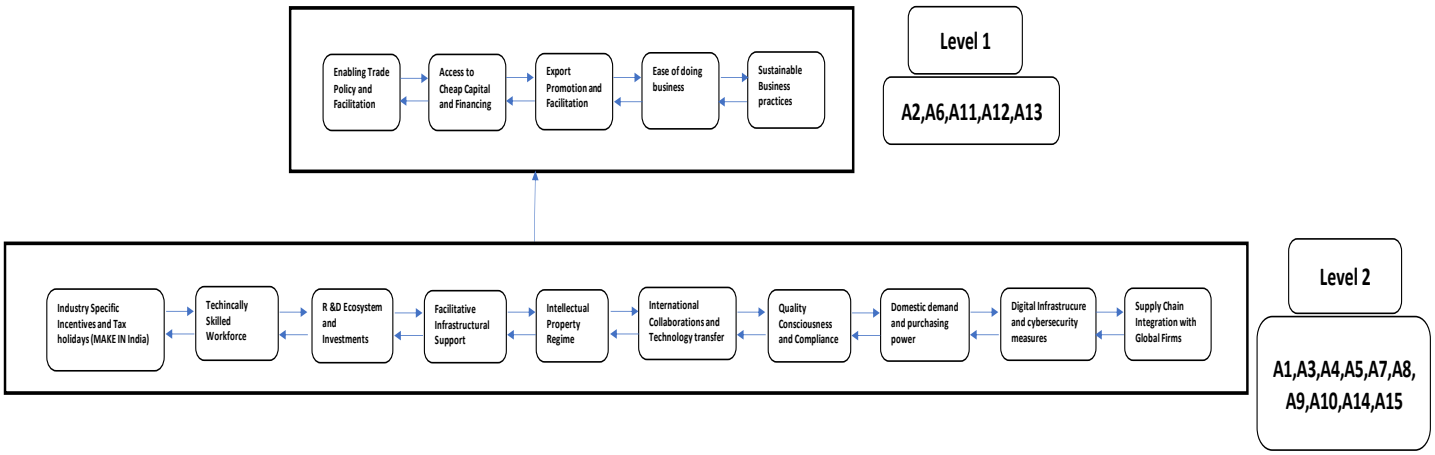
Level Partition

Variable_Names	**Reachability_Set**	**Antecedents_Set**	**Intersection_Set**	**Level**
A1	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	**2**
A2	A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11 A12 A13 A14 A15	A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11 A12 A13 A14 A15	A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11 A12 A13 A14 A15	**1**
A3	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	**2**
A4	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	**2**
A5	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	**2**
A6	A1 A2 A3 A4 A5 A6 A7 A8 A9 A11 A12 A13 A14 A15	A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11 A12 A13 A14 A15	A1 A2 A3 A4 A5 A6 A7 A8 A9 A11 A12 A13 A14 A15	**1**
A7	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	**2**
A8	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	**2**
A9	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	**2**
A10	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	**2**
A11	A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11 A12 A13 A14 A15	A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11 A12 A13 A14 A15	A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11 A12 A13 A14 A15	**1**
A12	A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11 A12 A13 A14 A15	A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11 A12 A13 A14 A15	A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11 A12 A13 A14 A15	**1**
A13	A2 A6 A11 A12 A13	A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11 A12 A13 A14 A15	A2 A6 A11 A12 A13	**1**
A14	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	**2**
A15	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	A1 A3 A4 A5 A7 A8 A9 A10 A14 A15	**2**

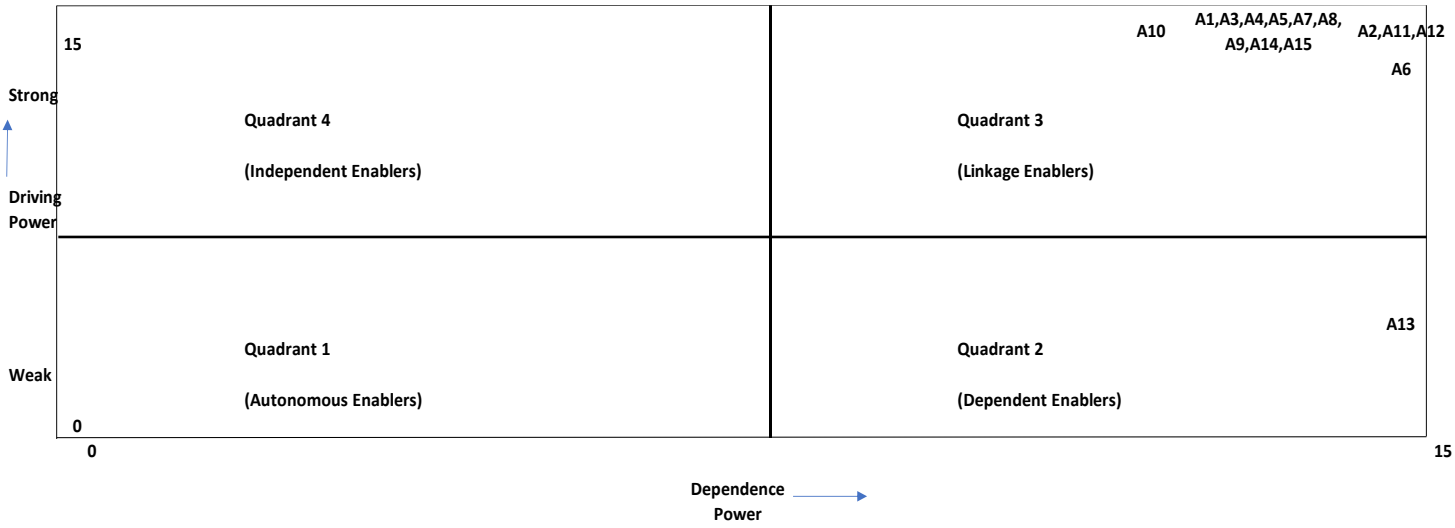
Diagraph



Conceptual Model



MICMAC


15
Strong
Driving
Power
Quadrant 4
(Independent Enablers)
A10
A1,A3,A4,A5,A7,A8,
A9,A14,A15
A2,A11,A12
A6
Quadrant 3
(Linkage Enablers)
A13
Quadrant 1
(Autonomous Enablers)
Weak
Quadrant 2
(Dependent Enablers)
0
0
15
Dependence
Power